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# IJISPM



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The mission of the IJISPM – International Journal of Information Systems and Project Management – is the dissemination of new scientific knowledge on information systems management and project management, encouraging further progress in theory and practice.

The IJISPM publishes leading scholarly and practical research articles that aim to advance the information systems management and project management fields of knowledge, featuring state-of-the-art research, theories, approaches, methodologies, techniques, and applications.

The journal serves academics, practitioners, chief information officers, project managers, consultants, and senior executives of organizations, establishing an effective communication channel between them.

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The journal content provides relevant information to researchers, practitioners, and organizations, and includes original qualitative or qualitative articles, as well as purely conceptual or theoretical articles. Due to the integrative and interdisciplinary nature of information systems and project management, the journal may publish articles from a number of other disciplines, including strategic management, psychology, organizational behavior, sociology, economics, among others. Articles are selected for publication based on their relevance, rigor, clarity, novelty, and contribution to further development and research.

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All correspondence and questions should be directed to João Varajão (Editor-in-Chief).

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**International Journal of Information Systems and Project Management (IJISPM)**
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# EDITORIAL

It is our great pleasure to bring you the first number of the 13th volume of IJISPM. In this issue, readers will find important contributions on information systems project management mentoring, digital transformation projects, blockchain adoption, and teamwork in virtual project teams.

## Mentoring adoption across the information systems project management process: Perceptions of IS project managers

B Tan, Paul TM Leong

*To-date, there appears to be a dearth of information systems (IS) project management mentoring research relating to mentoring practices across the IS project management process. This study contributes to our understanding of the nature of mentoring practices in IS projects. Practicing IS project managers in multinational companies were asked about their mentoring experiences. Findings were based on data collected via a web-based descriptive survey. Four key observations were noted. Mentoring practice adoption was perceived as positive. Practicing IS project managers were cognizant of the benefits that can accrue from mentoring adoption. The drive for project success was a key motivation. Adoption was more expedient and forthcoming in an informal relationship situation. Overall, mentoring was perceived to enhance IS project management practice. The paper concludes by providing some directions for future research.*

## A structured taxonomy for effective digital transformation project implementation: Development, validation, and practical insights

Rahnuma Tarannum, Bertha Joseph Ngereja, Bassam Hussein

*The aim of this study was to develop and validate a taxonomy designed to assist organizations in formulating their Digital Transformation Project implementation strategies. In creating this taxonomy, we sought to blend both conceptual frameworks and empirical data. The initial phase involved a scoping review that synthesized existing literature to lay the foundation for the taxonomy. Subsequently, we aimed to validate the taxonomy by gathering feedback from industry experts in Germany using a closed card sorting technique, complemented by case study analysis. This structured compilation of information regarding implementation strategies, presented through the taxonomy, simplifies the process for practitioners. Such a taxonomy enables practitioners to adopt a standardized vocabulary, which supports decision-making, encourages learning from previous successes and challenges, and facilitates the application of these lessons to their projects. Additionally, we have included practical case scenarios within the taxonomy, offering guidance for organizations on leveraging it in the execution of digital transformation projects.*

## Blockchain adoption factors

Carlos Bernardino, Francisco Cesário, Carlos J. Costa, Manuela Aparicio, João Tiago Aparicio

*Blockchain technology is a distributed ledger that promises transformative changes across various sectors, yet its adoption and integrations in small and medium-sized organizations remain limited. This study investigates the factors that influence the adoption of blockchain technology, emphasizing the significance of Trust and Security as key moderators. Using a questionnaire distributed to a diverse group of employees and analyzing responses through Structural Equation Modeling (SEM-PLS), we constructed a predictive model of blockchain adoption. Our analysis reveals that Performance Expectancy and Social Influence positively affect the intention to adopt blockchain, indicating that perceived effectiveness and peer support drive adoption. Trust significantly enhances this intention, underscoring the importance of confidence in the*

*technology's reliability and security. Environmental Concerns present a barrier, suggesting sustainability perceptions can deter adoption. This study conclusively demonstrates that promoting trust, addressing environmental sustainability, and leveraging social influence are pivotal for accelerating blockchain adoption in small and medium-sized organizations.*

### Measuring and predicting teamwork quality in virtual project teams

Markus Behn, Gilbert Silvius

*More and more members of project organizations collaborate in virtual teams. Due to globalization and more recently driven by the impact of the Covid-19 pandemic, the number of virtual project team members grew significantly, and many leaders look for key factors which allow virtual teams to reach a higher level of Teamwork Quality. This article summarizes previous investigations to develop a measuring instrument for both Teamwork Quality and potential predictors. Based on a literature review a conceptual model with 30 salient items measuring ten latent predictors as well as one latent concept for Teamwork Quality has been developed and transformed into a survey. The questionnaire was shared online and completed by 211 members of virtual project teams. Afterwards an Explorative Factor Analysis as well as a Reliability Analysis have been performed to explore the structure of the items. The result suggested one dependent measure for Teamwork Quality in virtual project teams and three latent predictors. These factors have been included into a Structural Equation Model and have been supported by a Confirmatory Factor Analysis. The steps described led to three factors (Personal Commitment, Team Balance & Mutual Support, Result Orientation) that have an influence on the latent variable "Willingness to succeed".*

We would like to take this opportunity to express our gratitude to the distinguished members of the Editorial Board, for their commitment and for sharing their knowledge and experience in supporting the IJISPM. Special thanks to professors Alberto Rodrigues da Silva, Miguel Mira da Silva and Jacinto Estima, who collaborated in editing this issue by inviting two selected best articles from the International Conference on Information Systems Development (ISD 2023).

Finally, we would like to express our gratitude to all the authors who submitted their work for their insightful visions and valuable contributions.

We hope that you, the readers, find the International Journal of Information Systems and Project Management an interesting and valuable source of information for your continued work.

The Editor-in-Chief,

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RESEARCH ARTICLE

# Mentoring adoption across the information systems project management process: Perceptions of IS project managers

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## Abstract

To-date, there appears to be a dearth of information systems (IS) project management mentoring research relating to mentoring practices across the IS project management process. This study contributes to our understanding of the nature of mentoring practices in IS projects. Practicing IS project managers in multinational companies were asked about their mentoring experiences. Findings were based on data collected via a web-based descriptive survey. Four key observations were noted. Mentoring practice adoption was perceived as positive. Practicing IS project managers were cognizant of the benefits that can accrue from mentoring adoption. The drive for project success was a key motivation. Adoption was more expedient and forthcoming in an informal relationship situation. Overall, mentoring was perceived to enhance IS project management practice. The paper concludes by providing some directions for future research.

## Keywords

IS project management mentoring adoption; characteristics of mentoring practice; project success; descriptive survey.

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## 1. Introduction

The use of mentoring in organizations to support individuals' professional development is not uncommon. The value of mentoring has long been emphasized in the workplace (Griffiths et al., 2018; Maheshwari et al., 2023; Swap et al., 2001). The pervasiveness of mentoring adoption has been reported in many disciplines, including management, academia, counselling, social work, sociology, and medicine and health care (Swap et al., 2001; Jakubik et al., 2017; Lleó et al., 2018; Mullen & Klimaitis, 2021).

Equally, mentoring plays an important role in IS project management practices. For instance, the adoption of mentoring in project management practices is exemplified in the New York State Government Office of Information Technology Services' Project Management Guidebook (New York State IT Services, Feb 22 2024) and in the advocacy of the Project Management Institute (www.pmi.org). These two organizations encourage the practice of project management mentoring through purposeful adoption. Mentoring relationships provide a platform to utilize limited resources in a productive manner. They facilitate the up-skilling of project managers and team members through experiential-based learning (Gustafson & Darragh, 2023).

Despite the value and pervasiveness of mentoring, there appears to be a paucity of research on mentoring practices across the IS project management process. This paper presents the results of a descriptive survey which assessed the landscape of mentoring practice adoption. In the context of this study, mentoring practice adoption refers to the nature and characteristics of mentoring adoption as experienced and perceived by practicing IS project managers across the IS project management process.

This study aims to contribute to a better understanding of mentoring by way of providing an assessment of its practices informed by the experiences and perceptions of practicing IS project managers in multinational companies. It focuses on the 'whats' and 'whys' of mentoring adoption across the IS project management process. Broadly, the 'whats' relate to the general attitude/outlook of the survey participants towards mentoring adoption. This includes their attitudes towards mentoring practice, their understanding of mentoring and adoption characteristics, perceived obstacles to adoption, and lastly the advice of IS project managers to intending adopters. In terms of the 'whys' of mentoring adoption – the reasons/rationale why IS project managers adopted mentoring, why IS project managers were motivated to adopt mentoring, and lastly the benefits that result from adoption.

Consequently, the two research questions guiding this study are - What are the perceptions of IS project managers towards the adoption of mentoring? Why are mentoring practices being adopted by IS project managers?

This study contributes to the extant literature by shedding some light on mentoring adoption in IS project management practice. The participating IS project managers perceive mentoring can enhance the practice of IS project management and that mentoring can be more expedient and forthcoming when conducted in an informal relationship. Mentoring enhances the translation of tacit knowledge into knowledge that is more explicit and definite. IS project management mentoring not only facilitates solutions to project problems at hand but also prepares IS project managers for future projects. Evidence of the professional development of the IS project managers in this study is clear; and better career development is an underlining consideration that motivates practicing IS project managers in the adoption of mentoring. In addition, based on the findings, this study recommends some future research opportunities.

The next section of this paper considers mentoring literature in the context of process improvements in the IS project management process. It is followed by a section describing the research method and participants. The empirical findings of this study are then presented in the form of a report on mentoring practices and this is followed by a discussion of the results. The paper concludes by highlighting possible future research on the topic.

## 2. Related research

Competencies of project managers are considered a key success factor in the effective management of IS projects (Ochoa Pacheco et al., 2023). IS project managers play a critical role; of which, they are responsible for making critical project decisions. As such, prior experiences can improve project success. Awareness of potential pitfalls and learning from past mistakes can be very helpful.

This study is cognizant of prior research related to the roles of mentors and mentoring (as opposed to the adoption of mentoring practice) that have appeared in the IS literature. Examples include the review study by Stray et al. (2020) that noted the growth and importance of mentors (often called coaches) in the Agile community, and the study by Santos et al. (2007) that considered the role of mentoring in the project execution phase in Software Process Improvement (SPI).

Many other studies identified specific benefits of mentoring and the role of mentoring in IS projects, for example:

- Mentoring has played an integral part in the professional development of women and minorities in computing (Burrell & Nobles, 2018);
- Implicit (a form of informal) mentoring is useful in open-source development (Feng et al., 2022);
- Mentoring contributed to the onboarding of newcomers in agile project teams (Gregory et al., 2022);
- Mentoring is multi-faceted combining training, in project guidance and offline hand-holding (Ramaswamy, 2001).

Mentoring has also received significant attention in the broader management, leadership and organizational studies literature. In recent years, there have been several review articles on mentoring in organizations. For instance, in educational leadership (Mullen & Klimaitis, 2021); in workplace mentoring (Ivey & Dupré, 2022); and in employee development (Wahdiniawati & Sarinastiti, 2023). These reviews highlighted mentoring articles in many domains including school / higher education, medicine / nursing, sports management / coaching, and also in vulnerable and minority communities. Mentoring is also well documented in the disciplines of psychology, counselling, social work and sociology (Maker Castro & Cohen, 2021; Keller et al. 2020).

Despite the widespread practice of mentoring, empirical studies of mentoring in various contexts remain low to date. The study by Amanda and Akpana (2023) on mentoring and employee productivity in organizations was motivated by a dearth of documented empirical studies on how mentoring in terms of career support, psychological support, and information sharing influence employees' productivity. In another study, the author expressed little attention has been paid to understanding the lived experiences of law advocates regarding mentoring, in particular, what it meant to both mentors and mentees, how mentoring was practiced and the associated challenges (Wilson, 2022). There is also a limited understanding of the critical mentoring (relational) processes that generate lasting benefits for young mentees which Goldner and Ben-Eliyahu attempted to address in their recent study (Goldner & Ben-Eliyahu, 2021).

Overall, mentoring-related research adds up to less than the sum of its parts. To this end, studies in relevant contextual domains have progressed on an incremental basis while core concepts and theory have attracted relatively little attention.

In the IS project management area and in spite of the evidence that mentoring practice adoption and associated project success improvement can benefit both IS project managers and the IS professionals (as alluded to earlier in this section), there is relative paucity of empirical research into the mentoring adoption and practice in support of the IS project management process. As observed in the broader disciplines mentioned above, mentoring can be expected to also contribute prominently in IS project management. This study therefore seeks to address the gap in our understanding of this context through a study of IS project managers.

## 3. The Research Method

As the aim of this research is to describe and better understand the nature and characteristics of mentoring across the IS project management process, a descriptive survey is adopted. This method is employed given the desire to further understand the experiences and perceptions of practicing IS project managers who are mentees learning from, and being guided by, a (usually) more experienced individual or group of individuals. The intent is to derive maximum meaning from the experiences and perceptions of the practicing IS project managers regarding the adoption of mentoring across the IS project management process. It enables us to identify key attributes, such as the attitudes of IS project managers to mentoring practice and their knowledge and understanding of mentoring as a practice, as well as the characteristics of mentoring adoption. It also supports our investigation of the experiences and perceptions of practicing IS project managers with regard to the obstacles to adoption, and their advice to intending adopters.

The descriptive survey research method is generally considered appropriate for gathering broad-based practice information such as sought in this study. It has been used previously in IS and mentoring studies. For example, a requirements engineering study used a web-based descriptive survey research approach on the common practices, approaches, and techniques of the software development industry (Neill & Laplante, 2003) and a descriptive survey was employed in a study of mentoring for change in teacher technology education (Ward et al., 2002).

As the study is descriptive in nature (i.e. neither theory building nor theory testing), the survey questions do not follow any conceptual framework/model; but rather are framed along the broad dimensions of: rationale for adoption of mentoring; characteristics of adoption of mentoring; perceived benefits; barriers/obstacles; and recommendations for intending adopters. These were drawn from the literature (both academic and practitioner).

Appendix A presents the survey instrument designed to determine broad adoption patterns and characteristics. It contains mainly closed questions but for some questions, some free text input is permitted. This free text option in some questions allows participants to further expand on the answers to selected survey questions or to provide a response where none of the options outlined fits. The closed questions were simple branching type question with a 'yes' or 'no' answer; multiple-choice type question with one or many mandatory selection(s); and multiple-choice type question with an option for the participants to insert personalized inputs and complete Likert multi-point scales where they are asked to select a preferred option on a scale of 'Strongly Agree', 'Agree', 'Neither', 'Disagree' or 'Strongly Disagree'.

To fine-tune the survey instrument, pre-testing was carried out with five IS project managers. Feedback and suggestions were solicited during pre-test to ensure clarity of the questionnaire and survey instructions. The responses from the pre-test were excluded from the final results. In anticipation of the busy schedules of the participating IS project managers, the survey was designed to take approximately 15-20 minutes to complete.

The research participants in this study (including the pre-test) were selected from 87 multinational corporations (MNCs) that were based in Malaysia's Multimedia Super Corridor (MSC). MSC Malaysia is a special economic zone and a high-technology business district spanning the federal territories of Kuala Lumpur and Putrajaya, central-southern Selangor and parts of western Negeri Sembilan. We anticipate being able to secure a reasonable number of responses to our email survey invite from MNCs located in the MSC given businesses in the MSC are in the high-technology sector. Twenty-six of the 87 MNCs participated in the survey. The listed industry categories of these MNCs and the numbers of participants in each category are shown in Figure 1.


Fig. 1. Industry categories of participating MNCs

(with number of participating IS project managers indicated)

A total of 46 IS project management practitioners completed the survey. The profile of the research participants can be found in Appendix B. At the time of the survey, 27 of the participants described themselves as practicing IS project managers, i.e. they took the lead role in project management. Fifteen described themselves as having taken the lead role in project management in previous projects. Nine participants did not describe themselves as having taken (or currently taking) the lead role in project management and/or indicated no prior or current experience of mentoring adoption. As such, the nine participants did not complete the section of the survey designed to gather IS project managers' experiences of mentoring adoption (i.e. questions 20, 21, 23, 24, 25 and 26). This explains why responses to the survey questions were aggregated as being from either 46 or 37 participants.

As the methodology employed is a descriptive survey, the responses were analyzed and presented in aggregated form; wherein data for both the open and closed questions are categorized and aggregated into charts such as histograms and bar charts. In other words, simple frequency counts of responses are employed. These representations were used together with excerpts from participants' responses to open-ended questions to examine and analyze the landscape of mentoring adoption in IS projects.

## 4. Findings: Characteristics of mentoring practice in IS project management

In this section, the landscape of mentoring adoption across the IS project management process is reported. It is essentially an assessment of the state of mentoring practice i.e. the 'whats' and 'whys' of mentoring adoption; beginning with the 'whats' and then progressing to the 'whys'.

### *4.1. Mentoring practice adoption – the 'Whats'*

Overall, the results of the survey analysis highlighted a generally positive attitude towards mentoring. The general perception was that mentoring was an effective means to develop one's potential. This overall positive attitude was affirmed in the recommendations the participating IS project managers offered to those intending to adopt mentoring.

### *4.1.1 Attitude and mentoring knowledge of IS project managers*

Tabulation of the responses in Figure 2 shows that no negativity was evident in the participants' responses to the question 'What is your general attitude towards mentoring?', where 9 out of the 46 participants had a neutral stance towards mentoring. The remaining 37 participants (about 80%) ranked themselves as having a positive (21 out of 46) or very positive (16 out of 46) attitude towards mentoring. Generally, the participants appeared positive towards mentoring; and this may also be said of their attitude towards the adoption of mentoring in a project environment.

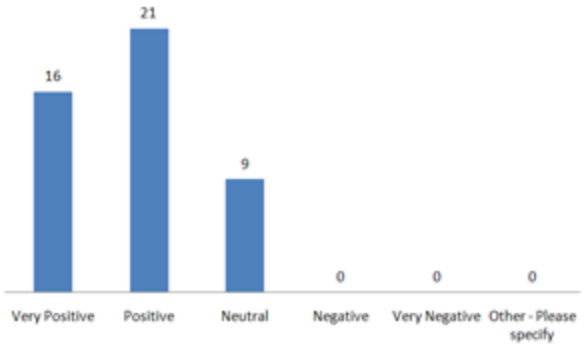


Fig. 2. General attitudes towards mentoring

The number of participating IS project managers that considered themselves as having poor knowledge of the subject of mentoring is small (4 out of the 46 participants). Similarly, and as shown in Figure 3, the number of participating IS project managers that considered themselves as having excellent knowledge of the subject of mentoring is also small (3 out of 46). Just a single participant indicated that had no knowledge of the subject of mentoring. Overall, the majority of the participating IS project managers (38 out of 46 i.e. more than 80%) rated themselves as having reasonable knowledge on the subject of mentoring. The breakdown of these 38 IS project managers is 15 and 23, and respectively each indicates very good and moderate knowledge. Overall, it can be said that most of the participating IS project managers considered themselves to be knowledgeable about mentoring.

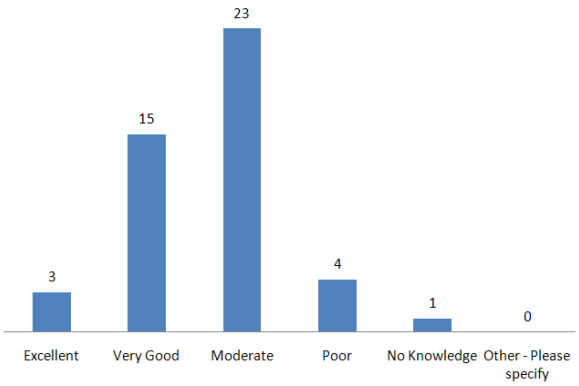


Fig. 3. Knowledge of mentoring - IS project manager self-rating

Figure 4 shows the breakdown of the selection votes received for each of the sources of information. In response to a question on the source of information regarding their mentoring knowledge (which allowed for selection of multiple sources), 'University or institution of higher learning' attracted only five votes of the total of 131 votes received. 'Personal experience' attracted the highest number of votes (40 out of 131). This is followed by 'Observing others in my work unit' (25 out of 131), 'Discussion with peers' (24 out of 131) and 'Reading about it' (23 out of 131). These results emphasized the importance of self-exploration, practice-based learning and anecdotal knowledge in the participants' knowledge of mentoring, which together (the top four) accounted for over 85% of the responses. This may be suggestive of high self-interest and also alludes to a high sense of awareness towards the positives of mentoring relationships. In contrast, few acquired mentoring knowledge through the 'Internet' (12 votes) and very few participants acquired mentoring knowledge (5 votes) during their university education.

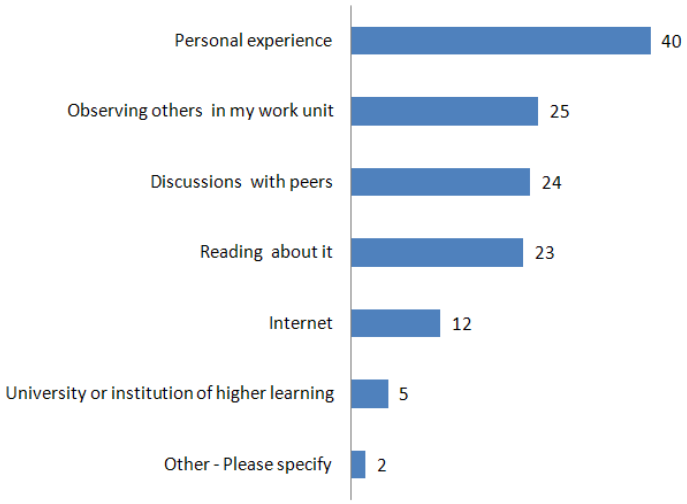


Fig. 4. Mentoring knowledge - sources of information

Two free-format responses were received in response to this survey question. They were 'in-house training courses and materials' and 'thought it is a good idea'. The first response of 'in-house training' indicates a likelihood that organizations recognized the importance and relevance of mentoring to their IS project managers. The second response may not provide a clear answer to the question but nevertheless it was a positive inclination towards mentoring adoption rather than a negative one.

### *4.1.2 IS project managers' general perception of mentoring*

Responses to a question seeking to reveal project managers' views on the role of mentoring across the IS project management process were dominated by two perceptions. The first was that mentoring was an effective method for the general improvement of IS project managers; and the second was that mentoring is better adopted using a spontaneous approach. These options each received 32 and 24 votes respectively out of the 71 casted (note that selection of multiple options was permitted). In contrast, the remaining options selected are illustrated in Figure 5 and they each received 5 or fewer votes. The implications of these additional responses were that mentoring is not as effective when one's immediate superior is involved and the yardstick of mentoring may not necessarily be based on whether IS project managers are of 'high potential' or otherwise.

Three free-format responses to this open-ended survey question were received. They were:

- 'Mentoring cramps the style of the IS project manager',
- 'Develops not only hard skills but more importantly the soft skills as well', and
- 'Mentoring is for the successful completion of a complicated, high-end project'.

The first free-format response seems negative, as it appears that mentoring can possibly constrain an individual's style and approaches taken in the management of projects. The second response appears to incline towards individual self-improvement; whereas the third response suggests that mentoring can possibly contribute towards improving IS project success.

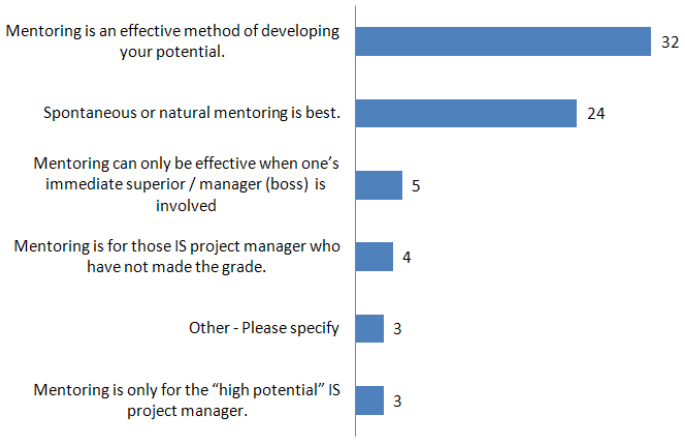


Fig. 5. General perceptions of mentoring

### *4.1.3 Adoption characteristics*

Thirteen adoption characteristics drawn from the literature were put to survey participants who were asked to complete a Likert scale from 'Strongly Disagree' to 'Strongly Agree' indicating the extent of their agreement regarding each characteristic. Figure 6 shows the participating IS project managers' responses to these mentoring characteristics categorized by Disagree (includes both Disagree and Strongly Disagree), Neither and Agree (includes both Agree and Strongly Agree).

The most agreed-with mentoring characteristic was that of 'a trusted and confidence adoption relationship' (35 out of 37 participants, or around 94%); of whom 7 were that of 'Strongly Agree'. Broadly, this reflected the importance of a trusted mentor-mentee relationship.

The next three most agreed-with characteristics were:

- An informal and on an as-required basis;
- A learning-to-do (i.e. apprenticeship) approach;
- Driven by business domain knowledge.

These characteristics were agreed with by a minimum of 31 (out of 37) participants. The mentor and mentee being the same gender did not seem to be significant in the adoption process – this characteristic was agreed with by only one (out of 37) participant. In fact, 22 (out of 37) participants disagreed with this option, with 14 (out of 37) indicating neutrality.

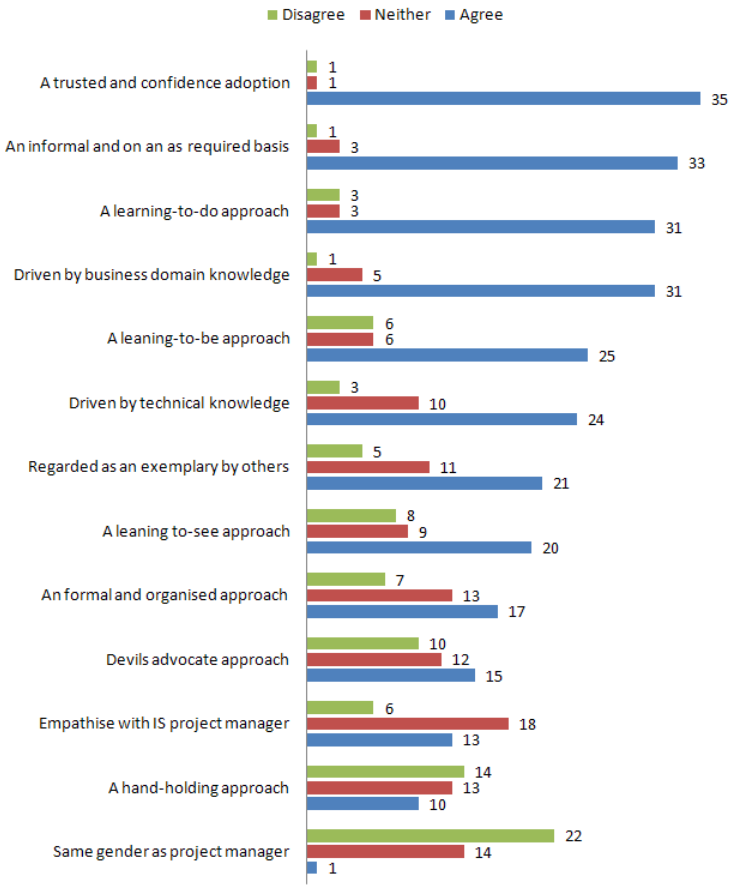


Fig. 6. Mentoring adoption characteristics

*Note: The figures for 'Agree' above are the sum of the 'Agree' and 'Strongly Agree' survey responses; the figures for 'Disagree' above are the sum of the 'Disagree' and 'Strongly Disagree' survey responses. This applies to the discussion of all Likert scale-type questions in this paper.*

The remaining eight adoption characteristics received mixed responses; they are listed below in the order of level of agreement:

- A learning-to-be approach;
- Driven by technical knowledge;
- Regarded as exemplary;
- A learning to-see approach;
- A formal and organized approach;
- Devil's advocate approach;
- Empathize with IS project manager;
- A hand-holding approach.

Overall, the four most agreed-with mentoring adoption characteristics reflected learning by observation of more experienced individuals and the importance of technical knowledge. In contrast, the four least agreed-with mentoring adoption characteristics reflected that of a formal and organized approach with elements of project mentors playing the role of a devil's advocate requiring empathy or a handholding approach.

### *4.1.4 Resistance to adoption*

When the participants were asked to rate the barriers they faced in mentoring adoption on the Likert scale, the top most agreed-with options were non-availability of experienced project managers (as mentors) and lack of time. These two barriers were agreed with by 28 and 27 (out of 37) participants, respectively. Seven of the 28 responded with 'Strongly Agree' to the lack of availability of suitably experienced project managers being a barrier, while six (of the 27) responded similarly to lack of time being a barrier.

Figure 7 ranks the barriers to mentoring adoption as perceived by the participating IS project managers from most agreed-with to least agreed-with.

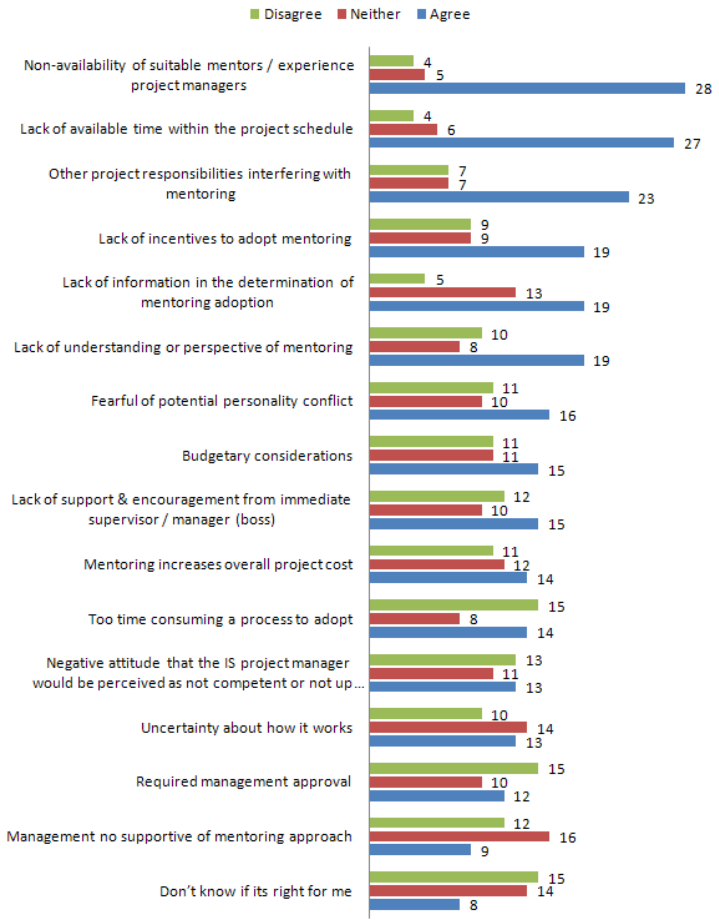


Fig. 7. Barriers to mentoring adoption

The next four barriers listed in Figure 7 were agreed with by between 19 and 23 (out of 37 participants) respectively. They are:

- Other project responsibilities interfering with mentoring;
- Lack of incentives to adopt mentoring;
- Lack of information in the determination of mentoring adoption;
- Lack of understanding or perspective of mentoring.

The next eight barriers listed in Figure 7 were agreed with by between 12 and 16 participants. Amongst them are:

- Fearful of potential personality conflict;
- Budgetary considerations;
- Lack of support & encouragement from immediate supervisor/manager (boss) ;
- Mentoring increases overall project cost.

The two least agreed with barriers were 'Management not supportive of mentoring approach' and 'Don't know if it's right for me'. Nine and eight (out of 37) participants agreed with these respectively. These results reinforce the respondents' personally favourable perception of mentoring as well as general organisational support for the practice.

#### *4.1.5 Advice to those intending to adopt mentoring*

Participants were asked to indicate on a Likert scale their agreement with various recommendations to IS project managers who were contemplating the adoption of mentoring as a supporting mechanism (see Figure 8). Overall, the results showed that participants were inclined to encourage adoption. The recommendation 'Mentoring to be encouraged and be adopted on a need basis' was agreed with by 34 out of the 37 participants and 9 of these responded with 'Strongly Agree'. In contrast, the recommendation 'Mentoring must not be adopted at all' was agreed with by only two participants, 1 of whom responded with 'Strongly Agree'. The next three most agreed-with recommendations further underscored the positive sentiment towards encouraging adoption, with a focus on soliciting support from more experienced in-house individuals on an as-needed basis and adopting mentoring for selected IS project management processes instead of the entire process.

The next five choices of recommendations selected by participants were a 'mixed bag', but again the inclination seemed to be more towards adoption than not.

When the practicing IS project managers were asked whether they would recommend having a project mentor to their colleagues/peers, almost 12% said they would not. The two reasons selected were that 'It takes too much project time' and 'Management is not supportive'. In addition, two participants provided their own responses in the free-format space provided:

- '*Every individual should be able to learn from their mistakes. Having a mentor all the time would be like spoon-feeding.*'
- '*Mentoring slow down the project. They should have sufficient knowledge in own area.*'

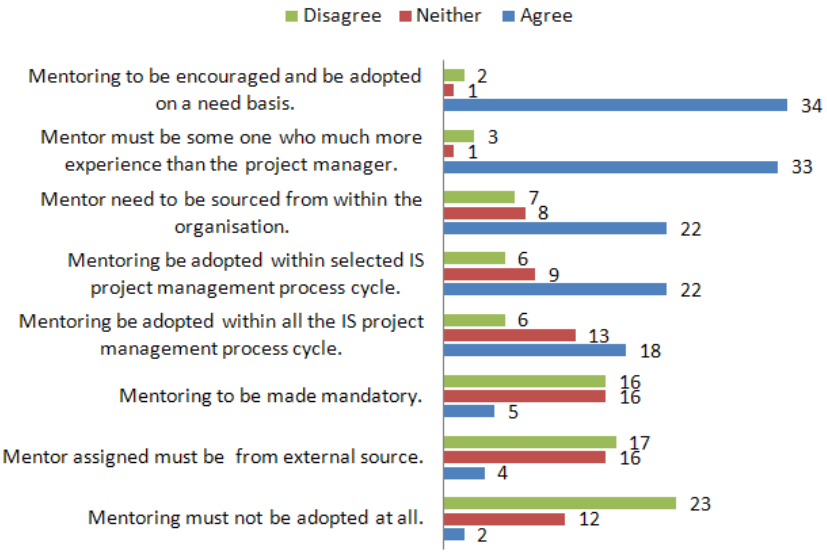


Fig. 8 Advice to those intending to adopt mentoring

### *4.2. Mentoring practice adoption – the 'Whys'*

Overall, the survey data indicated the key motivations for mentoring adoption as project success, connectivity to a network of experienced individuals, camaraderie, and the accrued benefits of mentoring. Amongst the benefits, participants identified accessibility to expertise and knowledge gain. The context of the mentoring relationship is that of a free and open exchange of knowledge and experience driven by the guidance, support and encouragement of more experienced individuals over the duration of the IS project.

The next two subsections present findings of the survey in relation to the second research question. The first subsection reports the reasons for the adoption of mentoring, whereas the second subsection reports on the benefits delivered through mentoring adoption in IS projects, both as primarily informed by practicing IS project managers in response to the survey questions.

#### *4.2.1 Rationale for mentoring adoption*

The 15 predetermined rationales for mentoring adoption have been ranked in the order of most agreed with to least agreed with in Figure 9. All the participating IS project managers agreed that the availability of a free and open exchange of knowledge and experience was a reason for adoption. Only two participants agreed that the fulfilment of statutory requirements contributed to adoption with 19 others disagreeing and a further 16 taking a neutral stance. Similar results were obtained regarding the rationale 'It is part of management & company policy': six agreed, 11 disagreed and 20 were neutral. These findings suggest that mentoring practice adoption in IS projects is rarely due to a need to comply with internal company policies or to fulfil statutory requirements.

The rationales 'Encouraged by my immediate superior/manager (boss) to do so' and 'Recommended by my peer & colleague' received a mixed response from the participants although overall the responses to these rationales were more positive than negative. In contrast, the number of those who agreed with the rationale 'Helps my career' was significantly larger than the number of those who disagreed. This trend is true of the remaining nine adoption rationales. Each attracted the agreement of between 30 to 36 participants. Two common denominators of these supported rationales are desire for personal self-improvement and for project success.

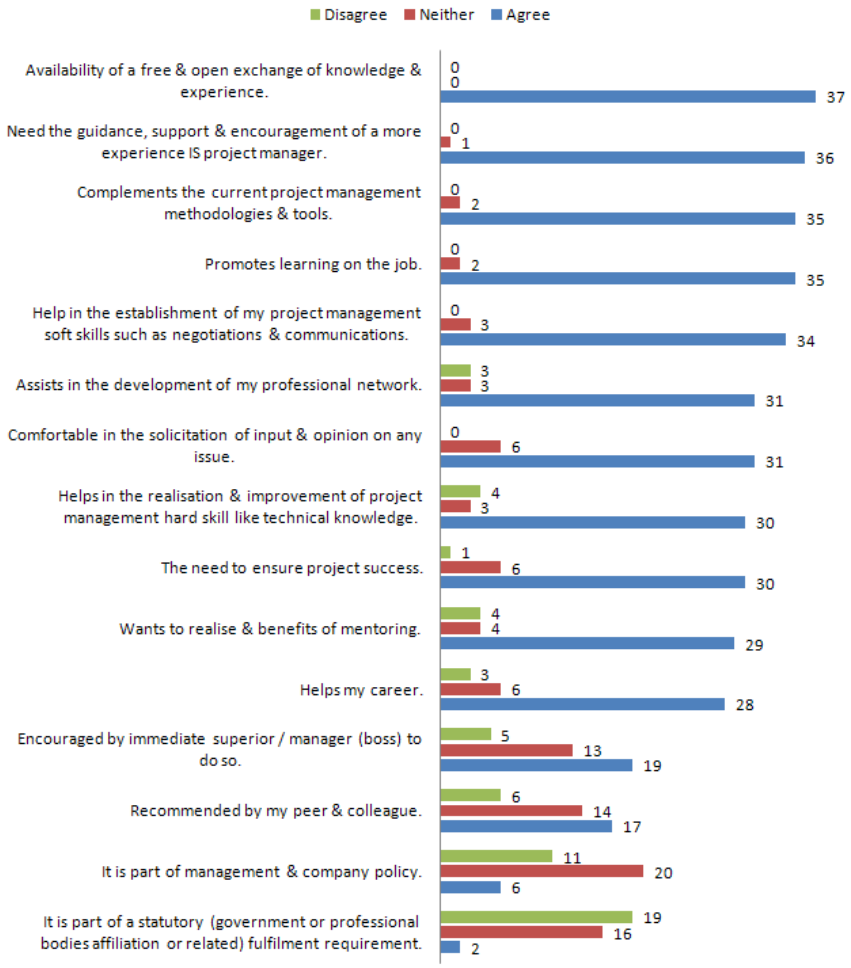


Fig. 9. Rationale of mentoring adoption

### *4.2.2 Benefits of mentoring*

When the participants were asked about the benefits that mentoring adoption delivers to IS projects, the two most agreed with options were access to expertise and knowledge gain (35 of 37 participants, in both cases). Of these, 10 responded with 'Strongly Agree' with respect to access to expertise and 11 responded the same way to knowledge gain. The benefits are ranked in order of most agreed with to least agreed-with in Figure 10.

Seven benefits were agreed with by between 31 and 34 (out of 37) participants:

- Enable and provide feedback, reflection & introspection of the project;
- Better anticipation of project risk;
- Better resolution of project issues;
- Contribute to project knowledge base of the organization;
- Increase my confidence as a project manager;
- Increase probability of project success;
- Development of project interpersonal & communication skills.

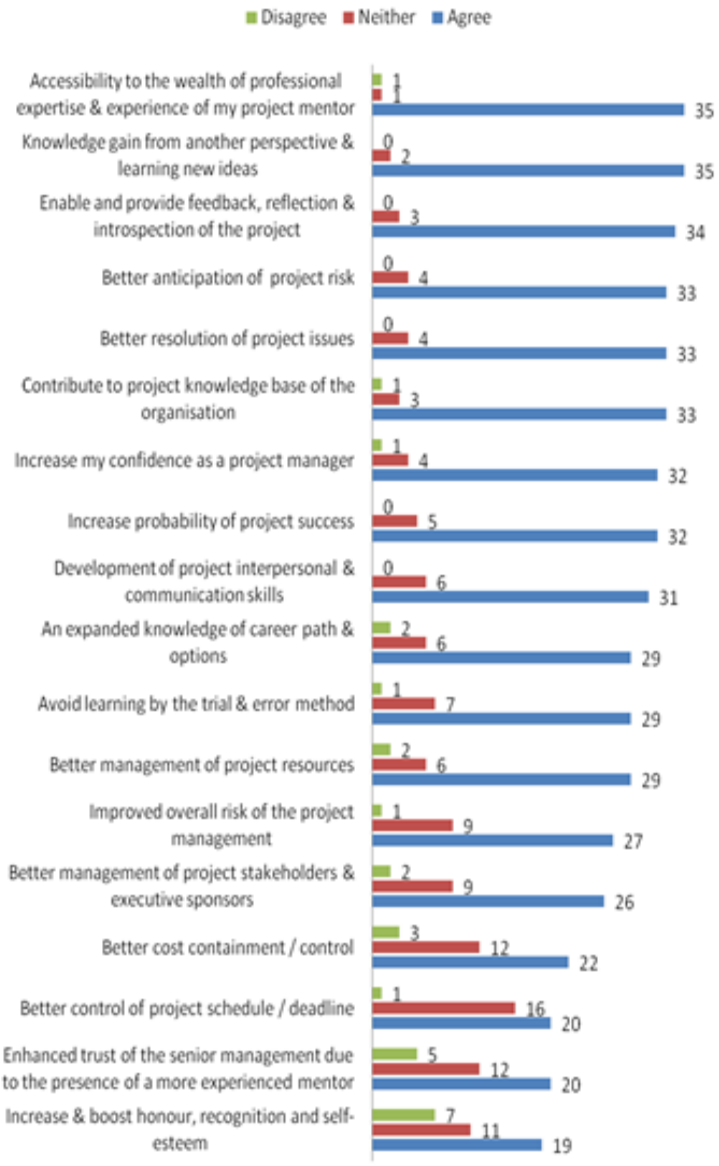


Fig. 10. Benefits of mentoring adoption

Five benefits were agreed with by between 26 and 29 (out of 37) participants each:

- An expanded knowledge of career path & options;
- Avoid learning by the trial & error method;
- Better management of project resources;
- Improved overall risk of the project management;
- Better management of project stakeholders & executive sponsors.

Four benefits were agreed with by between 19 and 22 (out of 37) participants each:

- Better cost containment/control;
- Better control of project schedule/deadline;
- Enhanced trust of senior management due to the presence of a more experienced mentor;
- Increase & boost honour, recognition and self-esteem.

The last two benefits in the above list were the most disagreed with – by 5 and 7 (out of 37) participants respectively.

Overall, it is clear that the participants' feedback from the survey was very positive and there seemed to be a great awareness of the benefits of mentoring adoption.

## 5. Discussion

This assessment of the nature of mentoring practice adoption across the IS project management process covers two areas in the discussion: the 'whats' and 'whys' of mentoring adoption as perceived by IS project managers. Broadly, the 'whats' relate to the general attitude/outlook of the survey participants towards mentoring adoption. This includes their attitudes towards mentoring practice, their understanding of mentoring and adoption characteristics, perceived obstacles to adoption, and lastly the advice of IS project managers to intending adopters. The second area of discussion is the 'whys' of mentoring adoption – the reasons/rationales why IS project managers adopted mentoring, why IS project managers were motivated to adopt mentoring, and lastly the benefits that result from adoption.

Overall, participants conveyed positive attitudes towards the adoption of mentoring practice across the IS project management process; no negative attitudes were reported but some respondents were neutral. This broadly positive outlook resonates with mentoring adoption across other disciplines such as academia, counselling, management, social work and legal/medical fraternity (Keller et al., 2020; Maker Castro & Cohen, 2021; Ivey & Dupré, 2022; Wahdiniawati & Sarinastiti, 2023; Amanda & Akpana, 2023). The results of this study indicated that the responding IS project managers considered themselves to be generally knowledgeable about mentoring, well aware of the benefits accrued to mentoring, and also well read in areas related to mentoring. In addition, the sources of mentoring knowledge cited by IS project managers reflected a sense of personal interest; with the most cited sources for mentoring knowledge were their own personal experiences, reading and exploring, and observations and discussions with peers. This was consistent with Hairon et al.'s (2020) observation that effective mentoring generally is supported by a good knowledge of mentoring.

The overall positive perception of IS project managers towards the adoption of mentoring indicates their belief that it is an effective method of developing one's potential. In addition, mentoring was considered best carried out in a spontaneous manner. This finding is consistent with the broad assertion of numerous studies that have found that mentoring is an appropriate and efficacious mechanism for the betterment of the mentee (Taylor & Woelfer, 2009; Mullen & Klimaitis, 2021).

Two of the key characteristics of mentoring adoption perceived by the participants were trusted and confidential relationships established on an informal and as-required basis; and being able to learn from more experienced individuals. These characteristics resonate with the many definitions of the mentoring relationship (Cowen, 2024; Janssen et al., 2016; Crabwell-Ward et al., 2004). Regarding the occurrences of learning, participants perceived the learning-to-do, learning–to-be and learning-to-see approaches as being effective.

With respect to other characteristics of mentoring adoption across the IS project management process, three of the most noteworthy are now considered. First, the mentoring relationship was found to be non-gender biased. This is consistent with the general indication of workplace mentoring that the mentor and mentee may not necessarily be of the same gender (Sosik & Godshalk, 2000). The second noteworthy characteristic was that the notion of mentors 'holding the hands' of

their mentees received a mixed response from participants. The need for handholding may be dependent on numerous factors such as the mentee's level of experience and the nature of the project. Overall, it seems consistent with the suggestion that there is a need to strike a balance (Parsloe & Leedham, 2016). Third, and finally, was the characteristic of mentors playing the role of devil's advocate, which also received a mixed response from respondents. A devil's advocate approach seems consistent with the broader concept of encouraging deeper reflection and introspection; it facilitates the understanding and development of the IS project manager (Conway, 1995).

The main barriers identified to the adoption of mentoring were the non-availability of suitable project mentors and lack of available time within the project schedule. Time and availability factors are not uncommon barriers. Other obstacles perceived by IS project managers were - being kept busy with project responsibilities; lack of incentives; being fearful of potential personal conflict; and budgetary considerations. These perceived obstacles are common across the discipline of medicine and in academia (Lane & Clutterbuck, 2004; Young & Perrewé, 2000).

The broadly positive outlook on mentoring discussed was also evident in the advice participants had for their peers who were intending to adopt mentoring. Such positive recommendations have been noted in other fields (Lleó et al., 2018; Porterhouse et al., 2024).

We now shift our attention to the 'whys' of mentoring adoption: the rationale, motivation and benefits perceived by IS project managers. When project managers were asked in the survey to state their agreement or disagreement with the reasons as to why mentoring is adopted, overall, they indicated a strong awareness of the benefits that can accrue from mentoring, such as: learning on the job; refining aspects of soft skills; assistance in project problem-solving; knowledge acquisition; encouragement/support and conferring/consulting. This is consistent with the broad whys of mentoring mentioned in the literature earlier (Swap et al., 2001; Griffiths et al., 2018; Burrell & Nobles, 2018; Ngereja & Hussein, 2021; Feng et al. 2022; Gregory et al., 2022; Maheshwari et al., 2023).

The availability of a free and open exchange of knowledge and experience was a reason unanimously agreed with by the responding IS project managers. In addition, mentoring was not generally adopted for reasons of compliance – IS project managers adopted it of their own volition. While monetary and economic considerations were general motivating factors, human capital elements; self-esteem and self-actualization were also powerful motivations for mentoring adoption for the participants.

As a result of the above-noted ambience of trust and confidentiality in the mentee/mentor dyad relationship, the creation of a stronger personal network is likely. This would provide a basis for the enhancement of social capital. New knowledge may be generated by mentors and the mentees solving project problems in a collaborative effort (Henriques & Curado, 2009).

This study noted the participants' high degree of awareness of the benefits accrued from mentoring adoption and a mentoring relationship. This was amongst the many benefits experienced by IS project managers in this study. Access to a wealth of expertise and experience in an environment that offers active feedback and introspection; and better anticipation of project risks and better resolutions of project problems were cited as the main benefits by participants. These are related to the benefit of capability and skill enhancement.

## 6. Conclusion and future research

Table 1 presents a summary of the key findings from this study. It represents the most agreed-with responses from the survey. In other words, these findings denote the more important aspects of mentoring adoption as perceived by the practicing IS project managers.

Table 1. Summary of key findings

| Survey Themes | Description |
|---|---|
| Attitude Towards Mentoring Adoption | Generally positive attitude towards mentoring as an effective means to develop one's potential. Affirmed in the recommendations offered to those intending to adopt mentoring. |
| Knowledge of Mentoring / Sources of Information | Moderate to excellent knowledge of mentoring because of personal experience, observing others, discussion with peers, reading about mentoring and in-house training courses and materials. |
| Mentoring Adoption Characteristics | A trusted mentor-mentee relationship, an informal and as required approach, a learning-to-do (apprentice) approach, and driven by business domain knowledge. |
| Rationale for Mentoring Adoption | Availability of a free and open exchange of knowledge and experience, needing the guidance, support and encouragement of a more experienced IS project manager, and promotes learning on the job. |
| Benefits of Mentoring Adoption | Access to the wealth of professional expertise and experience of a project mentor and to gain new knowledge and new ideas from another perspective. |
| Barriers to Mentoring Adoption | Non-availability of suitably experience mentors, lack of time within the project schedule, and other project responsibilities interfering with mentoring. |
| General Perceptions of Mentoring | Mentoring is an effective method of developing one's potential; and mentoring is best carried out in a spontaneous manner. |
| Advice to Those Intending to Adopt Mentoring | Mentoring to be encouraged and adopted on a need basis, soliciting mentoring from more experienced in-house colleagues, adopting mentoring for selected IS project management processes instead of the entire cycle. |

Mentoring practice adoption across the IS project management process was perceived by the participants as generally positive and rewarding. Their responses suggested that the mentoring relationship not only provided support through advice and guidance from more experienced individuals but also provided invaluable up-skilling opportunities. Significantly, practicing IS project managers appreciated the support and learning received in times of need; they found that what they learned could be put into practice. Additionally, this generally positive attitude towards mentoring may be a result of IS project managers' au courant attitude towards mentoring knowledge; the quest for mentoring knowledge appears to have its source in strong personal interest in mentoring.

The practicing IS project managers in this study were cognizant of the benefits that can accrue from mentoring practice adoption. The benefits of capabilities and skills enhancement for professional development were clear. The participants identified access to the wealth of expertise and experience of mentors and knowledge gain as amongst the top benefits. The generally positive attitude towards mentoring and the knowledge of benefits that accrue from mentoring practice adoption meant that the participants generally recommended mentoring to intending adopters without hesitation.

The key motivation to adopt mentoring across the IS project management process was the drive for project success. The advantages of connecting to a network of experienced individuals and the awareness of the benefits emanating from mentoring relationships were two other motivating factors. In addition, a sense of esprit de corps – which can deepen a relationship – also drives practicing IS project managers towards mentoring practice adoption. Better and improved career development seems to be the underlining consideration of these motivations. The practicing IS project managers identified the advantages of learning on the job, refinement of soft skills, project problem-solving, support, encouragement, and conferring/consulting.

Furthermore, the study's participants agree that mentoring practice adoption was more expedient and forthcoming in an informal relationship environment, which is characterized and sustained by active feedback, introspection and reflection. The relationship mentoring dyad relationship was perceived by IS project managers as one of trust and confidentiality where free and open exchange can occur. The connectedness of the mentoring dyad enhances and in turn increases the ability and inclination to learn.

Impediments to mentoring practice adoption identified by participants were the non-availability of suitable project managers as mentors and lack of time over the duration of a project. These impediments can prevent full realization of the benefits of mentoring adoption, which can in turn devalue efforts and compromise project success. Further to this, such impediments may diminish the state of expectation of IS project managers due to the generally high level of positive awareness.

The above conclusions suggest future research opportunities in IS project management mentoring vis-à-vis IS project success rates and the up-skilling of IS project managers. Future research could be conducted in the areas of cognitive skills enhancement for problem-solving, personal interaction skills improvement, the provision of knowledge bases of lessons learnt. A longitudinal study of the perspectives of project owners and project mentors in each of the areas identified above may also be useful. Further empirical research in these areas not only can contribute meaningfully towards IS project success but also help to corroborate that IS project management mentoring is an effective platform for the up-skilling and learning of novice IS project managers.

This study did not explicitly address factors related to gender and gender differences that could influence the results. On a broad basis, the mentoring adoption survey of this study seems to indicate a low gender preference by the participating IS project managers. There are however some inconsistencies in the literature about gender differences in mentoring; where gender and gender differences of the mentoring dyad are known to influence the expected outcome of a mentoring relationship (Sosik & Godshalk, 2001). To further understand the issues of gender, gender differences and gender preferences of the mentoring dyad, further studies should be conducted in these areas.

Finally, future research can be conducted around staff retention. This study did not set out to explore mentoring adoption and the development of a community and as such an attitude of esprit de corps which may reduce turnover. This could be harnessed towards improving retention of IS project managers.

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## Appendix A. The survey questionnaire

**This survey has two sections i.e. Section A and Section B.**

**When you have completed this survey, please click the 'Submit' button at the bottom of the page to send us your answers for processing.**

**Section A**

**1. Are you currently an IS Project Manager? Please select one. ***

- ○ Yes
- ○ No

**2. What is the nature of your current IS project? Please select any that applies. ***

- ○ Business Applications Related Software System Project
- ○ Systems Related Software System Project
- ○ Computer Hardware Related Project
- ○ Networking Related Project
- ○ Communications Related Project
- ○ A Combination of any of the above-mentioned
- ○ Other - Please specify

**3. What phase of the IS project management process cycle are you currently at? Please select any that applies. ***

- ○ Initiating
- ○ Planning
- ○ Executing
- ○ Monitoring and Controlling
- ○ Closing
- ○ Other

**4. Do you have a mentor currently? Please select one. ***

- ○ Yes
- ○ No

**5.Would you prefer a mentor assigned to your project? Please select one. ***

- ○ Yes
- ○ No

**6.Would you recommend to your peers or colleagues that they adopt the mentoring process in their project? Please select one. ***

- ○ Yes
- ○ No

**7.What would be the reasons that you would NOT recommend the adoption of mentoring to your peers or colleagues in their project? Please select any that applies. ***

- ☐ An IS project mentor is not useful.
- ☐ It takes too much project time.
- ☐ Management is not supportive.
- ☐ Getting a mentor is detriment to their career
- ☐ Do not believe in mentoring.
- ☐ It would reflect negatively on them.
- ☐ Other - Please specify

**8. What would be the reason(s) that you would prefer a mentor assigned to your projects. Please select any that applies. ***

- ☐ An IS project mentor would be helpful.
- ☐ Avoid the trial and error approach.
- ☐ Increase the probability of success.
- ☐ Enhance the trust of senior management.
- ☐ Want a better managed IS project.
- ☐ Want an expanded knowledge of career path and options.
- ☐ Be effective as a IS project manager.
- ☐ Other - Please specify

**9. What would be the reason(s) that you recommend the adoption of mentoring to your peers or colleagues? Please select any that applies. ***

- ☐ An IS project mentor would be helpful.
- ☐ Avoid the trial and error approach.
- ☐ Increase the probability of success
- ☐ Enhance the trust of senior management.
- ☐ Want a better managed IS project.
- ☐ Want an expanded knowledge of career path and options.
- ☐ Be effective as a IS project manager.
- ☐ Other - Please specify

**10.Were you an IS project (leader) manager previously? ***

- ○ Yes
- ○ No

**11. What was the nature of your IS project previously? Please select any that applies. ***

- ☐ Business Applications Related Software System Project
- ☐ Systems Related Software System Project
- ☐ Computer Hardware Related Project
- ☐ Networking Related Project
- ☐ Communications Related Project
- ☐ A Combination of any of the above-mentioned
- ☐ Other - Please specify

**12. Did you have a mentor in your previous IS project? Please select one. ***

- ○ Yes
- ○ No

**13. Would you have preferred a mentor assigned? Please select one. ***

- ○ Yes
- ○ No

**14. Would you recommend to your peers or colleagues that they adopt the mentoring process in their project? Please select one. ***

- ○ Yes
- ○ No

**15. What would be the reasons that you would NOT recommend the adoption of mentoring to your peers or colleagues in their project? Please select any that applies. ***

- ☐ An IS project mentor is not useful.
- ☐ It takes too much project time.
- ☐ Management is not supportive.
- ☐ Getting a mentor is detriment to their career
- ☐ Do not believe in mentoring.
- ☐ It would reflect negatively on them.
- ☐ Other - Please specify

**16. What would be the reason(s) that you would prefer a mentor assigned to your projects? Please select any that applies. ***

- ☐ An IS project mentor would be helpful.
- ☐ Avoid the trial and error approach.
- ☐ Increase the probability of success
- ☐ Enhance the trust of senior management.
- ☐ Want a better managed IS project.
- ☐ Want an expanded knowledge of career path and options.
- ☐ Be effective as a IS project manager.

- [ ] Other - Please specify

**17. What would be the reason(s) that you recommend the adoption of mentoring to your peers or colleagues? Please select any that applies. ***

- [ ] An IS project mentor would be helpful.
- [ ] Avoid the trial and error approach.
- [ ] Increase the probability of success
- [ ] Enhance the trust of senior management.
- [ ] Want a better managed IS project.
- [ ] Want an expanded knowledge of career path and options.
- [ ] Be effective as a IS project manager.
- [ ] Other - Please specify

**18. What is the nature of mentoring in your IS project? Please select any that applies. ***

- [ ] Formal
- [ ] Informal.
- [ ] Internal mentor.
- [ ] External mentor.
- [ ] Mentor is of much more experience than me.
- [ ] Mentor is of less experience than me.
- [ ] Mentor is of equivalent experience like me.
- [ ] Other - Please specify

**19. What would be you think is the nature of mentoring in the IS project? Please select any that applies. ***

- [ ] Formal
- [ ] Informal.
- [ ] Internal mentor.
- [ ] External mentor.
- [ ] Mentor is of much more experience than me.
- [ ] Mentor is of less experience than me.
- [ ] Mentor is of equivalent experience like me.
- [ ] Other - Please specify

**Section B.**

**20. What is the mentoring relationship like? Please select any that applies. ***

- ☐ Assigned by immediate supervisor / manager (boss).
- ☐ Self assigned.
- ☐ Meet mentor in person.
- ☐ Meet mentor in virtual (electronic) space.
- ☐ Other - Please specify

**21. How is mentoring schedule within the IS project management process? Please select any that applies. ***

- ☐ On a scheduled basis.
- ☐ On a need basis.
- ☐ On an ad-hoc basis.
- ☐ As per instructed by management.
- ☐ When crisis hits.
- ☐ Other - Please specify

**22. Please state your agreement or disagreement to the following statements. Please select one option for each row.**
**"The reasons for the adoption and application of mentoring are :"**

| | Strong Agree | Agree | Neither | Disagree | Strong Disagree |
|---|---|---|---|---|---|
| Need the guidance, support and encouragement of a more experience IS project manager * | ○ | ○ | ○ | ○ | ○ |
| Encouraged by immediate superior / manager (boss) to do so. * | ○ | ○ | ○ | ○ | ○ |
| Recommended by my peer and colleague. * | ○ | ○ | ○ | ○ | ○ |
| Comfortable in the solicitation of input and opinion on any issue. * | ○ | ○ | ○ | ○ | ○ |
| Promotes learning on the job. * | ○ | ○ | ○ | ○ | ○ |
| Helps my career. * | ○ | ○ | ○ | ○ | ○ |
| Wants to realise the benefits of mentoring. * | ○ | ○ | ○ | ○ | ○ |
| It is part of a statutory (government or professional bodies affiliation or related) fulfilment requirement. * | ○ | ○ | ○ | ○ | ○ |
| It is part of management and company policy. * | ○ | ○ | ○ | ○ | ○ |
| The need to ensure project success. * | ○ | ○ | ○ | ○ | ○ |
| Assists in the development of my professional network * | ○ | ○ | ○ | ○ | ○ |
| Complements the current project management methodologies and tools * | ○ | ○ | ○ | ○ | ○ |

| | | | | | |
|---|---|---|---|---|---|
| Helps in the realisation and improvement of my project management hard skill such as technical knowledge. * | ○ | ○ | ○ | ○ | ○ |
| Help in the establishment of my project management soft skills such as negotiations & communications. * | ○ | ○ | ○ | ○ | ○ |
| Availability of a free and open exchange of knowledge and experience * | ○ | ○ | ○ | ○ | ○ |

**23. Please state your agreement or disagreement to the following statements. Please select one option for each row.**
**"The followings are considered as key mentoring adoption characteristics :"**

| | Strong Agree | Agree | Neither | Disagree | Strong Disagree |
|---|---|---|---|---|---|
| An formal and organised approach * | ○ | ○ | ○ | ○ | ○ |
| An informal and on a as-required basis * | ○ | ○ | ○ | ○ | ○ |
| A learning-to-do approach * | ○ | ○ | ○ | ○ | ○ |
| A leaning-to-be approach * | ○ | ○ | ○ | ○ | ○ |
| A leaning to-see approach * | ○ | ○ | ○ | ○ | ○ |
| A trusted and confidence adoption * | ○ | ○ | ○ | ○ | ○ |
| A hand holding approach * | ○ | ○ | ○ | ○ | ○ |
| Devils advocate approach * | ○ | ○ | ○ | ○ | ○ |
| Same gender as project manager * | ○ | ○ | ○ | ○ | ○ |
| Empathise with IS project manager * | ○ | ○ | ○ | ○ | ○ |
| Regarded as an exemplary by others * | ○ | ○ | ○ | ○ | ○ |
| Driven by technical knowledge * | ○ | ○ | ○ | ○ | ○ |
| Driven by business domain knowledge * | ○ | ○ | ○ | ○ | ○ |

**24. Please state your agreement or disagreement to the following statements. Please select one option for each row.**
**"The adoption of mentoring in IS project would deliver :"**

| | Strong Agree | Agree | Neither | Disagree | Strong Disagree |
|---|---|---|---|---|---|
| Better control of project schedule / deadline * | ○ | ○ | ○ | ○ | ○ |
| An expanded knowledge of career path and options * | ○ | ○ | ○ | ○ | ○ |
| Better management of project stakeholders and executive sponsors * | ○ | ○ | ○ | ○ | ○ |
| Development of project interpersonal and communication skills * | ○ | ○ | ○ | ○ | ○ |
| Better management of project resources * | ○ | ○ | ○ | ○ | ○ |
| Contribute to project knowledge base of the organisation * | ○ | ○ | ○ | ○ | ○ |

| | | | | | |
|---|---|---|---|---|---|
| Accessibility to the wealth of professional expertise and experience of my project mentor * | ○ | ○ | ○ | ○ | ○ |
| Better anticipation of project risk * | ○ | ○ | ○ | ○ | ○ |
| Increase probability of project success * | ○ | ○ | ○ | ○ | ○ |
| Better cost containment / control * | ○ | ○ | ○ | ○ | ○ |
| Increase my confidence as a project manager * | ○ | ○ | ○ | ○ | ○ |
| Knowledge gain from another perspective and learning new ideas * | ○ | ○ | ○ | ○ | ○ |
| Enhanced trust of the senior management due to the presence of a more experienced mentor * | ○ | ○ | ○ | ○ | ○ |
| Improved overall risk of the project management * | ○ | ○ | ○ | ○ | ○ |
| Avoid learning by the trial and error method * | ○ | ○ | ○ | ○ | ○ |
| Increase and boost honour, recognition and self-esteem * | ○ | ○ | ○ | ○ | ○ |
| Enable and provide feedback, reflection and introspection of the project * | ○ | ○ | ○ | ○ | ○ |
| Better resolution of project issues * | ○ | ○ | ○ | ○ | ○ |

**25. Please state your agreement or disagreement to the following statements. Please select one option for each row.**
**"The obstacles in the adoption of mentoring in IS project are :"**

| | Strong Agree | Agree | Neither | Disagree | Strong Disagree |
|---|---|---|---|---|---|
| Lack of information in the determination of mentoring adoption * | ○ | ○ | ○ | ○ | ○ |
| Lack of support and encouragement from immediate supervisor / manager (boss) * | ○ | ○ | ○ | ○ | ○ |
| Lack of available time within the project schedule * | ○ | ○ | ○ | ○ | ○ |
| Required management approval * | ○ | ○ | ○ | ○ | ○ |
| Mentoring increases overall project cost * | ○ | ○ | ○ | ○ | ○ |
| Budgetary considerations * | ○ | ○ | ○ | ○ | ○ |
| Uncertainty about how it works * | ○ | ○ | ○ | ○ | ○ |
| Management no supportive of mentoring approach * | ○ | ○ | ○ | ○ | ○ |
| Negative attitude that the IS project manager would be perceived as not competent or not up to mark * | ○ | ○ | ○ | ○ | ○ |
| Too time consuming a process to adopt * | ○ | ○ | ○ | ○ | ○ |
| Lack of understanding or perspective of mentoring * | ○ | ○ | ○ | ○ | ○ |

| | | | | | |
|---|---|---|---|---|---|
| Non-availability of suitable mentors / experience project managers * | ○ | ○ | ○ | ○ | ○ |
| Other project responsibilities interfering with mentoring * | ○ | ○ | ○ | ○ | ○ |
| Fearful of potential personality conflict * | ○ | ○ | ○ | ○ | ○ |
| Lack of incentives to adopt mentoring * | ○ | ○ | ○ | ○ | ○ |
| Don't know if its right for me * | ○ | ○ | ○ | ○ | ○ |

**26. Please state your agreement or disagreement to the following statements. Please select one option for each row.**
**"My recommendations to any IS project manager are:"**

| | Strong Agree | Agree | Neither | Disagree | Strong Disagree |
|---|---|---|---|---|---|
| Mentoring be adopted within all the IS project management process cycle. * | ○ | ○ | ○ | ○ | ○ |
| Mentoring be adopted within selected IS project management process cycle. * | ○ | ○ | ○ | ○ | ○ |
| Mentoring to be made mandatory. * | ○ | ○ | ○ | ○ | ○ |
| Mentoring to be encouraged and be adopted on a need basis. * | ○ | ○ | ○ | ○ | ○ |
| Mentor need to be sourced from within the organisation. * | ○ | ○ | ○ | ○ | ○ |
| Mentor must be some one who much more experience than the project manager. * | ○ | ○ | ○ | ○ | ○ |
| Mentoring must not be adopted at all. * | ○ | ○ | ○ | ○ | ○ |
| Mentor assigned must be from external source. * | ○ | ○ | ○ | ○ | ○ |

**27. What is your general attitude towards mentoring? Please select any that applies. ***

- ○ Very Positive
- ○ Positive
- ○ Neutral
- ○ Negative
- ○ Very Negative
- ○ Other - Please specify

**28. How would you rate your knowledge on mentoring? Please select any that applies. ***

- ○ Excellent
- ○ Very Good
- ○ Moderate
- ○ Poor
- ○ No Knowledge
- ○ Other - Please specify

**29. What are your sources of information of mentoring knowledge? Please select any that applies. ***

- ☐ Personal experience
- ☐ Observing others in my work unit
- ☐ Reading about it
- ☐ Discussions with peers
- ☐ Internet
- ☐ University or institution of higher learning
- ☐ Other - Please specify

**30. What are your perceptions concerning mentoring in IS project management? Please select any that applies. ***

- ☐ Mentoring is only for the "high potential" IS project manager.
- ☐ Mentoring is for those IS project manager who have not made the grade.
- ☐ Mentoring is an effective method of developing your potential.
- ☐ Mentoring can only be effective when one's immediate superior / manager (boss) is involved
- ☐ Spontaneous or natural mentoring is best.
- ☐ Other - Please specify

**31. End of Survey.**

## Appendix B. Profile of the 46 research participants

| | Participant Code | Gender | Description |
|---|---|---|---|
| 1 | PM-01-21 | Male | IT Implementation Service Provider |
| 2 | PM-02-06 | Male | Computers & IT Supplier |
| 3 | PM-03 | Female | Manufacturing & Distribution |
| 4 | PM-04 | Female | IT Implementation Service Provider |
| 5 | PM-05-16 | Male | IT Implementation Service Provider |
| 6 | PM-16-11 | Female | Manufacturing & Distribution |
| 7 | PM-07 | Male | IT Implementation Service Provider |
| 8 | PM-08-05 | Female | Computers & IT Supplier |
| 9 | PM-09 | Male | Computers & IT Supplier |
| 10 | PM-10 | Male | IT Implementation Service Provider |
| 11 | PM-11-02 | Male | Computers & IT Supplier |
| 12 | PM-12 | Male | International Television |
| 13 | PM-13-15 | Male | IT Implementation Service Provider |
| 14 | PM-14-08 | Male | Computer Security |
| 15 | PM-15 | Male | Computers & IT Supplier |
| 16 | PM-16 | Male | Consulting & Investment Services |

| | Participant Code | Gender | Description |
|---|---|---|---|
| 17 | PM-17-10 | Male | Consulting & Investment Services |
| 18 | PM-18-03 | Male | International Courier Services |
| 19 | PM-19 | Male | Computers & IT Supplier |
| 20 | PM-20-14 | Female | Engineering |
| 21 | PM-21 | Male | Computers & IT Supplier |
| 22 | PM-22 | Male | Computers & IT Supplier |
| 23 | PM-23 | Male | Manufacturing & Distribution |
| 24 | PM-24-20 | Male | Banking & Finance |
| 25 | PM-25-17 | Male | Telecommunications |
| 26 | PM-26 | Male | Manufacturing & Distribution |
| 27 | PM-27 | Male | Computer Security |
| 28 | PM-28 | Male | Engineering |
| 29 | PM-29-19 | Male | Computers & IT Supplier |
| 30 | PM-30-12 | Male | International Television |
| 31 | PM-31 | Male | Engineering |
| 32 | PM-32-07 | Male | IT Implementation Service Provider |
| 33 | PM-33-04 | Male | Computers & IT Supplier |
| 34 | PM-34 | Male | IT Implementation Service Provider |
| 35 | PM-35 | Female | Telecommunications |
| 36 | PM-36 | Female | Telecommunications |
| 37 | PM-37 | Male | Computers & IT Supplier |
| 38 | PM-38-01 | Female | Semiconductor |
| 39 | PM-39 | Female | Consulting & Investment Services |
| 40 | PM-40 | Male | Semiconductor |
| 41 | PM-41-09 | Male | Banking & Finance |
| 42 | PM-42-13 | Male | Banking & Finance |
| 43 | PM-43 | Male | Telecommunications |
| 44 | PM-44-18 | Male | Telecommunications |
| 45 | PM-45 | Male | Computers & IT Supplier |
| 46 | PM-46 | Male | Engineering |

## Biographical notes

Felix B Tan is Professor and Associate Dean Research in the Faculty of Design and Creative Technologies at Auckland University of Technology. He served as the Editor-in-Chief of the *Journal of Global Information Management* for 15 years. He was also on the Council of the Association for Information Systems. He has published in journals including *MIS Quarterly, Information & Management, European Journal of Information Systems, Information Systems Journal, Journal of Information Technology, Communications of the AIS and Communications of the ACM.*
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Paul Leong was a practicing IS Project Manager before joining Auckland University of Technology initially with the Department of Business Information Systems and then the School of Computer and Mathematical Sciences, where he was with the Software Engineering Research Laboratory. He holds a PhD with research interests in IS project management and business process improvement

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RESEARCH ARTICLE

# A structured taxonomy for effective digital transformation project implementation: Development, validation, and practical insights

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## Abstract
The aim of this study was to develop and validate a taxonomy designed to assist organizations in formulating their Digital Transformation Project implementation strategies. In creating this taxonomy, we sought to blend both conceptual frameworks and empirical data. The initial phase involved a scoping review that synthesized existing literature to lay the foundation for the taxonomy. Subsequently, we aimed to validate the taxonomy by gathering feedback from industry experts in Germany using a closed card sorting technique, complemented by case study analysis. This structured compilation of information regarding implementation strategies, presented through the taxonomy, simplifies the process for practitioners. Such a taxonomy enables practitioners to adopt a standardized vocabulary, which supports decision-making, encourages learning from previous successes and challenges, and facilitates the application of these lessons to their projects. Additionally, we have included practical case scenarios within the taxonomy, offering guidance for organizations on leveraging it in the execution of digital transformation projects.

## Keywords
digital transformation projects; card sorting technique; case study analysis; implementation strategies; taxonomy development.

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## 1. Introduction

The noticeable advancements in digital technologies and their increasing prevalence have served as a profound inspiration for organizations to transform their operations and business models (Ardito et al., 2018). This transformation involves modifications in activities, processes, business models, and capabilities, taking into account potential disruptions (Correani et al., 2020). When an organization begins or enhances its use of digital technologies by integrating information technology, innovation, and organizational change to meet customer needs, it is called Digital Transformation (Hafseld et al., 2021; Morakanyane et al., 2017; van Dyk & Van Belle, 2019). A project designed to carry out such digital transformation is referred to as a Digital Transformation (DT) Project (Gertzen et al., 2022).

In the late 20th and early 21st centuries, digital technologies were increasingly integrated into business processes, leading to the adaptation of the DT Project (Barthel & Hess, 2019). Numerous industries have experienced a market shift in recent years, driven by better responsiveness to customer demands (Barthel & Hess, 2019). Consequently, organizations are compelled to engage in DT Projects to stay competitive, as 40% of businesses that do not adapt to new technologies may face extinction within the next decades (Kutzner et al., 2018). Hence, to avoid this great fall and to stay competitive, companies are continually reinventing themselves and pursuing digital transformation (Fuchs et al., 2019; Henriette et al., 2015).

The prospect of undertaking a DT Project in an organization is promising and exciting but poses significant challenges (Setzke et al., 2020). The predominant reason for the majority of failure cases (approximately 70%) is a misunderstanding of the characteristics and definition of DT Projects (Mirkovic et al., 2019; Smith, 2020). Besides, the implementation of DT Projects often fails due to the lack of comprehensive guidelines and widely shared implementation strategies (Setzke et al., 2020).

Digital transformation has gained wide research recognition multiple times. The scholars have investigated its definition (Fuchs et al., 2019), domain (Kutzner et al., 2018), existing barriers (Vogelsang et al., 2019), implementation (Setzke et al., 2020), and influencing factors (Dörr et al., 2023) and organized those in a manner through building a taxonomy. While observing the research related to the DT Project, it came to light that the researchers have analyzed the factors causing complexity in the DT Project (Hafseld et al., 2021) and the framework to analyze the DT Project success (Mahboub & Sadok, 2022). A recent publication by Hermann et al. (2024) created a taxonomy for initiating Digital Innovation Projects in SMEs. These authors used taxonomy to consolidate interpretations from prior research and contribute to future studies (Glass & Vessey, 1995; Sabherwal & King, 1995). Besides, taxonomy is utilized to provide a structured perspective when the field of research has its specific area of interest (Glass & Vessey, 1995).

To date, there are limited scholarly developments that have explored the characteristics contributing to the successful implementation of Digital Transformation Projects (Baier et al., 2022; Morakanyane et al., 2017). Therefore, we will investigate DT Project characteristics to understand their outlook and implementation strategy. Accordingly, a taxonomy will be developed to provide those characteristics with a concrete structure with standard terminology. Such a taxonomy is important because it will foster a better understanding of the dimensions of DT projects, thus aiding efficient implementation. Therefore, the objective of our study is "*to develop and validate a taxonomy aimed at helping organizations shape their implementation strategies for Digital Transformation projects.*"

To fulfill the research objective, we focused on building a taxonomy that includes essential characteristics for implementing DT Projects in organizations. The taxonomy development technique suggested by Nickerson et al. (2013) will be taken as a guideline. The development was done in three iterations. A scoping literature review was carried out to consolidate insights on the definition and characteristics of DT Projects from existing articles. This helped to frame the initial base of the taxonomy. After that, the card sorting technique was applied to incorporate the perspectives of practitioners involved in DT Projects. Thereafter, a case study analysis was conducted to gather instances specifically focusing on DT Projects

from various organizations in Germany. Through the multi-method study of combining scoping review, card sorting technique, and case study analysis, we bring in a new perspective of developing taxonomies, which other studies have not done before. Finally, some relative contextual factors have been presented from the collected case studies, which will help to understand specific situations while implementing DT Projects.

The paper is structured as follows. In section 2, related works have been discussed. Section 3 presents the research methodology. Sections 4, 5, and 6 discuss the analysis regarding taxonomy development. Sections 7, 8, and 9, respectively, include a cross-case analysis, implications of the research, and conclusion, including limitations and future scopes.

## 2. Related Works

### *2.1. Digital Transformation Project and its impact*

To understand the meaning and impact of a Digital Transformation (DT) Project on an organization, we analyzed the perspectives of various authors on organizational DT efforts. This approach will help us to clarify the need for a taxonomy from an organizational standpoint.

A project can be regarded as a Digital Transformation Project when it integrates information technology, innovation, and organizational change, offering a comprehensive perspective on all involved facets (Hafseld et al., 2021). Considering these facts, the outcome of a DT Project is expected to differ from a Traditional IT Project (Barthel & Hess, 2019; Gertzen et al., 2022). These projects use new technologies to streamline organizational processes, increase efficiency, reduce waste, and enhance data management, aiming to improve decision-making and facilitate the digital transformation of a business (Gertzen et al., 2022). Hence, it can be said that organizational structure, technology, and innovation are the three main focus factors for DT Projects (Hafseld et al., 2021).

Stakeholder mapping significantly impacts DT Projects, focusing on trust, influence, and relationships (Filho et al., 2021; Novelli & Paoloni, 2022). While mapping, it is necessary to ensure stakeholders' influence does not negatively impact the project and that sufficient trust is built among all parties (Filho et al., 2021; Novelli & Paoloni, 2022). Given these considerations, upcoming leaders need robust technical skills, people management, and business knowledge (Urbach et al., 2019).

DT Projects prefer agile methods like SCRUM over the waterfall (Corejova et al., 2020). Such projects often encounter time delays and budget overruns, requiring increased flexibility and adaptability (Baker, 2014). Utilizing agile methodologies overcomes these limitations, prioritizing prompt delivery for enhanced project efficiency (Baker, 2014).

Combined with technological transformation, the DT Project has a bigger impact on the business (Urbach & Ahlemann, 2019). Organizations must leverage digital technologies into strategies, transform work routines and processes, reimagine their business model, and align their value proposition (Legner et al., 2017). While a monthly or quarterly release cycle was once standard, DT Projects now require daily builds due to their structured processes (Urbach et al., 2019).

### *2.2. Implementation Strategy*

Implementation strategy can be noted as a method through which we can boost the versatility, implementation, and sustainability of an innovation (Proctor et al., 2013). It was challenging to identify a suitable implementation strategy to reach our research objective. According to Mazza et al. (2013), when a research area has not been thoroughly reviewed, a scoping review helps establish a foundation for understanding the key aspects of that field. Subsequently, we decided to begin with a scoping review. Additionally, it is crucial to consider the experience and judgment of practitioners and researchers throughout the implementation of any specific strategies (Kirchner et al., 2023). Therefore, we decided to involve practitioners associated with DT Projects to further develop our strategy.

### *2.3. Taxonomy and its Validation Techniques*

Before developing the taxonomy, we concentrated on evaluating its effectiveness in meeting the research objectives. Additionally, we explored the most appropriate validation technique for the taxonomy.

Taxonomy is referred to as an empirical and theoretical exploration of classification, encompassing its foundations, principles, procedures, rules, and identification (Bailey, 1994; Satava et al., 2003). It simplifies things for practitioners by giving them standard terms, consistent categories, and organized frameworks, simplifying understanding in a field (Dörr et al., 2023; Hermann et al., 2024; Setzke et al., 2020). Taxonomy helps focus on key dimensions in decision-making and avoids distractions (Pfister & Lehmann, 2023). Before initiating a project, practitioners can utilize the taxonomy to study past projects, gaining insights into their structures and the factors contributing to their success or failure (Setzke et al., 2020). It aids in structuring thoughts, analysis, and communication (Dickson et al., 2023). These factors highlight the effectiveness of the taxonomy in helping organizations understand key dimensions for implementing a Digital Transformation (DT) Project and facilitating knowledge exchange during and after the process. Developing a taxonomy appears to be a suitable approach to address the lack of a structured DT Project implementation strategy.

After recognizing its effectiveness, we focused on exploring different approaches to validate the taxonomy and identify the most suitable way for our needs. The predominant approach for validating taxonomies has been identified to be Semi-Structured Surveys. For example, some authors have performed interviews with domain experts (Jöhnk et al., 2017; Li et al., 2021), and others have administered surveys to individuals within their respective fields (Ahmed & Kassem, 2018; Almalki et al., 2017; Toda et al., 2019). In some instances, open-ended questionnaires were utilized as the sole method (Toda et al., 2019) or in conjunction with multiple-choice or closed-ended questionnaires (Almalki et al., 2017; Tett et al., 2000). The card sorting technique has also been observed as a method for capturing the perspectives of domain experts and users regarding the taxonomy, subsequently validating it (Haimson et al., 2021; Huber et al., 2023).

#### *2.3.1 Card Sorting Technique*

Among multiple approaches of taxonomy validation techniques, the card sorting technique seems suitable to initially collect the perspectives of domain experts (Haimson et al., 2021; Huber et al., 2023). Card sorting is an engaging research method to understand participants' comprehension and organization of concepts (Conrad et al., 2019; Nawaz, 2012). In qualitative analysis, the card sorting technique lets researchers examine conscious and subconscious thoughts but is more effective with fewer participants and limited time (Wood & Wood, 2008). The items in the card sorting method can be presented in two different ways: open and closed (Fincher & Tenenberg, 2005; Wood & Wood, 2008). Open card sorting lets participants freely group cards and name groups, ideal for early research without pre-analysis. Closed card sorting allows participants to organize cards into preset groups, often used for analysis validation (Fincher & Tenenberg, 2005; Wood & Wood, 2008). We opted for closed card sorting as we planned to frame the initial taxonomy beforehand through a scoping review, and the target was validating our already collected information.

#### *2.3.2 Case Study Analysis*

Case studies are often used to discover any unknown facts inductively or test any generated analysis deductively (Gammelgaard, 2017). In qualitative analysis, loosely structured case studies can have a greater impact according to the researcher's desire (Maxwell, 2008). When selecting cases, it is advisable to focus on the desired data sets rather than opting for an open approach (Gammelgaard, 2017). Maxwell (2008) identified three different ways to analyze case studies while falling into qualitative analysis. *Categorizing Strategies* involve coding data from case studies into structured categories. *Connecting Strategies* identify relationships among elements in texts. *Memos and Displays* emphasize data visibility and retrieval methods rather than analysis (Maxwell, 2008). The most reliable and legitimate method is the combination of *Categorizing Strategies* and *Connecting Strategies,* as it decreases the chance of missing an important vision (Maxwell, 2008). As a consequence, we went further to validate the taxonomy through this approach.

## 3. Research Methodology

While developing this taxonomy, we followed the method provided by Nickerson et al. (2013) which is highly acceptable and has been widely applied for the last five years in the domain of digital disruption (Szopinski et al., 2019). The taxonomy development by Jöhnk et al. (2017) and Fuchs et al. (2019) were also utilized.

This research has been designed in six steps. Firstly, we identified the research objective and target group. Our focus was on including practitioners actively engaged in DT Projects to gather their perspectives toward implementing such projects. Table 1 includes participants' roles in the industries. The participants were mostly top and mid-level employees of the respective organizations. Missing organization information is marked with "-". The table also shows their card-sorting session participation and associated cases. For some organizations, either case collection or card sorting was done. This sign "*" indicates that one of the two was not performed. While there was some overlap in data collection methods among organizations, we avoided participant overlap. Specifically, practitioners involved in card sorting were not included in the case study analysis and vice versa to prevent bias.

Table 1. Overview of the Participants

| Card Sorting Session | Cases | Participants' role | Industry | Organization established | Number of Employees (2023) | Organizations' Revenue in € (2022) |
|---|---|---|---|---|---|---|
| 1 | 6 | a. Chief Operations Officer<br>b. Chief Executive Officer | Educational Technology | 2023 | 2 | None |
| 2 | * | 2 Project Coordinators | Business Consulting and Service | 2014 | 150 | ~ 5 M |
| 3 | 8, 9 | a. Project Manager<br>b. Deputy Project Manager | Computer Software | 1969 | 4800 | 228.67M |
| 4a, 4b | 10, 11 | 4 Product Managers | Bank and Financial Service | 2014 | 400 | 10B |
| * | 1, 3 | Managing Director | Consulting Business and Corporate Investment | 2012 | - | - |
| * | 2 | Project Consultant | Financial Service | 2002 | 25 | - |
| * | 4 | a. Chief Executive Officer<br>b. Chief Technical Officer | Health Care Software Development | 2007 | 22 | 8M |
| * | 5 | Project Manager | Business Consulting and Service | 1995 | 800 | 1.39B |
| * | 7 | Project Coordinator | Digital Business Transformation and Consulting | 1990 | 20000 | 1.19B |

The taxonomy development process was done in three iterations. We began the first iteration through a conceptual-to-empirical approach. Due to a lack of research on DT Project characteristics, we conducted a scoping review to gauge the field's knowledge level. This review has been driven by the guidance of Munn et al. (2022) and Petres et al. (2020). We began the scoping review on June 11, 2022, utilizing Google Scholar. Therefore, only articles published before this date were included. From the review, we extracted the initial set of characteristics and their respective dimensions for taxonomy. After that, in the next iteration, our focus was to gather the feedback of experts on the previously defined dimensions and characteristics. For this purpose, we used a closed card sorting technique as it is commonly suggested to conduct validation of previously done analysis (Wood & Wood, 2008). To execute this approach, the guidance has been adapted from the work of Nurmuliani et al. (2004) and Fincher & Tenenberg (2005). Compiling the results from five groups and considering the common feedback, a few adjustments were made to the initial taxonomy. As the defined objective and subjective ending conditions were not met, we opted for the third iteration. During the third iteration, we performed an explorative, qualitative-empirical research approach by collecting case studies. The research of Jöhnk et al. (2017) and Fuchs et al. (2019) was a great help in analyzing those case studies by applying a categorizing strategy. The data collection took place from June 2023 to October 2023. After the third iteration, the taxonomy was revised again. By the end of this iteration, we were confident enough about meeting the subjective ending conditions and the objective ending conditions that were defined earlier. Therefore, no further analysis was done. To identify the relationship of the dimensions and characteristics among the collected case studies through connecting strategy, a cross-case analysis was also done at the end.

The summary of the steps integrated into the research design of this paper is presented in Table 2.

Table 2. Elaborated Research Design

| | |
|---|---|
| **Phase 1: Setting Research Objective** | ▪ Research Objective: to develop and validate a taxonomy aimed at helping organizations shape their implementation strategies for DT Projects.<br>▪ Target group was defined to be the practitioners who are engaged in DT Projects. |
| **Phase 2: Planning** | ▪ The meta characteristics of this taxonomy are intended to confine the characteristics of DT Projects during the implementation phase and help to define the strategic move in the early stage. Consequently, the meta-characteristic was structured as *"Implementation Strategies of Digital Transformation Project"*.<br>▪ Objective Ending questions: a) Each characteristic possesses uniqueness within its respective dimension, b) Each dimension and characteristic is distinct and not replicated, c) No characteristic was combined or divided in the final iteration and d) The characteristics in the dimensions need to be mutually exclusive and collectively exhaustive.<br>▪ Subjective Ending questions: The taxonomy needs to be concise, robust, comprehensive, extendible, and explanatory. |
| **Phase 3: Gathering data from articles through Scoping review** | ▪ Keyword-based Searching: Digital Transformation Project, Digital Transformation, Digitalization Project, Digitalization, Digitalisation Project, Digitalisation, Digitization Project, Digitization, Digitisation Project, and Digitisation.<br>▪ 528 articles were included by incorporating all articles found for each keyword up to the 6th page. |

| | |
|---|---|
| | ▪ Screening Process:<br>o Five steps screening.<br>o Included only peer-reviewed articles in the English language which were relevant to the research objective.<br>o Ended up sorting with having 29 relative articles.<br>▪ Quality Assessment: cross-checked the process of screening and went through the selected articles thrice to validate the collected dataset from those articles.<br>▪ The initial set of characteristics with their dimension was gained from this scoping review. |
| **Phase 4: Validating taxonomy by applying Card-Sorting technique** | ▪ Intention to gather the thoughts of experts under the defined dimensions and characteristics of the taxonomy.<br>▪ Participants: Ten participants from four different organizations in Germany.<br>▪ Platform: Miro.<br>▪ Card Sorting Sessions' Structure:<br>o 13 fixed cards representing the dimensions and 31 free cards representing the characteristics of the taxonomy.<br>o 45-minute sessions with groups of 2 people.<br>▪ Combining five different scenarios from the sessions and the feedback from the participants, resulted in modifying the earlier taxonomy. |
| **Phase 5: Validating Taxonomy by Case Study Analysis** | ▪ Intention: to assess whether the dimensions and characteristics of the taxonomy align with the perspectives of professionals.<br>▪ Case Criteria: DT Projects which are ongoing or finished from start-ups to established companies to keep variation in industries.<br>▪ Steps of Case Analysis:<br>o A set of questionnaires based on the characteristics of DT projects was sent out to the participants in the form of a template.<br>o Arranged 30-minute online sessions with each participant to describe the purpose of the research and the case collection along with describing the questionnaires. In case of groups of 2 people, we allocated 45-minute sessions.<br>o At least 1 week time was provided to fill out the template after the sessions.<br>▪ Collected Case Study Sample: Eleven case studies from eight organizations.<br>▪ Open coding of the collected cases led to refining the taxonomy. |
| **Phase 6: Cross Case Analysis** | ▪ Conducting a cross-case analysis in a variable-centred approach.<br>▪ Observing and identifying the connections among the cases based on the taxonomy. |

## 4. Gathering Data through Scoping Review

In the first iteration of taxonomy development, a scoping review was done to find out the dimensions and their characteristics concerning the implementation of DT Projects. As a consequence, the dimensions and characteristics mentioned here were progressively discovered while conducting the review from the perspective of the selected articles. In Table 3, each dimension of the DT Project will be elaborated along with their characteristics against their literature background.

Table 3. Reflection of scoping review in DT Project dimensions

| Dimensions | Results from the scoping review |
|---|---|
| *Project Objective* | We aimed to discover why organizations implement DT Projects. *Business Re-invention,* as a reason for implementation was observed in 69 organizations reinventing products, business models, and processes to impact the economic environment (Effah & Nuhu, 2017; Ivančić et al., 2019; Rossato & Castellani, 2020; Zoppelletto et al., 2020). According to 13 articles, organizations aimed to improve their processes' *performance*. The intent behind this, varied from multiple perspectives., e.g., building a new business model (Elg et al., 2021), bringing digital products and services (Almeida et al., 2020), improving process quality (Hagberg et al., 2016) etc. |
| *Project Drivers* | In this scoping review, project drivers are identified as primary catalysts essential for project execution. In terms of *organizational/business value*, it encompasses all the values that contribute to the overall vitality and prosperity of the firm in the long run (Effah & Nuhu, 2017; Hagberg & Jonsson, 2022). *Innovation* indicates the urge to create value with new products, processes, or business models (Rachinger et al., 2018; Rossato & Castellani, 2020). In the realm of *digital technology*, the project's fundamental objective is to integrate web technologies into the equation (Björkdahl, 2020; Heberle et al., 2017; Pagán Ruiz, 2014). |
| *Project Initiators* | Project initiation refers to the focus on a broader organization or small unit while initiating the project planning (Daradkah et al., 2018). We discovered two distinct parts of process initiation: *top-down* and *bottom-up*. 27.5% of the articles have shared that initiation was done according to one of those approaches. For example, a top-down approach was seen in (Effah & Nuhu, 2017; Elg et al., 2021; Rossato & Castellani, 2020). On the other hand, the bottom-up approach has been noticed by (Hafseld et al., 2021, 2022; Ivanǎćet al., 2019). |
| *Project Triggering Factors* | Two distinctive types of project-triggering factors were discovered from the scoping review; one referring to *internal* factors focusing on organizational or business issues (Effah & Nuhu, 2017; Ivanǎćet al., 2019; Rowbottom et al., 2021) and another referring to *external* factors focusing on technology and market-related aspects (Branca et al., 2020; Caputo et al., 2021; Pagán Ruiz, 2014; Ulas, 2019). In some cases, DT projects were driven by both business improvements and evolving customer needs and technological advancements (Kraus et al., 2021; Tung et al., 2020; Zoppelletto et al., 2020). |
| *Organizational View* | When adopting a project, a significant consideration is the *temporary organizational view* (Turner & Müller, 2003). In the scoping review, 70.4% of organizations were observed to begin DT projects as temporary organizational views (Hafseld et al., 2021, 2022; Kraus et al., 2021; Tung et al., 2020). |
| *Nature of Project Novelty* | After scrutinizing the articles used in this scoping review on DT Project initiation or transformation, two clear groups were identified. One of these refers to enhancing or modifying organizational processes, termed *novel to the organization* (Cijan et al., 2019; Legner et al., 2017; Ulas, 2019; Verhoef et al., 2021). Another one refers to the target market indicated as *novel to market* (Almeida et al., 2020; Branca et al., 2020; Jovanović et al., 2018; Mergel et al., 2019). Additionally, 24.1% of the articles concentrated on |

| Dimensions | Results from the scoping review |
|---|---|
| | meeting the needs of both the target market and the organization simultaneously (Hagberg & Jonsson, 2022; Kuusisto, 2017; Zoppelletto et al., 2020). |
| *Innovation Area* | When initiating a project, it is typical to pinpoint a specific area of focus known as the 'Innovation Area,' categorized into *product, process, service, and business model* dimensions. (Barthel & Hess, 2019). From the scoping review, we found that organizations mainly prioritize process as their chosen innovation area, with six articles exclusively using DT Projects to introduce diversity into their processes. (Effah & Nuhu, 2017; Rossato & Castellani, 2020; Tung et al., 2020). Service is the second most favored area, as indicated by three articles that specifically selected it (Hafseld et al., 2021, 2022; Holley, 2004). Fourteen articles notably combined services with one or two other innovation areas (Almeida et al., 2020; Hagberg et al., 2016; Hagberg & Jonsson, 2022). |
| *Team Autonomy* | Building a successful team involves strategically aligning autonomy and structure with the project's requirements (Zainal et al., 2020). The teams mentioned in the selected articles were seen to have two significant types. Most of the articles from the scoping review discussing team autonomy have highlighted having *low autonomy* during their project (Elg et al., 2021; Heberle et al., 2017; Rowbottom et al., 2021). Only one article (Hafseld et al., 2021) indicated the importance of maintaining a fully autonomous team with *high autonomy*. |
| *Team Formation* | Regarding team formation, the goal was to determine whether project teams adhere to interdisciplinary patterns including technical and business departments, or only members from a single department. Consequently, the characteristics of this dimension were named *interdisciplinary team* and *team with only specific discipline people*. The study indicates that the initial formation style is more commonly preferred in assembling a project team (Elg et al., 2021; Hagberg & Jonsson, 2022; Ivanǎćet al., 2019; Zoppelletto et al., 2020). |
| *Leader of DT* | A diverse range of leadership styles were discussed in the scoping review. Some articles uttered of having *specific leaders for DT* (Hafseld et al., 2021; Heberle et al., 2017; Riedl et al., 2017; Ulas, 2019). It was observed that in Hafseld et al. (2022) and Hafseld et al. (2021) researchers discovered that despite assigning a designated leader, there was a tendency to follow the guidance of the *project manager* in executing DT projects. |
| *Expertise of Project Members* | In establishing a proficient team, incorporating expertise related to the subject matter is a key necessity (Guinan et al., 2019). Having only *external* expertise was not a familiar aspect of the articles as combining internal expertise from different areas is typically easier due to their familiarity with each other and the organizational culture (Effah & Nuhu, 2017; Legner et al., 2017; Rachinger et al., 2018; Rowbottom et al., 2021). Exceptionally, Ivanǎć et al., (2019) have portrayed a project team including only *internal* experts. |
| *Project Management Method* | Choosing a suitable project management methodology works as a crucial element in the way to ensure project success by avoiding project risk (Salameh, 2014). Therefore, the reflections of this element were expected to be more visible in the data set. Surprisingly, only two articles have directly addressed this aspect. Those were focused on the design thinking process (Hafseld et al., 2021, 2022) which is widely known as an *agile* iterative process (Panke, 2019). |
| *Project Acceptance* | When considering the adoption of a new project structure, it becomes crucial to assess the team's and market acceptance percentage and implement measures to reinforce acceptance. A significant majority (72.4%) of the chosen articles have placed a strong emphasis on enhancing project acceptance within organizations (Ivanǎćet al., 2019; Kraus et al., 2021; Tung et al., 2020). This highlights the significance attributed to this critical success factor in the initiation or transformation of DT Projects. |

## 5. Validating Taxonomy by applying Closed Card Sorting

This iteration continued with the card sorting technique. Five sessions with 10 people from various organizations resulted in five different taxonomy views. We used a Google Sheet to analyze how practitioners' views look compared to the previously built taxonomy. The result of this iteration is demonstrated in Figure 1. If all 10 practitioners chose a characteristic under the same dimension, it shows 100%. If six chose it, it shows 60%. These percentages indicated how practitioners' thoughts match the initial taxonomy.

| Implementation Strategies | Project Dimensions | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Project Objective | Project Driver | Project Initiators | Project Triggering Factors | Organizational View | Nature of Project Novelty | Innovation Area | Team Autonomy | Team Formation | Leader of DT | Expertise of Project Members | Project Management Method | Project Acceptance |
| Performance Improvement | 60.00% | 20.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 20.00% |
| Business Re-invention | 80.00% | 20.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Business Value | 0.00% | 80.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 20.00% |
| Innovation | 80.00% | 20.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Digital Technilogy | 0.00% | 80.00% | 0.00% | 0.00% | 0.00% | 0.00% | 20.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Top-down | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Bottom-up | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Hybrid | 0.00% | 0.00% | 0.00% | 40.00% | 20.00% | 0.00% | 20.00% | 20.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Internal | 0.00% | 0.00% | 0.00% | 60.00% | 0.00% | 20.00% | 0.00% | 0.00% | 0.00% | 0.00% | 20.00% | 0.00% | 0.00% |
| External | 0.00% | 0.00% | 0.00% | 60.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 40.00% | 0.00% | 0.00% |
| Non-temporary | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Temporary | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Towards Market | 0.00% | 0.00% | 0.00% | 20.00% | 0.00% | 80.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Towards Organization | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 80.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 20.00% |
| Product | 20.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 80.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Process | 0.00% | 20.00% | 0.00% | 0.00% | 0.00% | 0.00% | 80.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Business Model | 0.00% | 20.00% | 0.00% | 20.00% | 0.00% | 0.00% | 60.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Service | 20.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 80.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| High Autonomy | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Low Autonomy | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Interdisciplinary Team | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Team with only specific discipline people | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Specific Leader for DT | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% | 0.00% |
| Project Manager | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 20.00% | 80.00% | 0.00% | 0.00% | 0.00% |
| Full Internally sourced | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 20.00% | 0.00% | 80.00% | 0.00% | 0.00% |
| Mixed with internal and external personnal | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 40.00% | 0.00% | 60.00% | 0.00% | 0.00% |
| Agile | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Traditional | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Hybrid | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 20.00% | 80.00% | 0.00% |
| Inside Organization | 0.00% | 0.00% | 0.00% | 20.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 20.00% | 0.00% | 60.00% |
| End Customer | 0.00% | 20.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 80.00% |

Fig. 1. Result of Card Sorting Sessions

With 10 participants, the place for a characteristic was considered final if its cell number showed 60% or above, indicating a vote from at least half the participants. In this way, we intended to determine the degree of alignment among the dimensions and the characteristics (Righi et al., 2013). Figure 1 shows the final destinations for characteristics in green cells. We adjusted the initial taxonomy based on this iteration.

First, 80% of the participants thought that the characteristic *Innovation* is suitable to be in the dimension of the “Project Objective”. In the previous iteration, a similar characteristic named *Business Re-invention* existed in the same dimension. During feedback, practitioners were asked why they chose *Innovation* for "Project Objective" instead of *Business Re-invention*. The consensus was that *Innovation* was more easily understood than the latter term and seemed suitable. On the contrary, the terminology *Business Reinvention* was not easy to understand and confusing. Due to clarity and practitioners’ preference, *Innovation* was reclassified from "Project Driver" to "Project Objective". Secondly, 80% of practitioners agreed on the characteristics of the "Project Acceptance" dimension. However, they collectively suggested consolidating both *internal* and *external* customers into a single characteristic named *End User* to better reflect project scenarios. As a result, the "Project Acceptance" dimension now includes only the *End User* characteristic in this iteration.

## 6. Validating Taxonomy by Case Study Analysis

Using a pre-defined template and individual sessions, insights were gathered from each case through open coding. Table 4 demonstrates the application of the developed taxonomy in each case.

Table 4. Collected Cases' Descriptions

| Case No | Industries | Case Descriptions |
|---|---|---|
| 1 | *Consulting Business and Corporate Investment* | This was a digital business case that demanded new competencies. The *goal* of this project was to implement a new *business model* that complements existing plant products with a data-driven monitoring system. Through this project, they planned to build a *digital* extension in the form of a digital data model without which *the organization* can face a high level of disruption in the future. With time the transparency and acceptance of the new business model were significantly increased by the *employees*. The starting point for *initiating* this project was in the company's lean management where they wanted to add some *business value* to the company. They followed *classical project management* to design a target action plan and the distribution of roles and responsibilities. The project team was *formed* with three project managers from lean management and one human resource manager. They also took three consultants from *external parties* in their team to help in moderation and process management. |
| 2 | *Financial Service* | Like Case 1, this project was also driven by *business value* and *digital technology*. This specific case relates to developing a new technology/tool that will fit into the company's digital transformation strategy. The main *objective* of the project is the generation of a new analytical tool with additional intelligence (AI) on the data generated in the monitoring of web traffic through artificial intelligence. The project has a direct *impact* on the company by increasing competency and being a source of higher turnover when the final product is developed. The *employees' motivation* was necessary to accept the change coming with the project to ensure a stable workspace. The project was run by eight people including the *internal* and *outsourced* team. The organizational structure of the project followed the *balanced matrix organization structure* adapted for this. Thus, obtaining optimum coordination between agents and better dissemination of horizontal and vertical information was easy to handle. In this way, the final decision-making also does not fall exclusively into the hands of the *project manager*. Seeking to ensure fast project implementation they have applied *agile* project methodology which involves constant collaboration with the project partners. |
| 3 | *Consulting Business and Corporate Investment* | In this case, the organization planned to run the specific project to make their "discovering hidden talent" task more organized and *digitalized*. Through this project, they targeted to take competence management *inside the organization* to the next level by making training measures more efficient; digitally uncovering hidden talents, and documenting those qualifications comprehensively to make them easily searchable. They also aimed to increase *employee attractiveness* and staff retention rate. They opted to initiate this project to keep pace with the rapidly changing world, enhance their *customer service,* and increase the turnover consequently. At the beginning of this project, the idea and goal of this project were briefly discussed with the training provider, in the presence of the business consultant and the supervisor of the software. Through this phase, the *management* agreed on developing the competencies jointly and paving a single way for those through a competence management software system. To fulfill the mentioned goal above, they formed an *agile* project *team* including a business consultant, a person from human resources who is a part of the training providing program, and a supervisor from IT support who knows software. They decided to have a *non-hierarchical team* to provide |

| Case No | Industries | Case Descriptions |
|---|---|---|
| | | the *maximum degree of opportunity* to manage work. This decision worked very well for them to act more quickly to reach the desired common goal. |
| 4 | *Health Care Software Development* | During the pandemic due to COVID-19, many companies went for remote working to keep up their business. This project was initiated in one of those companies. The *goal* of this project was to help create a working environment in the *employees'* homes and overcome the data security challenges on the part of the organization at the same time. Dedicated resources as well as the IT *team*, supported by the *management*, was the efficient combination for the digital transformation in this project. The readiness to accept the change both from the *employee and the organizational side*, was the main consideration in the way of the project's success. They implemented new practices to achieve *business* growth and meet *customer* needs. The organization chose to drive the project according to the *Scrum* method. The project team was formed with *internal expertise*, all holding the same role as the process owner. It was a cross-functional team where all the members worked collaboratively to reach a common goal. The team was kept as a self-managed team by providing the *highest autonomy* while keeping a good connection among all. |
| 5 | *Business Consulting and Service* | This is the first case that seems to have been an objective towards *innovation* driven by *business value* and *digital technology*. The goal was to align IT more closely with *customer needs* and create end-to-end responsibility for IT while ensuring operational stability during the transformation phase. They wanted to *improve their performa*nce by implementing a *new operating model* considering there could be challenges and complexities. Given the complexity and scope of the project, the team was formed with decision-ready participants from IT, business, HR, and finance and they followed an *iterative approach*. Different *internal* employees led the project occasionally to make them adjust with the targeted customer. Help from *external* consultants was also taken when needed. The first level of *leadership* in IT has been the core team. The project had seen to have a direct impact on both *inside and outside* the organization and improving their customer service. They expected to improve consistency in *business development* and better alignment with customer needs. |
| 6 | *Educational Technology* | This DT Project was aimed at relaunching their AI companion with three *new* primary features. The idea was not to merely *digitalize* the already existing career guidance, but rather to *reimagine* the way Gen Zs imagine careers. They are combining human efficiency with Artificial Intelligence to power up this disruption. This project is fully intended to fill up the *desire of the market*. The project was initiated through a *bottom-up* approach. As a small company, they kept the project *team* small with 4 people maintaining a *non-hierarchical* structure to avoid complexity. One backend developer, one frontend developer, one product owner, and one designer were involved, and they changed roles if needed. Though the team did not follow any methodology strictly, some part of *Agile* was adopted. |
| 7 | *Digital Business Transformation and Consultancy* | This project has a partial intention to improve their website, which is their *product*, through their shared DT project. The goal of this DT project was to *update* the layout of their website so that *people* can directly order cars online. Utilizing the project, they targeted to catch the attention of *potential customer* groups and increase their online sales. This project was initiated through a top-down approach. The project team involved nearly 40 people including creative, social media, copywriting, and product managers. The team followed *agile methodology* to carry on their task though they had *mid* autonomy. To them, the most important things were fast delivery and keeping in a continuous feedback loop with clients. This project had the intention to serve the *organizational work structure* by rearranging their team setup according to the different workstreams of their products. |

| Case No | Industries | Case Descriptions |
|---|---|---|
| 8 | *Computer Software* | This case is collected from a German multinational software organization. The main *aim* of this DT Project was to *enhance* and streamline the procurement *processes* within *their organization*. During the annual health check, the *audit team* noticed that the cost of the procurement department was going higher. Consequently, the organization needed to control the process and decrease the cost. To accomplish the project, a *team* was formed with 9 people from 2 different departments. Of them, four were *external* people. The team was a combination of project manager, project portfolio reviewer, and business analyst with 2 stakeholders from other business units. It was a fully *autonomous* team *led* by a defined *project manager*. According to the company's normal structure, the project started its journey through *traditional or waterfall methods*. |
| 9 | *Computer Software* | This case has been collected from the same organization as Case 8. The ultimate *objective* of this DT project was to *automate* every step of deployments from the hardened operating system to the application including all necessary configurations. With this, the organization wanted to ensure *business continuity* and save valuable IT resources. Together with that, they wanted to implement a collaboration approach between *information technology* and business units to enable valuable contributions towards their other project. The project *team* was created with 5 people from *multiple* departments. They did not have a *specific leader* as a result whenever anyone needed guidance the other members had reached out to help. This indicates practicing *shared leadership*. Like the previous case, this was also maintained by the *traditional or waterfall project* management method. The initiation of this case was on purpose to bring some changes in the set-up of the *GitHub tooling process*. It will eventually help to migrate repositories to GitHub, implement monitoring dashboards to observe those, and set alerts in case any hamper goes on. |
| 10 | *Financial Technology* | The project was meant to serve the *internal customer*, which means the employees of the organization. They wanted to provide a user-friendly platform for booking desks and rooms in the office, where users could also see where the booked resource is in the office. The plan was to make the booking *process* easier and *comfortable*. The project *team* has been formed including three Software Engineers, a Software Developer, a Product Manager, and two Designers. The idea for this project was generated by one of the *software engineers*. Hence, the engineer and the product manager were *leading* the project. They had quite a lot of *autonomy* since this was an internal project. The team followed the *agile methodology*, especially the reflex of the scrum, to run this project. They had been doing their work through sprints. This is an ongoing project where the team is making new additions to their web *service* according to the demand. |
| 11 | *Financial Technology* | The *objective* of this DT project is to reach a broader *target group* and leverage a large customer base of *their partner*. They want to improve both their *product* and *process* to reach the goal. To enhance the product, their strategy involves constructing a new, integrated interface, incorporating new features that are frequently requested by *customers,* and leveraging business growth. To conduct the project, a *team* was formed with 10 people from the *product department* and 20 from *the engineering* from *internal* and *partner* organizations. This project was *led* by the product people and C-level by practicing the *shared leadership* method. The idea of *initiating* the project and the direction to run the project comes from company leadership, founders, and C-level executives. Therefore, it has a *mid-level* of autonomy. The team chose to follow the path guided by *agile* methodology. |

After the open coding, we adjusted the taxonomy according to the analysis. Firstly, none of the cases mentioned the "Organizational View" dimension. Therefore, we opted to exclude this dimension from the taxonomy. Secondly, we removed the characteristic *Team with only specific discipline people* from the "Team Formation" dimension as it did not appear in any of the cases. Thirdly, we considered excluding *Hybrid* from the "Project Initiators" and "Project Management Method" dimensions, as it was not mentioned in any of the reviewed cases. Fourthly, a new characteristic *Shared Leadership* has been added to the dimension "Leaders of DT" as nearly 36% of the cases mentioned it. Lastly, *Mid Autonomy* was added to the "Team Autonomy" dimension, reflecting its presence in nearly 20% of the cases. Considering all those adjustments, we finally came up with the taxonomy demonstrated in Figure 2.

| ***Dimensions*** | ***Implementation Strategies*** | | | |
|---|---|---|---|---|
| *Project Objective* | Innovation | | Performance Improvement | |
| *Project Driver* | Business Value | | Digital Technology | |
| *Project Initiators* | Top-down | | Bottom-up | |
| *Project Triggering Factors* | Internal | | External | |
| *Nature of Project Novelty* | Towards Market | | Towards Organization | |
| *Innovation Area* | Product | Process | Business Model | Service |
| *Team Autonomy* | High Autonomy | Mid Autonomy | Low Autonomy | |
| *Team Formation* | Interdisciplinary Team | | | |
| *Leader of DT* | Specific Leaders for DT | Project Manager | Shared Leadership | |
| *Experise of Project Members* | Full internally sourced | | Mixed with internal and external personnel | |
| *Project Management Method* | Traditional | | Agile | |
| *Project Acceptance* | End Users | | | |

Fig. 2. The Final Taxonomy for DT Projects Implementation Strategy

Considering the dimensions and characteristics of the third iteration in Figure 2, we can say that the taxonomy is concise, distinctive, extendible, self-explanatory and comprehensive. The dimensions are mutually exclusive and collectively exhaustive, and the characteristics are unique. None of the dimensions was merged or split during the third iteration. As the taxonomy from the third iteration met all the defined conditions guided by Nickerson et al. (2013), we concluded the taxonomy development process and articulated it finally. Figure 3 shows the adjustments made in each iteration.

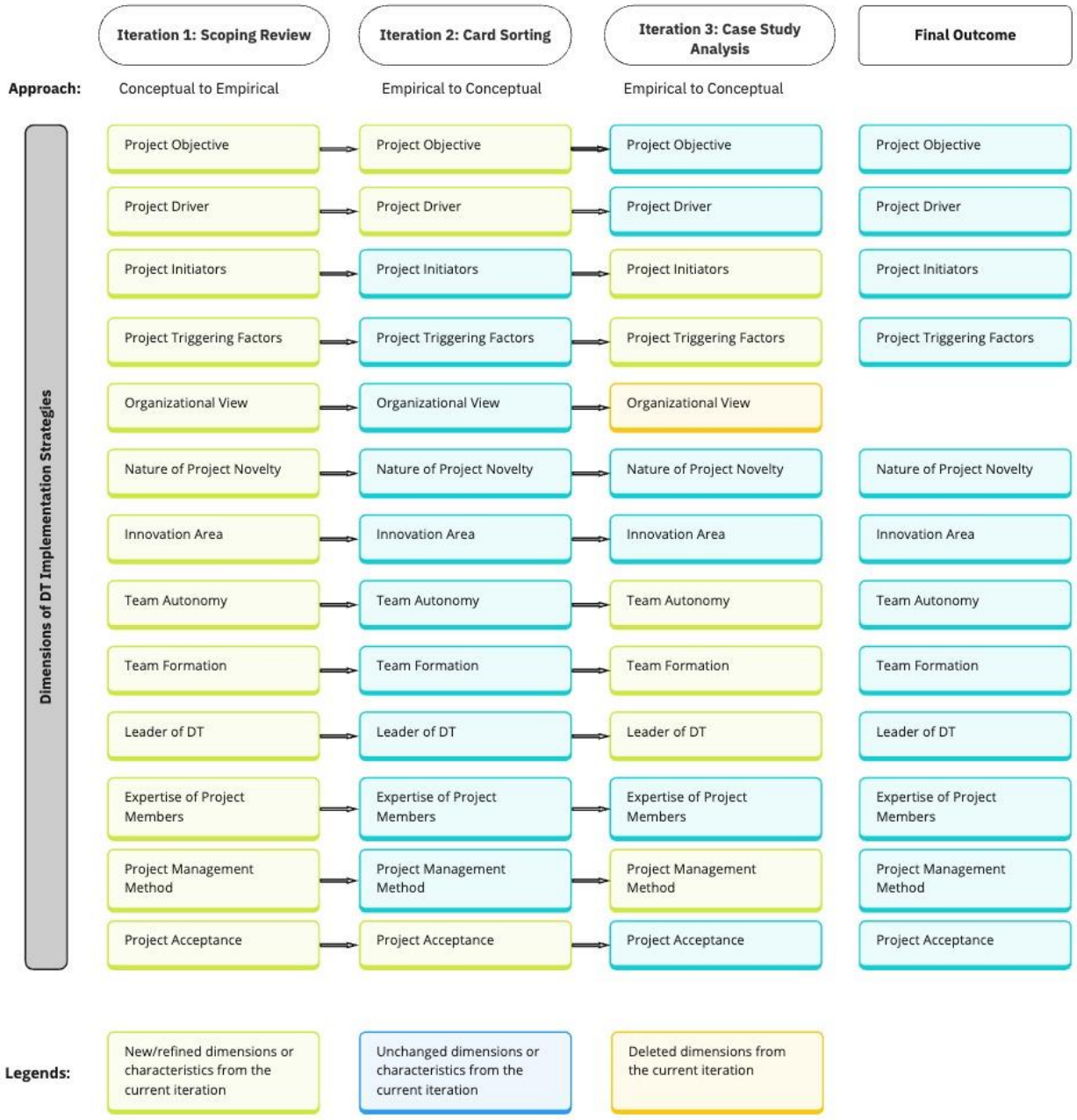


Fig. 3. Taxonomy Development Flow (diagram is inspired by (Hermann et al., 2024; Remane et al., 2016))

## 7. Cross Case Analysis

### *7.1. Project Objective with their innovation focus area*

The primary objective of all cases is seen to be improving organizational performance from various product, process, service, or business model perspectives. While cases 1, 2, 6, 7, and 11 focus on product enhancement and innovation, cases 3, 4, 7, and 9 aim to improve the work environment through digitalization. Besides, cases 5, 8, 10, and 11 emphasize process improvement via new business models, automation, or new functionalities. Only a few (i.e., cases 6 and 10) seek product innovation alongside performance improvement.

The cases are seen to be creating novelty either towards the organization or market or both. In the case of organization novelty, the cases wanted to either optimize their work processes (cases 2, 8), ensure business growth continuity (case 4), or ease employees' lives (case 10). Nearly half of the collected cases (i.e., cases 1, 3, 5, 7, 11) have aimed to influence both the organization and the market through their DT Projects, enhancing product, process, and business model, while attracting and retaining customers.

### *7.2. Project Origin*

Originating projects indicate three dimensions described in this taxonomy. For steering DT projects, all cases except case 10 considered both business value and digital technology. Case 10 focused solely on simplifying employees' daily activities. In other cases, the organizations initiated to elevate their business value by integrating digital technology into business models (cases 1, 5), products (cases 2, 6, 7, 11), work structures (cases 3, 4), or processes (cases 8, 9).

Project initiation can flow from general to specific aspects or vice versa. Among eleven cases, four DT Projects followed a bottom-up approach, initiated by lean management (case 1), project team members (cases 6, 10), and procurement management (case 8). In contrast, cases 3, 4, and 11 indicate project initiation from the top management level, later branching into specific sector-focused enhancements.

Concerning the origin of the projects, the cases differ in considering from which sector the project was triggered; internal or external. Five cases were triggered solely by organizational internal issues: improving business value (cases 1, 2), enhancing processes (cases 8, 9), and improving work-life balance (case 10). Cases 5-7 have solely focused on bringing value to external factors through their DT Projects being triggered by the target market. Conversely, DT Projects in three instances (cases 3, 4, 11) have been instigated by a combination of internal and external factors, considering business operations and expansion; and customer satisfaction.

### *7.3. Project Resource Planning*

Project team resources or expertise were mixed with internal and external (i.e., consultants, support engineers, students) personnel in cases 1, 2, 3, 8, and 11; and fully internally sourced in the rest of the cases. Incorporating internal resources into the project team, organizations in ten cases have opted to construct an interdisciplinary team. The personnel related to information technology (IT) has been commonly included in each case. Software developers, software designers, software engineers, business analysts, product managers, and project managers were commonly included in those cases. Along with them people from other departments, such as human resources (cases 1, 3, and 5), creative, social media, and copywriting (case 7), were noticed to be included occasionally.

Team autonomy has not been discussed in two cases. In the remaining cases, seven teams were highly autonomous, with only two having a mid-level of autonomy differing from the majority. Subsequently, selecting leaders for those project teams diverge significantly. Project Managers have been seen to be in the leading role for cases 2 and 8. Cases 5 and 10 indicate having multiple specific leaders throughout their projects, each fulfilling specific roles as needed. Surprisingly, four cases (3, 6, 9, and 11) have uttered of having no specific leaders during their project life duration.

### *7.4. Project Management and Acceptance*

While implementing DT Projects, the cases have considered either traditional waterfall project management or agile project management. The projects explored in cases 2-7, 10, and 11 extensively focused on the adoption of agile methodology. Only three cases (cases 1, 8, and 9) emphasized the projects based on traditional project management. No traces of hybrid project management, combining traditional and agile methods, were observed in these cases.

Project acceptance has been considered a factor in all the cases while implementing DT projects. In most cases, employee acceptance was crucial for ensuring project stability (cases 1, 2, 4, 6, 8-10), maintaining motivation and support (case 3), retaining employees (case 5), and improving partner relations (case 11). Alongside gaining employee approval, cases 4, 6, 7, and 11 also considered customer acceptance of the project.

A summary of this cross-case analysis can be found in Figure 4.

| ***Dimension*** | **Case 1** | **Case 2** | **Case 3** | **Case 4** | **Case 5** | **Case 6** | **Case 7** | **Case 8** | **Case 9** | **Case 10** | **Case 11** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Project Objective* | Performance Improvement | Performance Improvement | Performance Improvement | Performance Improvement | Performance Improvement | Performance Improvement, Innovation | Performance Improvement | Performance Improvement | Performance Improvement | Performance Improvement, Innovation | Performance Improvement |
| *Project Driver* | Business Value, Digital Technology | Business Value, Digital Technology | Business Value, Digital Technology | Business Value, Digital Technology | Business Value, Digital Technology | Business Value, Digital Technology | Business Value, Digital Technology | Business Value | Business Value, Digital Technology | Digital Technology | Business Value, Digital Technology |
| *Project Initiators* | Bottom-up | - | Top-down | Top-down | - | Bottom-up | - | Bottom-up | - | Bottom-up | Top-down |
| *Project Triggering Factors* | Internal | Internal | Internal, External | Internal, External | External | External | External | Internal | Internal | Internal | Internal, External |
| *Organizational View* | - | - | - | - | - | - | - | - | - | - | - |
| *Nature of Project Novelty* | Towards Market, Towards Organization | Towards Organization | Towards Market, Towards Organization | Towards Organization | Towards Market, Towards Organization | Towards Market | Towards Market, Towards Organization | Towards Organization | Towards Organization | Towards Organization | Towards Market, Towards Organization |
| *Innovation Area* | Product Business Model | Product | Process | Process, Service | Process, Service, Business Model | Product, Service | Product, Process, Service | Process, Service | Process, Service | Process, Service | Product, Process, Service |
| *Team Autonomy* | - | High | High | High | - | High | Mid | High | High | High | Mid |
| *Team Formation* | Interdisciplinary Team | - | Interdisciplinary Team | Interdisciplinary Team | Interdisciplinary Team | Interdisciplinary Team | Interdisciplinary Team | Interdisciplinary Team | Interdisciplinary Team | Interdisciplinary Team | Interdisciplinary Team |
| *Leader of DT* | - | Project Manager | Shared Leadership | - | Specific Leaders for DT | Shared Leadership | - | Project Manager | Shared Leadership | Specific Leaders for DT | Shared Leadership |
| *Expertise of Project Members* | Mixed with Internal and External Personnel | Mixed with Internal and External Personnel | Mixed with Internal and External Personnel | Fully Internally Sourced | Fully Internally Sourced | Fully Internally Sourced | Fully Internally Sourced | Mixed with Internal and External Personnel | - | Fully Internally Sourced | Mixed with Internal and External Personnel |
| *Project Management Method* | Traditional | Agile | Agile | Agile | Agile | Agile | Agile | Traditional | Traditional | Agile | Agile |
| *Project Acceptance* | End User | End User | End User | End User | End User | End User | End User | End User | End User | End User | End User |

Fig. 4. Cross Case Analysis

## 8. Implications

This study focuses on defining key dimensions for implementing DT projects, resulting in a taxonomy shown in Figure 2. It has exclusively concentrated on capturing the attributes of DT projects and the organizational perspective related to this particular project type. Consequently, The taxonomy reflects this focus, omitting aspects like complexity, uncertainty, expertise level, and project duration typically found in conventional project management models (Abdulhafedh, 2021).

In this section, potential contextual factors will be discussed based on the analysis conducted in each step of taxonomy development and cross-case analysis. Given the limited number of cases in this study, definitive empirical statements are not possible, so the discussion will focus on speculative insights into these contextual factors.

### *8.1. Guidance to Implement DT Projects*

Individual DT Projects have seen to gain success with their defined organizational goal though they differed from each other from some perspective. Thus, it can be assumed that there is no certain frame that can make a DT project successful. It varies from project to project. Accordingly, it can be difficult to have one way to describe the way to implement such projects. Using classification i.e. taxonomy can be a better approach which leads us to develop one.

### *8.2. Dimensions and Characteristics for DT Project Implementation Clustering*

Practitioners' participation in the card sorting technique shows familiarity with the dimensions and characteristics included in this taxonomy. Despite lacking a defined structure for implementing DT Projects, they continuously apply these concepts and achieve success with their methods. This highlights the relevance of the taxonomy's dimensions and characteristics for successful DT Project implementation.

### *8.3. Understanding the situation to implement DT Projects*

It was observed that DT Projects are predominantly executed to achieve performance improvement in the organization's products, processes, services, or business models. Mature companies emphasize innovation less, while start-ups and growing companies embrace risk for stability (Lippitt & Schmidt, 1967). This factor creates opportunities to introduce innovation through their initiated projects. Business value is found to be the most defined catalyst for DT Projects. This indicates companies implement DT projects for long-term financial growth and better project performance. Digital technology is also a commonly recognized motivator though the project's drive isn't always solely from technological advancement. On another note, DT projects are initiated equally through top-down and bottom-up approaches, indicating both are viable depending on project needs.

### *8.4. Independence of Targeted Domains in DT Project Implementation*

The project objective involves enhancing or innovating products, processes, services, or business models within an organization. Strategically, during the implementation of the DT project, this dimension remains fully independent. By defining project goals, companies choose areas for innovation or improvement, thus delineating the project's innovation domain.

### *8.5. The environment-oriented with DT project implementation*

The project's initiators and its intended beneficiaries are closely connected. Projects initiated by internal needs aim for organizational novelty, while external triggers focus on the target market. Nevertheless, it is observed that in some instances, the project goal may be oriented to meet both the organization's and the customer's requirements, irrespective of whether the trigger point is internal or external. The dimension of project acceptance is seen to be highly related to the dimension of project novelty. It indicates that the project's acceptance often hinges on those for whom the goal is intended).

### *8.6. Formation of teams for DT Projects*

DT project discussions often focus on team characteristics, with organizations typically preferring interdisciplinary teams of internal and external employees Interdisciplinary team helps to have cross-functional knowledge which serves as a reasonable cause to have one. Including internal and external expertise enhances the opportunity to gather valuable knowledge, regardless of its availability within the organization. Considering team autonomy, most analyzed cases favor high team autonomy and a non-hierarchical structure. To sustain collaboration and ensure collective output, projects are mostly led by managers or designated leaders. On the contrary, DT Projects are also seen to be operated without a designated leader, with team members assuming leadership roles based on their expertise and project needs.

### *8.7. Preferred Project Management method in implementing DT Projects*

Companies often opt for variations of agile methodologies when implementing DT projects. However, companies that have consistently used the traditional or waterfall approach tend to stick with it and succeed in their DT projects. This implies that while agile is preferred for DT projects, alternative approaches do not pose obstacles for organizations.

In summary, implementing DT projects varies based on internal and external contextual factors such as organizational structure, culture, target market, available competence, maturity level, and so on.

## 9. Conclusion and Contributions

In this research, we uncovered and classified DT Project implementation strategies into twelve distinct dimensions within the taxonomy based on insights from scholars and professionals. These dimensions encapsulate the key dimensions of DT Projects, including:

1. Project objective: The goals intended to be achieved.
2. Project driver: The primary force propelling the project forward.
3. Project initiators: The origins of project ideation.
4. Project triggering factors: The motivations for undertaking the project.
5. Nature of project novelty: The intended beneficiaries of the project.
6. Innovation area: The specific focus areas targeted for innovation.
7. Team autonomy: The degree of independence granted to the project team.
8. Team formation: The strategy for organizing the project team.
9. Leader of DT: The appointed project leadership.
10. Expertise of project members: The composition and skill set of the project team.
11. Project management method: The optimal methodology for managing the project.
12. Project acceptance: The critical stakeholders for project approval.

By adopting a standardized classification, this taxonomy seeks to enhance clarity and precision in discussing DT Project implementation strategies among DT Project practitioners and academic researchers. For instance, terms like "agile implementation," "shared leadership," or "innovation areas" may be interpreted differently. What exactly does adopting an "agile implementation" strategy mean? By referring to this taxonomy, stakeholders can understand these terms, facilitating enhancing communication about project strategies.

Moreover, this structured approach aims to improve information exchange about DT strategies. Often, communication fails due to vague terminology. It's anticipated that this taxonomy will enable meaningful exchanges about digital transformation projects, strategies, and lessons learned, fostering coherence and productivity.

The taxonomy's dimensions are mutually exclusive and collectively exhaustive, meaning they are distinct yet comprehensive. A combination of characteristics from each dimension can guide the implementation of a Digital Transformation (DT) project. These dimensions serve as a starting point for considering key elements, such as the project's objective or driver. By answering questions like *"What is the intended goal to achieve in this DT Project?"* or *"What is the motivation of undertaking the project?"*, organizations can select relevant characteristics from the taxonomy to form an initial set of strategies, helping to guide the next steps in the DT project's implementation.

The taxonomy was validated through a rigorous three-iteration process, engaging practitioners from a variety of organizations. Our case studies confirmed the dimensions' presence and importance, validating the taxonomy and its role in successful DT projects.

In the cross-case analysis, we found that organizations mostly initiate a DT Project to improve and digitalize their existing products, processes, services, or business models and add business value for the organization, target market, or both.

DT Project teams are highly autonomous and agile, comprising both external and internal personnel from various departments. Besides, the outlined contextual factors offer a roadmap for understanding and implementing DT projects. Reviewing the shared cases will provide insights into potential implementation challenges and study implications.

### *9.1. Limitations*

While conducting this study, we faced some limitations. For the scoping review, we only used Google Scholar, potentially missing relevant articles from other search engines. However, the initial inclusion had many articles, minimizing the limitation. In the empirical study, we focused on German organizations, which may differ from those outside Germany due to contextual factors. Another limitation is the sample size of 11 cases, which may affect the final stage of taxonomy development. Increasing the sample size can strengthen research results (Dolnicar et al., 2014), providing a focus for future studies.

### *9.2. Future Research Suggestions*

The developed taxonomy can aid DT Projects in various industries, whether startup or established, as demonstrated in the third iteration. Future research could focus on a specific genre to test the taxonomy's effectiveness. Concrete guidelines can be developed using this taxonomy, benefiting practitioners. However, the taxonomy does not guarantee DT Projects' success as it does not include KPIs but facilitates a deeper understanding of DT Projects' characteristics to enable the development of concrete guidelines for success. Future research could explore which KPIs, based on the taxonomy, can be used to evaluate DT Project success.

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RESEARCH ARTICLE

# Blockchain adoption factors

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## Abstract
Blockchain technology is a distributed ledger that promises transformative changes across various sectors, yet its adoption and integrations in small and medium-sized organizations remain limited. This study investigates the factors that influence the adoption of blockchain technology, emphasizing the significance of Trust and Security as key moderators. Using a questionnaire distributed to a diverse group of employees and analyzing responses through Structural Equation Modeling (SEM-PLS), we constructed a predictive model of blockchain adoption. Our analysis reveals that Performance Expectancy and Social Influence positively affect the intention to adopt blockchain, indicating that perceived effectiveness and peer support drive adoption. Trust significantly enhances this intention, underscoring the importance of confidence in the technology's reliability and security. Environmental Concerns present a barrier, suggesting sustainability perceptions can deter adoption. This study conclusively demonstrates that promoting trust, addressing environmental sustainability, and leveraging social influence are pivotal for accelerating blockchain adoption in small and medium-sized organizations.

## Keywords
blockchain; blockchain adoption; technology acceptance; technology use behavior.

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## 1. Introduction

Blockchain is the result of numerous technological innovations that spanned several decades, integrating data, functionalities, services, and microservices (Bernardino et al., 2022). The concept for this decentralized technology first came from Nick Szabo in 1988. The idea became a reality ten years later when the Bitcoin whitepaper (Nakamoto, 2017) was published, which aimed to instigate change within a failing financial world dominated by authority. It later became clear that complex financial instruments and declining trust among institutions played key roles in the 2008 crisis (Dhillon et al., 2021a). Such issues emphasized the need for reform within our financial system, addressing these problems and considering institutional trust and transparency. In 2009, the first Bitcoin block was mined, marking the beginning of the cryptocurrency era.

In 2015, following numerous criticisms regarding Bitcoin's closed nature to modifications, which limited the dissemination of the technology, the Ethereum blockchain was born (Buterin, 2013). This new blockchain started as a hard fork of the Bitcoin blockchain and is widely recognized as a successor to the Bitcoin protocol (Dhillon et al., 2021b). It caused a paradigm shift not only in the world of finance by continuing the penetration of Decentralized Finance (DeFi) but also more broadly by bringing the technology into discussion in academia, society, and especially within organizations with the introduction of smart contracts. These contracts represented a unique innovation, adding a new level of functionality and complexity to blockchain technology by enabling the development of decentralized applications not limited to the domain of decentralized finance. They introduce a programable behavior in technology.

As distributed technological infrastructure is gaining traction, blockchain's widespread adoption is reaching several industry sectors. Insurance, logistics, supply chain, management, healthcare, energy, telecommunications, Internet of Things, and finance are examples of that (Bruneau & Matei, 2012; Clincy & Shahriar, 2019; Dhingra et al., 2024; Gan & Lau, 2024; Jena, 2022; Ni & Irannezhad, 2024; Rachad et al., 2024; Tsolakis et al., 2021; Zhang et al., 2024; Zhao et al., 2016). A trend is observed among C-suite executives, with around 33% (approximately 1000) either already harnessing or contemplating the adoption of blockchain technologies (Gan & Lau, 2024). However, despite its array of potential advantages, blockchain technology remains underexploited, particularly among individuals and smaller enterprises (Yli-Huumo et al., 2016). Energy consumption has been an important factor in blockchain adoption (Aparicio et al., 2022).

This research employs the Unified Theory of Acceptance and Use of Technology (UTAUT) to investigate a model that identifies factors influencing the adoption of blockchain technology. According to this model, the key drivers of technology adoption include performance expectancy, effort expectancy, social influence, and facilitating conditions. There has been limited application of the UTAUT theory in studying blockchain acceptance and usage. We aim to explore the components that affect blockchain technology adoption and find strategies to encourage its uptake among individuals and small businesses.

This research gathered quantitative data to enrich the literature on blockchain technology adoption and use. We surveyed to operationalize a theoretical framework aiming to contribute insights that could benefit individuals, corporations, and policymakers interested in utilizing blockchain technology.

The paper is organized as follows. Section 2 presents the Research Background. Section 3 outlines the research model and hypotheses. Section 4 describes the methodology and the empirical study, with the results provided in Section 5. Section 6 offers a discussion of the findings. Finally, Section 7 concludes the paper by summarizing the main findings and contributions to research, discussing practical implications, addressing the study's limitations, and suggesting opportunities for future research

## 2. Research background

A fundamental characteristic of blockchain is its decentralized nature, operating on a distributed data structure based on nodes. These nodes maintain the consistency of data decentralization through consensus mechanisms, which are essential for validating new transactions and allowing them to be added to the blockchain (Dhillon et al., 2021). Consensus processes ensure that all blocks are verified and agreed upon by most participants before being added to the data structure, known as the "Merkle Tree". All transactions are recorded and aggregated into a dataset known as a block. Each block, once confirmed, is cryptographically linked to its predecessor, creating a chain of blocks — true to the system's name (Abreu et al., 2018). This architecture guarantees both the temporal sequencing and the traceability of every transaction (Yawalkar et al., 2023).

A central aspect of consensus lies in the fact that mining is used to achieve consensus and to prevent users from the problems of double spending, while simultaneously validating all transactions (Dhillon et al., 2021). This is vital in protecting the blockchain against criminal activities and human errors (Patrício & Ferreira, 2020). The blocks possess an immutable and unbreakable nature, ensuring that once data is recorded, it remains unchangeable and permanent, which is fundamental for the blockchain's security and trustworthiness (Prasetyo, 2018). Furthermore, using advanced cryptographic methods provides a transparent, robust, and efficient framework for recording and managing transactional data, bolstering privacy and security. Blockchain technology has the potential to make a big impact on reaching Sustainable Development Goals by supporting solutions that are more open, safe, and environmentally friendly. This affirmation is principally supported by the research efforts led by the United States and China (Bernardino et al., 2022).

The emergence of a novel blockchain version, adept at facilitating decentralized transactions and decentralized applications (DApps), poses a challenge to traditional commercial giants. The OpenSea marketplace is an example of a worldwide store where anyone can buy Non-Fungible Tokens without a central authority (Chalmers et al., 2022; White et al., 2022). In this evolving digital landscape, companies are finding themselves less reliant on centralized architectures or intermediaries for trust. This shift towards blockchain technology could revolutionize their operations by decentralizing systems, slashing transaction costs, and enhancing safety, transparency, and speed (Al-Jaroodi & Mohamed, 2019; Christidis & Devetsikiotis, 2016; Clincy & Shahriar, 2019).

A study that compares blockchain development platforms for developers, highlights some of the challenges faced by organizations that are attempting to transform the way they interact with other organizations, stating that some platforms are not suitable and revealing that the best platform depends on their needs (Clincy & Shahriar, 2019). Within the healthcare sector, India leads in research output, with IEEE Access being the foremost journal in publication volume (Dhingra et al., 2024). The attributes of blockchain, including security, traceability, transparency, and cost efficiency, have the potential to enhance supply chain transparency, bolster record-keeping, and combat the issue of drug counterfeiting (Dhingra et al., 2024; Rachad et al., 2024). The MediBlock platform reunifies the information distributed among different healthcare institutions, giving users the possibility to exercise the right of self-determination, changing from the traditional status to a more user-centered development (Bae et al., 2021). The COVID-19 pandemic has compelled insurance companies to transition from their traditional methods to digital platforms, with blockchain emerging as a pivotal technology for revolutionizing operations by enabling swift, transparent, and secure exchanges of verifiable data across all parties (Rachad et al., 2024).

A significant milestone in incorporating blockchain into industry models was enhancing food safety and authenticity through tracking premium products (Clincy & Shahriar, 2019). In 2018, the United Nations' World Wildlife Fund (WWF) initiated the "Blockchain Supply Chain Traceability Project," aimed at combating illegal, unreported, and unregulated (IUU) fishing activities within the tuna sector of the Western and Central Pacific Ocean. By employing blockchain technology, the project established a transparent and secure tracking system covering the tuna supply chain from catch to consumer, including fishing vessels, processing plants, and markets. This innovation allowed WWF and its collaborators to authenticate the

origin and legality of the tuna, ensuring its sustainable capture and transportation (Tsolakis et al., 2021). In 2019, VeChain, PwC, and Walmart China introduced the Walmart China Blockchain Traceability Platform on ThorChain, aiming to establish a secure food traceability system for comprehensive logistics management. VeChain ThorChain was tested and implemented 23 product lines. Q.R. Codes are central in this use case. Each product has a unique Q.R. Code that provides detailed and live product information. By using blockchain technology, which is secure and cannot be tampered with, everyone involved in the supply chain can share their information more openly, leading to better oversight and coordination (Clincy & Shahriar, 2019; Tan et al., 2018).

A thorough analysis of 452 scholarly and industry articles pinpointed areas like taxation, how to handle crypto assets and liabilities in accounting, and specific auditing methods that could be revolutionized by adopting blockchain technology in accounting (Cong et al., 2018; Jayasuriya & Sims, 2022). Factom, Libra, and Verady are companies creating blockchain solutions tailored for the auditing sector, aiming to lighten auditors' workloads, decrease fraud, and improve current processes, alongside other advantages (Abreu et al., 2018). Emerging trends in the field include new accounting methods, real-time accounting, triple-entry accounting, and continuous auditing. Given blockchain's strengths in offering unchangeable, append-only, shared, authenticated, and consensus-based data, coupled with artificial intelligence's (AI) capacity to learn from data and identify patterns for better decision-making, it is anticipated that continuous auditing will evolve to incorporate both AI and blockchain. This integration will create a sophisticated ecosystem that enhances audit processes (Han et al., 2023). A new system for marketplace identification was designed, focusing on the automated and decentralized establishment and auditing of secure, reliable attributes. It was developed and evaluated using Ethereum, which is a public blockchain, and Hyperledger Fabric, a permissioned blockchain (Yawalkar et al., 2023).

The Theory of Planned Behavior, Theory of Reasoned Action, Diffusion of Innovations Theory, and Social Cognitive Theory are instrumental in understanding and predicting technology adoption and success (Taherdoost, 2019). Models like DeLone and McLean's, the Technology Acceptance Model (TAM), and the Unified Theory of Acceptance and Use of Technology (UTAUT) employ these theories to evaluate the proliferation and effectiveness of emerging technologies. UTAUT theory is one of the most comprehensive theories that explain and identify the main determinants of technology acceptance (Tamilmani et al., 2022). This concept emphasizes the importance of concentrating on factors related to user acceptance to increase the adoption and utilization of technology. Improving the system quality can lead to increased user satisfaction, leading to increased use, and ultimately to positive individual and organizational impacts.

Recent studies by Yli-Huumo et al. (2016) reveal that Bitcoin dominated the discussion in 80% of selected academic papers, highlighting its prominence in scholarly discourse. Remarkably, the earliest articles on this topic were not published until 2012, underscoring the novelty of the subject. Additionally, the research indicated that academic authors have produced more scientific papers than industry ones. The United States has been the primary contributor to this body of work, with Europe (notably Germany and Switzerland) and Asia also making significant contributions (Bernardino et al., 2022). The studies have placed a strong emphasis on issues such as security, privacy, protocol design, energy efficiency, waste management, usability, and transparency. Companies that fully acknowledge the capabilities blockchain of blockchain are poised to gain the most benefits from adopting the technology (Ni & Irannezhad, 2024), which also suggests that the transformative impact on business processes is more significant than the technological aspects in deciding to implement blockchain. According to certain researchers, shifting to blockchain requires extensive changes in business operations (Tan et al., 2018). An examination of scholarly articles on blockchain applications in business identified key areas of focus, including governance, integrity verification, finance, data management, privacy and security, education, health, the Internet of Things, industrial management, and process management as the main fields of deployment (Casino et al., 2019).

Our research uncovered a study that integrates the DeLone & McLean model with the technology acceptance model (Janze, 2017), and more recently, we've identified substantial research on the unified theory as it relates to the acceptance and use of blockchain technology. Significant findings include factors such as facilitating conditions, initial trust, and

performance expectancy influencing bankers' intentions to adopt blockchain for financial transactions (Jena, 2022). Additionally, from the perspective of clients, it was found that information quality has the most significant positive effect on customers' intentions to utilize international payment services provided by banks that incorporate blockchain technology (Dam et al., 2020). According to most scientific studies, the primary blockchain use case is supply chain management. Studies based on the UTAUT adoption model assign facilitating conditions as the primary motivator for adopting this technology in this industry (Kabir et al., 2021).

Research (Saberi et al., 2019) identified the main obstacles to blockchain adoption across inter-organizational, intra-organizational, technical, and external dimensions. Meanwhile, a study by Sim & Kamaruddin (2023) applying the Theory of Planned Behavior (TPB) to assess the intent to adopt blockchain technology in the textile manufacturing industry in Johor revealed significant findings. There was a strong correlation between the attitude towards blockchain technology and the intention to use it. The study also identified a moderate connection between perceived behavioral control and usage intention, alongside a strong relationship between subjective norms and the intention to adopt blockchain technology. Alshurafat et al. (2022), in their study that integrates technostress elements with the technology acceptance model to investigate how technostress affects auditors' willingness to adopt blockchain technology, discovered that technostress impacts the perceived usefulness and ease of use of blockchain. They found that both perceived ease of use and perceived usefulness significantly predict auditors' attitudes towards adopting the technology, with perceived usefulness also being a crucial determinant of their behavioral intention to use blockchain technology.

Raddatz et al. (2023), employing the Health Belief Model (HBM) and analyzing responses from 304 participants, determined that factors such as the perceived severity of threats, susceptibility to these threats, awareness, and inertia play a significant role in shaping the perceived advantages of blockchain. These perceptions positively affect consumers' willingness to transition to blockchain-based applications. Despite the significant obstacle presented by consumers' comfort with traditional banking methods, raising awareness about the privacy protections offered by blockchain can encourage adoption, particularly among those with pronounced privacy concerns.

Liang et al. (2021) expanded on the fit-viability model (FVM) by exploring factors that affect managerial intentions to adopt blockchain technology, through an empirical study involving 242 managers predominantly from the medical and financial sectors. Utilizing the Fit-Viability and Task-Technology Fit models, alongside the Unified Theory of Acceptance and Use of Technology (UTAUT), they employed a Partial Least Squares (PLS) model to evaluate managers' intentions toward blockchain adoption. Their findings indicate that both functional and symbolic benefits positively influence managers' perceptions of task-technology fit. Moreover, they highlighted viability as a critical factor in the decision to implement blockchain technology. Ruangkanjanases et al. (2023) demonstrated the impact of essential factors like government regulations, social influence, perceived security, and blockchain's functional benefits on trust and satisfaction within relationship quality, which in turn affects the intention to adopt blockchain. This conclusion was drawn from analyzing data from 460 survey respondents using SmartPLS 3, highlighting the crucial role of social influence and the practical benefits of blockchain in improving relationship quality and thus fostering a stronger inclination towards blockchain adoption. Javeed and Akram (2024) conducted empirical research within China's corporate sector, examining the organizational factors that promote the use of blockchain technology to advance the circular economy. They developed a theoretical framework showing how blockchain technology supports the enhancement of circular economy practices at the corporate level. Their findings highlight the crucial roles of organizational agility, institutional factors, strategic factors, and green knowledge management in reinforcing the link between blockchain technology and the circular economy. Moreover, they provide recommendations for policymakers on enhancing the circular economy by integrating blockchain technology.

The study by Waqar et al. (2024) focused on the challenges impacting the adoption of blockchain technology in small construction projects in Malaysia and found that the main areas for improvement in applying blockchain to small-scale building projects are related to economic and planning issues. In a study assessing how technology readiness impacts the

acceptance of mobile payment services in Brazil, the research focused on the interaction between common technology acceptance constructs, like perceived usefulness and ease of use, and those specific to financial services, such as trust and perceived quality. This study, drawing on Parasuraman's concept of technology readiness from 2000, demonstrated that trust, perceived usefulness, and the perceived quality of mobile payment services directly affect the acceptance of mobile payments (Caldeira et al., 2021).

## 3. Research model

The main point of this study is to understand the factors driving the adoption and use of blockchain technology, considering both the existing literature and the adoption theory. Based on the research background and the work of Zhang and Zhou (2020), who highlighted a gap regarding security and trust in blockchain systems ("*The related work about security and trust issues is summarized. The open issues are discussed, and future work is proposed. Because blockchains are highly distributed, some security and trust mechanisms are greatly needed.*" (Zhang & Zhou, 2020, p. 798)), we include two constructs: Security and Trust. The constructs are identified in Table 1.

Table 1. Constructs' definition

| Construct | Concept | Author |
|---|---|---|
| Performance Expectancy | *"The degree to which an individual believes that using the system will help him or her to attain gains in job performance."* | (Venkatesh et al., 2003, p. 447) |
| Effort Expectancy | *"The degree of ease associated with the use of the system."* | (Venkatesh et al., 2003, p. 450) |
| Personal Technology Acceptance | Person's propensity to embrace and use new technologies for accomplishing goals in home life or work. | (Wong et al., 2020) |
| Social Influence | *"The degree to which an individual perceives that important others believe he or she should use the new system."* | (Venkatesh et al., 2003, p. 451) |
| Security | The level where information is protected from security threats, leakage, and infringement. | (Chang et al., 2022) |
| Trust Transparency | *"The belief that blockchain technology and its services are safe, error-free, and transact transparently."* | (Chang et al., 2022, p. 4) |
| Environmental Concern | *"Represents the attribute of a person's compassion, worries, likes, and dislikes about the environment."* | (Hsu et al., 2014, p. 670) |
| Behavioral Intention | Behavioral intention to adopt a technology describes the individual's subjective likelihood that he or she will use or purchase that specific technology in the future. | (Venkatesh et al., 2003) |
| Use Behavior | Actual use of the technology. | (Tan et al., 2018) |

The following hypotheses were developed after considering the research objectives based on the UTAUT model for examining technological adoption, and the existing literature. According to Venkatesh et al. (2003), performance expectancy is "*the degree to which an individual believes that using the system will help him or her achieve gains in job performance*." This concept integrates the five preceding theories' elements: relative advantage, perceived utility, work fit, result expectations, and extrinsic motivation. Some studies highlight performance expectancy as one of the most important constructs regarding the use of technology (e.g., (Alraja, 2015; Benbasat & Barki, 2007)).

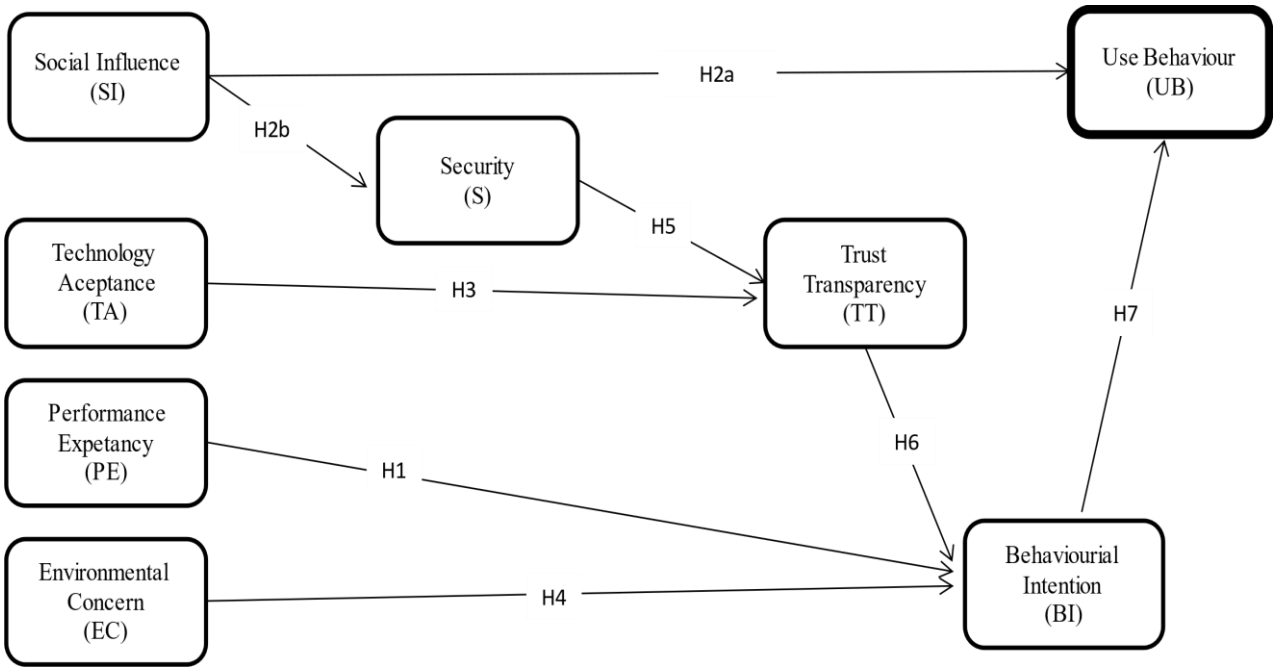


Fig. 1. Blockchain adoption research model

Based on the research by Venkatesh et al. (2003), this study posits that individuals are likely to adopt blockchain technology if they anticipate beneficial outcomes. Performance expectancy has a considerable influence on behavioral intention (Nazim et al., 2021) and plays a pivotal role in user adoption (Zhao et al., 2016). Key predictors for bankers' intention to utilize blockchain in banking transactions include facilitating conditions, performance expectancy, and initial trust, with initial trust also playing a crucial mediating role in the prediction of the intention to use blockchain (Cheng, 2020; Jena, 2022). Additionally, the transparency of blockchain trust impacts both performance and effort expectancy (Chang et al., 2022), while the relationship between perceived ease of use, behavioral intent, and actual usage is affected by the system's complexity. Consequently, performance expectancy is anticipated to positively influence behavioral intention (BI) (Fedorko et al., 2021). Based on the previous investigations, the following hypothesis is proposed:

H1: Performance Expectancy (PE) positively influences Behavioral Intention (BI).

Venkatesh et al. (2003) defined social influence as "the degree to which an individual perceives that important others believe he or she should use the new system". This concept encompasses social factors, subjective norms, and the concept of image. Despite various theories using different labels, all constructs that generate social influence share the underlying belief that an individual's actions are shaped by their perceptions of how others view them due to their technology usage. Numerous studies highlight the significance of social influence in adopting new technologies, indicating that an individual's social surroundings can be crucial in determining their willingness to use technology (Mazman et al., 2009). The influence of social factors from key groups, such as management and departmental teams, on the use of information systems was examined, revealing that managers exert the greatest influence on individuals' adoption of information systems, while the IT department has the least impact (Eckhardt et al., 2009). Furthermore, in the context of cybersecurity, the need for social influence to effect a change in security behaviors was identified (Das et al., 2014). Social catalysts such as peer interactions, demonstrations, and security presentations were found to either enhance awareness about security tools and threats, encourage better self-protection measures, or increase understanding of effective protection strategies. Particularly, having friends across various social circles who use a security feature significantly

motivates the adoption (Das et al., 2015). These findings suggest that social influence can significantly enhance the adoption and security perceptions of blockchain technology.

H2a: Social influence (SI) positively influences blockchain technology's use behavior (UB).

H2b: Social influence (SI) positively influences security (S) to use blockchain technology.

Personal technology acceptance is the propensity to adopt and exploit new technology to achieve personal or professional goals (Wong et al., 2020). Technology acceptance variables have been integrated in many recent studies in various contexts that consistently demonstrated and encouraged the integration of technology readiness in models (Sebastián et al., 2022; Khazaei, 2020; Wong et al., 2020). Limited understanding and knowledge of the Internet result in diminished trust levels (Thatcher et al., 2011) is aligned with a statement that is consistent with observations that trust, perceived usefulness, and the quality of mobile payment services directly impact the acceptance of mobile payments (Caldeira et al., 2021). The moderating roles of transparency and trust are significant in how information quality and the nature of the channel influence intentions (Venkatesh et al., 2016). Moreover, an individual's attitude toward new technology shapes their view of innovations in financial services (Dimitriadis & Kyrezis, 2010), with those more familiar with technology generally placing greater trust in it (Caldeira et al., 2021). Drawing on these insights, the following hypothesis is proposed:

H3: Personal technology acceptance (TA) positively influences trust transparency (TT).

Today's world faces unique, interconnected environmental challenges in areas including climate change, clean water, ocean health, and biodiversity (United Nations, 2024). Environmental concerns represent the attribute of a person's compassion, worries, likes, and dislikes about the environment (Hsu et al., 2014). Stern et al. (1995) and Turaga et al. (2010) demonstrated that ecological paradigm and awareness of consequences measure generalized beliefs about the nature of human-environment interactions, called "folk ecology", as a set of beliefs that may be influenced by social structure and values, that influence attitudes, beliefs, and behavioral intentions.

In Europe, sustainable consumption behavior can be associated with environmental concern, which is influenced by increased levels of environmental knowledge and environmental risk perception, suggesting that environmental concern strongly influences behavioral intention (Aseri & Ansari, 2023; Saari et al., 2021). Rejeb & Rejeb (2020) identified and classified blockchains according to the triple bottom line framework, namely the economic, social, and environmental dimensions of sustainability. The major challenge is the feeling that the public and environmentalists have regarding bitcoin mining, a blockchain technology that they see as a major energy consumer and $CO^2$ emitter (Badea & Mungiu-Pupăzan, 2021). This is aligned with the initial expectations of Environmental concern's impact on behavioral intention. At the business level, a study is being done on potential applications for this technology to improve environmental management and preservation efforts (Polas et al., 2022), even calling it a "game changer for green innovation." Despite the emergence of environmentally friendly projects and concepts within the blockchain space, their integration remains embryonic with minimal tangible impact. Prior research supports the notion that consumers' environmental concerns positively affect their behavioral intentions to engage with such technologies (Hartmann & Apaolaza-Ibáñez, 2012). Thus, the following hypothesis is formed:

H4: Environmental concern (EC) has a negative influence on Behavioral Intention (BI).

Security is characterized as a risk that presents a situation, condition, or event capable of inflicting economic damage on data or network resources through destruction, disclosure, alteration of data, denial of service, and/or instances of fraud, waste, and abuse (Kalakota & Whinston, 1997). Is also a crucial dimension where information is protected against risks, leaks, and violations (Chang et al., 2022). It is a significant theme in blockchain technology research, with 14 out of 41 (33%) papers focusing on security issues and constraints (Yli-Huumo et al., 2016). Although blockchain technology is still in the early stages of development, it relies on experts in security and cryptography to advance it to new levels of innovation and application (Garg et al., 2021; Patrício & Ferreira, 2020). Regarding the behavioral perspective, Mishra and Dhillon

(2006) and Lebek et al. (2013) achieved the need for human-centered security strategies, emphasizing internal control assessment, security policy implementation, individual values, beliefs, and security training as consistent themes that need to be observed. To answer the question "How does blockchain technology guarantee transparency, trust, and sustainability in the context of Agenda 2030?", a study analyzed the implementation of blockchain technology - projected to provide transparency and trust, and its linkages with business sustainability (Gomez-Trujillo et al., 2021). Various studies have shown that an increased sense of security leads to increased trust (Ray et al., 2011), which can have a positive effect on purchase decisions (Prasetyo, 2018). Security is a crucial element that affects one's intention to adopt new technology or to influence one's level of trust (Lim et al., 2019). Trust was used as a moderating factor between security and behavioral intention (Suh & Han, 2003). It was characterized by the perceived quality of information, manifesting through a tripartite structure of perceived information disclosure, clarity, and accuracy. This concept of transparency stands apart from similar constructs like informational justice and is adept at forecasting the perceived trustworthiness of a source, including aspects such as competence, benevolence, and integrity (Schnackenberg et al., 2021). The secure and trust-free blockchain-based transaction can potentially change many existing trust-based transaction systems (Beck et al., 2016). Blockchain technology has a significant and positive impact on the Transaction Security System, which has a significant and positive impact on User Experience (Hsu et al., 2014). Based on this theory, the following hypothesis is formed:

H5: Security (S) has a positive influence on Trust Transparency (TT).

In this and earlier research, trust transparency was defined based on the assumption that blockchain technology and its services are secure, error-free, and transact transparently (Chang et al., 2022), and was observed in various studies (Dagher et al., 2018; Francisco & Swanson, 2018; Khazaei, 2020). From the social psychologist's perspective, trust is characterized in terms of the expectation and willingness of the trusting party to engage in a transaction (Nwaiwu et al., 2020). In the field of technology, flexibility, ease, and benefits that users see in the technology to their activities, appear to be the foundation of initial trust, highlighting that for new or less tech-savvy consumers, early trust is critical for embracing new technologies such as blockchain (Jena, 2022). This suggests that trust has a favorable and strong predictive effect across its different components, particularly transparency and user data ownership (Wong et al., 2020), that impacts behavioral intention. In other words, a lack of faith in IT may induce consumers to quit using or investigating technology due to concerns about its performance or reliability (Thatcher et al., 2011), so trust could be the most important antecedent of behavioral intentions (Roca et al., 2009). The findings align with literature reviews indicating that blockchain technology facilitates the cryptographic and transparent creation and management of contracts, transactions, and records. This transparency in trust generation plays a pivotal role in shaping behavioral intentions. The following hypothesis is developed:

H6: Trust (TT) positively influences Behavioral Intention (BI)

Behavioral Intention (BI) reflects the likelihood of an individual adopting a specific technology. This concept has been extensively explored by social scientists, focusing on the intention to engage in prospective behavior. In the foundational UTAUT model, BI is shown to positively impact actual technology use. The correlation between behavioral intention and the use of technology is reinforced by various technology adoption models integrated within the UTAUT framework. The correlation between behavioral intention and the use of technology is reinforced by various technology adoption models integrated within the UTAUT framework (Khazaei, 2020). Based on these insights, the subsequent hypothesis is proposed:

H7: Behavioral intention (BI) positively influences use behavior (UB)

## 4. Method

This study seeks to identify the determinants influencing the acceptance and adoption of blockchain technology. It is based on the foundational constructs of the UTAUT (Venkatesh et al., 2003), with modifications incorporating insights from additional research (Alatiqi, 2022; Hsu et al., 2014; Nwaiwu et al., 2020). A thorough literature review facilitated the development of a user acceptance model, including examining supplementary variables. We collected data using quantitative and deductive methods with an empirical focus to better comprehend reality and society's perspective (Bryman, 2016). The initial target individuals were formed by personnel of Portuguese companies that require technology for daily operations. We distributed the questionnaire using the survey platform Qualtrics. The initial questions gathered individuals' employment function, as well as their company-based operation in Portugal, and whether their company required this technology for its activity.

The questionnaire had three sections. The first section introduced the researchers, the university, the study's purpose, anonymity, and voluntariness, as well as a summary of how blockchain technology is used, this helped respondents to contextualize. The following section included demographic questions, allowing segmentation of the target audience and the comparison of various genders, ages, and occupations. The third section included the model constructs. All variables were measured with a seven-point scale ("1 – Strongly Disagree" to "7 – Strongly Agree"). The dependent variable, use behavior, was measured with three items that were adapted from the literature (Alatiqi, 2022). A sample item is "I depend on blockchain to achieve my work tasks".

The measurement items are presented in Table 2. Regarding the predictor variables, performance expectancy was measured with four items (Venkatesh et al., 2003). A sample item is "I would find blockchain technology useful in my job". Social influence was measured with four items (Venkatesh et al., 2003). An example is, "People who influence my behavior think I should use blockchain technology." The behavioral intention was measured using three items adapted from the previous study. An example is "I intend to use blockchain technology in 6 months". Personal technology acceptance was measured using three items adapted from the previous survey. A sample item is "Typically; I do not hesitate to try out new information technologies.". Trust transparency was measured with four items used in a previous study by Chang et al. (2022), "Data in blockchain technology would be handled transparently." Security was measured with four items from the previous study. An example of an item is "Using Blockchain technology would be a way to protect from external threats, such as hacking". Environmental concern was measured with four items based on a previous study by (Clincy & Shahriar, 2019). A sample item is "I find Blockchain technology to be against environment conservation".

The questionnaire was developed and distributed in both Portuguese and English language. To preserve and affirm the value and substance of the questions after translation, a native speaker of both English and Portuguese reviewed the questionnaire. We collected the participation of 198 employees from organizations that operate in Portugal, who responded voluntarily. Non-probabilistic, practical, and deliberate sampling was employed. Email was the most common distribution method, followed by LinkedIn and personal contacts. It was observed that many respondents opened the questionnaire and answered the demographic questions, but not the defined items. This likely occurred because the technology is still relatively new, and the topic is complex (Berdik et al., 2021). As a result, when the number of new responses slowed down, the general strategy shifted towards blockchain technology to increase the percentage of respondents and acquire more knowledgeable individuals. The Orbis database of private corporations was accessed, and an e-mail was sent to every company discovered to have open activity in Portugal related to the blockchain. During data collection, responses were frequently downloaded and analyzed to determine their reliability and validity.

The sample characteristics are presented in Table 3. From December 2022 to February 2023, a total of 90 valid responses were gathered. Most respondents are male (80%) and between the ages of 30 and 49 (46%). Regarding their professional experience, the majority (60%) has ten or more years of work, 20% of the sample works in the field of information technology, and the largest sample (38%) responded with a non-optional field. Finally, 42% of them are team members.

Table 2. Measurement items

| Constructs | | Items | | Source |
|---|---|---|---|---|
| BI | Behavioral Intention | BI_1 | I intend to use blockchain technology in 6 months | (Venkatesh et al., 2003) |
| | | BI_2 | I predict I would use blockchain technology in 6 months | |
| | | BI_3 | I plan to use blockchain technology in 3 years | |
| EC | Environmental Concern | EC_1 | Environmental concern has a negative influence on intention to adopt blockchain | (Hsu et al., 2014) |
| | | EC_2 | I find Blockchain technology to be against environment conservation | |
| | | EC_3 | Using Blockchain technology decreases chances of achieving Sustainable Development Goals | |
| PE | Performance Expectancy | PE_1 | I would find the use of blockchain technology useful in my job | (Venkatesh et al., 2003) |
| | | PE_2 | Using blockchain technology enables me to accomplish tasks more quickly | |
| | | PE_3 | Using blockchain technology increases my productivity | |
| SI | Social Influence | SI_1 | People who influence my behavior think that I should use blockchain technology | (Venkatesh et al., 2003) |
| | | SI_2 | People who are important to me think that I should use blockchain technology | |
| | | SI_3 | The senior management in the organization has supported the use of blockchain technology | |
| | | SI_4 | In general, my organization has supported the use of blockchain technology | |
| S | Security | S_1 | Using Blockchain technology would be a way to protect from external threats, such as hacking | (Chang et al., 2022) |
| | | S_2 | Using blockchain technology would be a safe defense against risks such as information leakage | |
| | | S_3 | Using blockchain technology would be a way to protect from data forgery and alteration | |
| | | S_4 | Using blockchain technology would be useful to secure personal information | |
| TA | Personal technology acceptance | TA_1 | In general, I am not hesitant to try out new information technologies | (Wong et al., 2020) |
| | | TA_2 | I look forward to changes at work | |
| TT | Trust Transparency | TT_1 | Blockchain technology is trustworthy | (Chang et al., 2022) |
| | | TT_2 | Blockchain technology services are trustworthy | |
| | | TT_3 | Data in blockchain technology would be saved securely | |
| | | TT_4 | Data in blockchain technology would be handled transparently | |
| UB | Use behavior | UB_1 | I depend on blockchain to achieve my work tasks | (Tan et al., 2018) |
| | | UB_2 | I have used the Blockchain technology a lot in the past 4 weeks | |
| | | UB_3 | I create my own analyses using the Blockchain technology | |

Table 3. Sample characterization

| Sample (n=90) | No. | % | | No. | % |
|---|---|---|---|---|---|
| Gender | | | Job Role | | |
| Male | 72 | 80% | Team Member | 38 | 42% |
| Female | 18 | 20% | Supervisor/Leader | 9 | 10% |
| | | | Director | 10 | 11% |
| Age | | | Manager | 15 | 17% |
| <18 | 0 | 0% | Other | 18 | 20% |
| 18-29 | 23 | 21% | | | |
| 30-49 | 41 | 46% | Years of Experience | | |
| 50+ | 26 | 29% | <2 | 17 | 19% |
| | | | 3-9 | 18 | 20% |
| Business Unit | | | 10+ | 54 | 60% |
| IT | 18 | 20% | | | |
| Marketing | 3 | 3% | Company depends on IT | | |
| Finance | 14 | 16% | Nothing | 0 | 0% |
| Sales | 10 | 11% | Slightly | 8 | 9% |
| Customer Care | 5 | 6% | Highly | 45 | 50% |
| Human Resources | 6 | 7% | Totally | 37 | 41% |
| Other | 34 | 38% | | | |

## 5. Results

The structural equation modeling (SEM) with partial least squares (PLS) method is used to test the proposed model (Costa et al., 2016; Henseler et al., 2009). PLS-SEM was used to assess a non-normally distributed sample for a model with over six components to find relevant drivers and constructs (Hair et al., 2014). The measurement model was examined to evaluate the reliability and construct validity (Costa et al., 2016). A common rule of thumb is a value greater than 0.7 (Hair et al., 2014). To evaluate the constructs, indicators for reliability and validity were measured following (Henseler et al., 2009) proposed measurement model: Cronbach's alpha, Composite reliability, Average Variance Extracted (AVE), Fornell-Larcker criterion, and Heterotrait-Monotrait (HTMT). All the measurements proposed above are identified in tables 4 and 5, following (Henseler et al., 2009), and are supported by other authors (Hair et al., 2014).

To estimate the model using a PLS-SEM analysis and to ensure that the sample size would be adequate for this purpose, given that the maximum number of arrows pointing to a construct in our research model is three, this sample size is sufficient to achieve a statistical power of 80% for detecting $R^2$ values of at least 0.10, with a 10% probability of error (Cohen, 1992; Hair al., 2014).

Table 4. Model measurements

| | Cronbach's alpha | Composite reliability (rho_a) | Composite reliability (rho_c) | Average variance extracted (AVE) |
|---|---|---|---|---|
| BI | 0.884 | 0.889 | 0.928 | 0.812 |
| EC | 0.897 | 0.973 | 0.934 | 0.825 |
| PE | 0.945 | 0.949 | 0.964 | 0.900 |
| S | 0.910 | 0.913 | 0.937 | 0.787 |
| SI | 0.913 | 0.924 | 0.938 | 0.793 |
| TA | 0.768 | 0.793 | 0.895 | 0.810 |
| TT | 0.936 | 0.937 | 0.955 | 0.840 |
| UB | 0.864 | 0.865 | 0.917 | 0.788 |

Table 5. Fornell–Larcker criterion and AVE squared root, and Heterotrait-Monotrait (HTMT)

| | BI | EC | PE | S | SI | TA | TT | UB | BI | EC | PE | S | SI | TA | TT | UB |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BI | **0.901** | | | | | | | | | | | | | | | |
| EC | -0.322 | **0.908** | | | | | | | **0.341** | | | | | | | |
| PE | 0.584 | -0.182 | **0.949** | | | | | | 0.633 | **0.209** | | | | | | |
| S | 0.517 | -0.073 | 0.547 | **0.887** | | | | | 0.576 | 0.094 | **0.591** | | | | | |
| SI | 0.476 | -0.122 | 0.560 | 0.375 | **0.890** | | | | 0.518 | 0.128 | 0.590 | **0.395** | | | | |
| TA | 0.342 | -0.054 | 0.238 | 0.238 | 0.119 | **0.815** | | | 0.434 | 0.096 | 0.243 | 0.268 | **0.145** | | | |
| TT | 0.624 | -0.135 | 0.534 | 0.820 | 0.397 | 0.374 | **0.917** | | 0.687 | 0.146 | 0.567 | 0.884 | 0.427 | **0.428** | | |
| UB | 0.576 | -0.132 | 0.491 | 0.406 | 0.563 | 0.186 | 0.376 | **0.888** | 0.649 | 0.155 | 0.542 | 0.458 | 0.635 | 0.221 | **0.418** | |

To ensure that there is no multicollinearity, which threatens the model experimental design, the variance inflation factor (V.I.F.) was examined for all constructs before the structural model evaluation (Costa et al., 2016). After validating exterior model estimates, bootstrapping assessed structural model quality. Bootstrapping uses the sample as a population representation to evaluate the sampling distribution's shape, spread, and bias. The structural model's route significance was determined using 5000 subsamples. The validity of the structural model ensured the structural paths were assessed to measure the research hypotheses. Looking at Fig. 2, we observe that all hypotheses were supported. SI ($\beta = 0.375$, $p < 0.001$) explains S variation by 14.1%. S ($\beta = 0.774$, $p < 0.001$) and T.A. ($\beta = 0.171$, $p = 0.05$) explain 69.9% of TT variation. TT ($\beta = 0.425$, $p < 0.001$), PE ($\beta = 0.319$, $p < 0.05$), and EC ($\beta = -0.207$, $p < 0.05$) explain 51.8% of BI variation. 44.0% of UB variation is explained by BI ($\beta = 0.398$, $p < 0.001$) and SI ($\beta = 0.374$, $p < 0.001$). All paths are statistically significant, at $p < 0.05$** or $p < 0.001$***, and all hypotheses are supported (Hair et al., 2014).

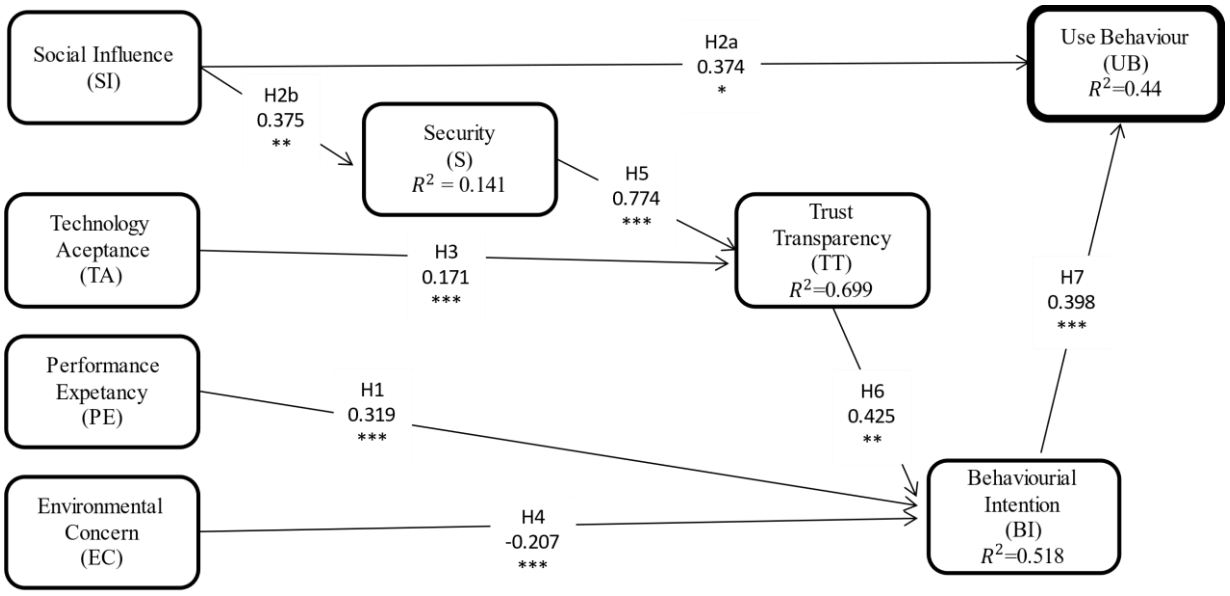


Fig. 2. Structural Blockchain adoption model results
Path *significant at $p < 0.05$; ** significant at $p < 0.010$; *** significant at $p < 0.001$.

As observed in Table 6, the presented model supports all trajectories with at least a moderate predictive impact. Checking the threshold values from previous studies (Chang et al., 2022; Alshurafat et al., 2023), we observe that hypotheses H3 and H4 have a moderate predictive impact, whereas hypotheses H1, H2, H5, H6, and H7 have a large effect.

Table 6. Hypothesis test

| Hypothesis | Independent Variable | | Dependent Variable | Standard deviation | β̂ | T Value | P Value |
|---|---|---|---|---|---|---|---|
| H1 | PE | -> | BI | 0.08 | 0.319 | 4.997 | 0.000 |
| H2a | SI | -> | UB | 0.083 | 0.374 | 2.267 | 0.023 |
| H2b | SI | -> | S | 0.1 | 0.375 | 3.409 | 0.001 |
| H3 | TA | -> | TT | 0.066 | 0.171 | 11.745 | 0.000 |
| H4 | EC | -> | BI | 0.091 | -0.207 | 3.751 | 0.000 |
| H5 | S | -> | TT | 0.066 | 0.774 | 4.477 | 0.000 |
| H6 | TT | -> | BI | 0.095 | 0.425 | 2.574 | 0.006 |
| H7 | BI | -> | UB | 0.08 | 0.398 | 4.456 | 0.000 |

## 6. Discussion

The research aims to demystify the dynamics behind employees' attitudes toward blockchain adoption by integrating the UTAUT model with additional variables that are particularly relevant to the blockchain context as Trust Transparency (TT), Security (S), Environmental Concern (EC), and Personal Technology Acceptance (TA).

We hypothesized that Performance Expectancy (PE) would positively influence Behavioral Intention (BI) to use blockchain technology H1. Our findings, showing PE ($\beta = 0.319$, $p < 0.001$), support this hypothesis and align with Venkatesh et al.'s UTAUT model (Venkatesh et al., 2003), also corroborating with several studies that underscore the importance of PE in technology adoption (Alraja, 2015; Benbasat & Barki, 2007). The positive correlation between PE and BI is consistent with the literature, emphasizing that individuals' belief in the job performance benefits of a system is a compelling factor in their decision to adopt it (Zhao et al., 2016).

SI significantly impacts UB and S, with ($\beta = 0.374$, $p < 0.05$) and ($\beta = 0.375$, $p < 0.01$), respectively, affirming H2a and H2b. This echoes Venkatesh et al.'s (2003) assertion on the pivotal role of social networks in shaping technology usage and security perceptions, highlighting the integral role of subjective norms and social dynamics within organizational and personal spheres in technology adoption (Eckhardt et al., 2009; Mazman et al., 2009). The relation between SI and S is particularly interesting, accounting for 14.1% of S variance, suggesting that the normative pressure and social dynamics within an organization can contribute to a secure technology environment, a notion also found in cybersecurity behavior change literature (Das et al., 2014; Das et al., 2015). These findings highlight the dual role of social factors in not only boosting blockchain adoption but also in enhancing its security posture, suggesting the need to leverage positive social endorsements, and understanding organizational dynamics for effective blockchain implementation.

The relationship between TA and TT is confirmed with ($\beta = 0.171$, $p < 0.001$), supporting H3. This finding is in line with studies that integrate technology acceptance variables and technology readiness, suggesting that an individual's predisposition to adopt new technologies for personal or professional goals can positively influence their trust in the system, especially in the context of emerging technologies (García et al., 2022; Khazaei, 2020; Wong et al., 2020). By highlighting the positive correlation between TA and TT, our study contributes to the understanding of how personal inclination towards technology can shape perceptions of trustworthiness in blockchain technology, suggesting that fostering technological openness is key to enhancing trust and transparency in blockchain implementations.

Environmental Concern (EC) revealed a negative influence on BI, evidenced by ($\beta$ = -0.207, $p < 0.001$), thus confirming H4. This finding aligns with the existing debate on blockchain's environmental implications, specifically its substantial energy consumption, as highlighted in some studies (Badea & Mungiu-Pupăzan, 2021; Rejeb & Rejeb, 2020). The results emphasize the critical need for environmentally sustainable blockchain innovations, suggesting that the technology's adoption is heavily influenced by ecological considerations. This insight encourages a shift towards the development of blockchain solutions that not only advance technological frontiers but also prioritize environmental stewardship, echoing the urgent call for sustainable practices within the blockchain domain.

Security (S) arises as a strong predictor of TT, with ($\beta$ = 0.774, $p < 0.001$), validating H5. This relationship underscores the fundamental link between security measures and the development of trust in blockchain technologies. The strong correlation between S and TT suggests that perceptions of security significantly influence the perceived transparency and integrity of blockchain systems. Consistent with existing literature (Hsu et al., 2014; Lim et al., 2019; Ray et al., 2011), our study highlights the importance of security in promoting trust among users, indicating that enhanced security protocols contribute to a more transparent and trustworthy blockchain environment. This insight is critical for blockchain development, emphasizing that advancing security features is not just about protecting data but also about enhancing the system's transparency, which in turn, reinforces user trust and experience.

Our study reveals TT as the primary influencer of BI towards blockchain, indicated by ($\beta$ = 0.425, $p < 0.001$), aligning with H6 and reflecting insights from prior research (Chang et al., 2022; Dagher et al., 2018; Francisco & Swanson, 2018; Khazaei, 2020). This highlights the importance of trust, cultivated through both the security and clarity of blockchain operations, for potential adopters. Trust is a crucial gatekeeper for technology acceptance, highlighting the imperative for blockchain infrastructures to be transparent and secure. Further exploration shows that TT is significantly shaped by S and TA, with ($\beta$ = 0.774, $p < 0.001$) and ($\beta$ = 0.171, $p < 0.001$), respectively. These factors together explain 69.9% of the variance in TT, showcasing a complex interaction where the perceived security of the technology and an individual's readiness to engage with innovations profoundly influence trust. This relationship between security, personal technology acceptance, and trust transparency, informed by studies on trust's foundational role in technology adoption (Roca et al., 2009; Jena, 2022; Thatcher et al., 2011; Wong et al., 2020), reinforces the critical need for secure, user-friendly blockchain systems that align with user expectations and readiness, thereby supporting adoption intentions.

We also confirm that BI significantly influences UB, supported by ($\beta$ = 0.398, $p < 0.001$), following hypothesis H7. This affirms the UTAUT model's assertion (Venkatesh et al., 2003), regarding the direct positive impact of BI on technology usage. The analysis demonstrates that BI, alongside SI, accounts for 44% of the variance in UB, with BI being the stronger predictor. This relationship is grounded in the broader framework of technology adoption theories within the UTAUT model (Khazaei, 2020), where the intention to use technology is a critical precursor to actual usage. The study further elucidates the dynamics influencing BI, identifying TT, PE, and EC as key factors. TT and PE positively contribute to BI, while EC shows a negative correlation, together explaining 51.8% of BI's variation. This interaction highlights the importance of trust and performance expectancy in developing an intention to adopt technology while also acknowledging the potential restriction effect of environmental concerns.

These findings, aligning with previous research (Caldeira et al., 2021; Mazman et al., 2009; Wong et al., 2020), highlight the complexity of technology adoption processes. They emphasize that an individual's intention to use technology, and ultimately their actual use behavior, is shaped by a convergence of factors, including the perceived benefits of the technology, trust in its security and transparency, and considerations of its environmental impact.

## 7. Conclusion

This study, supported by a literature review and an empirical investigation, constructed a predictive model to explain the factors influencing blockchain adoption, integrating technological, social, environmental, trust, security, and performance expectancy variables. Findings show that Behavioral Intention (BI) to adopt blockchain technology is significantly influenced by Social Influence (SI), Performance Expectancy (PE), Environmental Concern (EC), Security (S), and Trust Transparency (TT). The analysis integrates essential aspects such as technology, society, the environment, trust, and security, identifying Trust Transparency (TT) as a critical determinant, heavily influenced by security perceptions. Findings also show a complex interaction among these factors, offering a detailed outline for understanding the dynamics of blockchain adoption and providing insights for its practical and effective application.

The theoretical implications of this work extend the blockchain domain's knowledge base, dissecting the multifaceted drivers of its adoption. By highlighting the vital importance of trust and security within the theoretical discourse on technology acceptance, our study significantly contributes to the conceptual expansion of models like UTAUT in the context of blockchain. It lays the foundational groundwork for future theoretical explorations into the unique attributes of blockchain technology and their alignment with established and emerging technology adoption theories.

The practical implications of this work present a strategic guide for organizations and policymakers by pinpointing essential adoption factors. It underscores addressing key issues, trust, security, and environmental sustainability to foster an environment conducive to the widespread acceptance and utilization of blockchain technology. This research thus acts as a navigational tool for entities aiming to implement blockchain, highlighting the pathways toward successful integration and the enhancement of user trust and system sustainability.

This study's insights are limited because the empirical data was collected solely from respondents in Portugal, which may reduce generalizability to other regions due to cultural, economic, and regulatory differences. The sample's characteristics and industry focus might not fully capture the broader dynamics of blockchain adoption. Additionally, the evolving nature of blockchain technology and regulations could impact the long-term relevance of some findings.

Future research should expand the geographical scope of data collection to include diverse regions and countries, allowing for the examination of cultural, economic, and regulatory influences on blockchain adoption. Cross-industry comparisons should also be explored to account for sector-specific variations in adoption dynamics. Additionally, future studies should explore organizational factors influencing blockchain adoption, distinguishing between individual and systemic influences. Investigating blockchain's specific use cases across various sectors could expose distinct motivations driving adoption, providing deeper insights into its applicability and effectiveness. Moreover, assessing the broader ecosystem, including regulatory frameworks and the availability of blockchain expertise, is crucial for a comprehensive understanding of the adoption landscape.

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RESEARCH ARTICLE

# Measuring and predicting teamwork quality in virtual project teams

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## Abstract
More and more members of project organizations collaborate in virtual teams. Due to globalization and more recently driven by the impact of the Covid-19 pandemic, the number of virtual project team members grew significantly, and many leaders look for key factors which allow virtual teams to reach a higher level of Teamwork Quality. This article summarizes previous investigations to develop a measuring instrument for both Teamwork Quality and potential predictors. Based on a literature review a conceptual model with 30 salient items measuring ten latent predictors as well as one latent concept for Teamwork Quality has been developed and transformed into a survey. The questionnaire was shared online and completed by 211 members of virtual project teams. Afterwards an Explorative Factor Analysis as well as a Reliability Analysis have been performed to explore the structure of the items. The result suggested one dependent measure for Teamwork Quality in virtual project teams and three latent predictors. These factors have been included into a Structural Equation Model and have been supported by a Confirmatory Factor Analysis. The steps described led to three factors (Personal Commitment, Team Balance & Mutual Support, Result Orientation) that have an influence on the latent variable "Willingness to succeed".

## Keywords
virtual project teams; project management; teamwork quality; remote collaboration; team performance.

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## 1. Introduction

Virtual teams are frequently used within many international companies for all project sizes (Gallego et al., 2021) and the total number of employees acting in global virtual teams grew by 40% between 2010 and 2018 (RW3-CultureWizard, 2018). Already in 2018 (two years before the Covid-19 pandemic started), roughly every sixth company worldwide has been fully remote, meaning there were no offices and all employees had the freedom to work from wherever they preferred (Owl Labs, 2018). Globalization of business as well as the desire for innovation were the main triggers for virtual teams (Adamovic, 2017) before the pandemic became the strongest driver and caused a radical breakthrough in 2020 (Wrycza & Maślankowski, 2020), which affected all industries and service sectors alike (Herath & Herath, 2020). A lot of organizations were forced to close operations (at least temporarily) or to modify their business models to adapt to the new pandemic environment (Carroll & Conboy, 2020). Especially when the lockdown(s) came, many employees, who were not required physically on site, were asked to take their most important workspace equipment with them and to start working from home (Klonek et al., 2022).

For many employees and their managers, the sudden change was challenging, as no playbooks were available before Covid-19, which described how to change to a fully virtual team within days (Mortensen & Hadley, 2020). On top of that, a lot of those responsible became nervous as they were concerned they would lose control when employees started to work from home (Lindner, 2020). Contrary to these expectations, the performance of employees who worked in co-located teams before the pandemic and who moved into home offices during the lockdown(s), was at least sufficient. This conclusion results out of surveys revealing that 64% of organizations plan to keep remote working long-term and one third wants to reduce their office footprint permanently (Eagle, 2020). Virtual collaboration would have increased anyway, but Covid-19 has highlighted the possibilities and accelerated the transition. It can be expected that this type of cooperation will further increase (Swart et al., 2022). Hence, it should be explored by which factors Teamwork Quality (TWQ) in virtual project organizations is influenced.

Several researchers investigated team collaboration and TWQ in general but most of them focused on co-located teams only (Almås, 2021; Alsharo et al., 2017; Aram & Morgan, 1976; Lurey & Raisinghani, 2001). Compared to the existing literature this paper aims to answer the question *Which factors predict Teamwork Quality in virtual project teams and how can they be measured?* It summarizes existing literature with regards to TWQ and virtual (project) teams in the following paragraph. The next section describes the Research Strategy followed by a paragraph summarizing the research findings. Finally, a discussion and a conclusion section close the article.

## 2. State of research

During the literature review the authors followed the recommended inclusion and exclusion criteria developed by Clark et al. (Clark et al., 2019).

Table 1. Literature Inclusion and Exclusion Criteria

| Inclusion criterion | Description |
|---|---|
| Primary source | Literature collated and interpreted by authors directly |
| Relevant topic | Direct reference to research area |
| Literature hypothesis / proposition quality | Testable hypothesis or demonstrable proposition, which can be evaluated |
| Methodology quality | Research methodology included and applied |
| Data quality | Data is relevant and sources are traceable |
| Outcome quality | Evidence between gathered data and analysis results is transparent |

| Exclusion criterion | Description |
|---|---|
| Secondary source | Information can distort analysis |
| Irrelevant topic | Literature focuses on another topic or utilises the key words with another intention |
| Inadmissible quality | Untestable information and/or inadequate documentation |
| Unavailability | Literature was/is not available in data sources |
| Language duplication | Literature is a duplicate of other used literature |

Scopus was the primary tool for the literature review and most of the sources were less than five years old (with the exception of some seminal papers which formed the foundation for the research paper). Journals and books were the preferred sources supplemented by online articles and other internet sources.

### *2.1. Teamwork quality*

Working effectively in a team is one of the most important employee competencies nowadays (Kobushko et al., 2020). Furthermore, soft skills are vital, as they are the key for successful collaboration in project teams (Burba, 2017). Hoegl and Gemuenden (2001) defined TWQ as a measure of the quality of collaboration in teams that influences personal success as well as team performance (the latter one thereby differentiates between effectiveness and efficiency). Effectiveness describes the extent to which a project team meets expectations with regards to product quality, and efficiency refers to the degree to which the team meets project time and budget expectations (Lindsjørn et al., 2016).

Hoegl and Gemuenden (2001) also defined six facets of TWQ (Table 2) and claimed that behaviors of all these facets can be recognized when working with highly collaborative teams.

Table 2. Six facets of TWQ [20]

| Facet | Description |
|---|---|
| Communication | Frequent, informal, direct, and open communication |
| Coordination | Activities within the team are well structured and synchronized |
| Balance of Member Contributions | Team members can bring in their full expertise |
| Mutual Support | All members of the team help and support each other in carrying out their tasks |
| Effort | Team members exert all efforts to the team's tasks |
| Cohesion | There is a team spirit, members are motivated to maintain the team |

Aram and Morgan worked on team collaboration with focus on project teams in research and development laboratories. For this specific area they could not identify a direct link between interpersonal collaboration and performance of scientists and engineers, but they observed a relationship between the fulfilment of personal job needs and the performance level of team members (Aram & Morgan, 1976). Although their research was conducted more than 45 years ago, some of their survey questions are still valid and can be applied to studies related to virtual project teams.

Lurey and Raisinghani (2001) suggested that leaders should only add those people to their teams who are qualified for the job and Kobushko et al. (2020) indicated that a reward system could be implemented based on the results of a collective team task to improve Teamwork Quality. In addition, opportunities for personal growth are a strong motivator for those who perform well (Katzenbach & Smith, 2015). Moreover, the effect of trust on collaboration effectiveness has been confirmed by Cheng et al. (2016).

### *2.2. Virtual project teams*

A team is a social system, which consists of three or more people who are part of an organization, work on a common task and see themselves / are seen as team members (Hoegl & Gemuenden, 2001). For a virtual project team a similar description applies with the additional aspect that the team is geographically dispersed, meets rarely in person and collaborates mainly via Information and Communication Technologies (ICT) to reach common goals (Dulebohn & Hoch, 2017; Kukytė, 2021). Such a team faces challenges which usually do not appear in co-located teams or the impact of these challenges is much greater in (semi-) virtual teams (Clark et al., 2019). In addition, a high team virtuality can have a negative impact on team performance (Liska, 2022) and it is more difficult to solve conflicts remotely (Saltman, 2020). Summing up, one can say that it is more challenging to lead a remote team than a co-located one (Hoch & Kozlowski, 2014).

Especially since the beginning of the pandemic the number of project team members who collaborate virtually grew considerably as companies were forced to ask their employees not to come to the office anymore (Newman & Ford, 2021). Most of these employees appreciated the request to work from home (Junk, 2020) although it was a new experience for more than half of them (Kamouri & Lister, 2020). From a career development perspective opinions are balanced, when it comes to work from home permanently (Behn, 2023). Nevertheless, 47% of company leaders, who have been interviewed by Gartner about their intentions regarding flexible working after Covid-19, answered that they will allow working remotely fulltime and an additional 35% plan to allow working remotely for at least some time (Gartner, 2020). These plans confirm on one hand that organizations profit from the deployment of virtual teams (Großer & Baumöl, 2017) and on the other hand it means that virtual teams will become a part of the company culture and young candidates will probably ask for remote working possibilities when they decide to join a company (Tamang, 2020).

Geographical dispersion, electronic dependence, national diversity and structural dynamism have been identified as the four characteristics of virtual teams (Gibson & Gibbs, 2006).

#### *2.2.1 Geographical dispersion*

Project teams are often geographically dispersed because of missing experts' knowledge on site or because of lower labor costs in other countries. International collaboration is no longer an exception and many companies do not even emphasize the "global" or "virtual" aspects anymore (Jimenez et al., 2017). O'Leary and Cummings defined the different characteristics of geographic dispersion, which are also called performance inhibitors of dispersed teams (O'Leary & Cummings, 2007). The first one is the spatial dimension, meaning how big the geographical distance is between team members. This characteristic reduces spontaneous communication within the team. Spontaneous social interactions in front of the coffee machine or in the break room are not happening anymore for example (Kohntopp & McCann, 2020).

Furthermore, there is the temporal dimension, which is challenging real-time problem-solving due to different time zones and no (or limited) overlapping work hours. The third dimension is called configurational dimension and takes into account the number of locations team members are spread across and how the membership is balanced (e.g., two involved locations with ten team members at one site and one team member at the other site). A strong imbalance can cause a decreasing awareness of the work status of team members who work isolated at a site.

#### *2.2.2 Electronic dependence*

In virtual teams the usage of electronic media is usually higher compared to co-located teams (Kirkman et al., 2004). Companies have to go through digital transformation in all business areas and digital collaboration is no longer an option, if working remotely (Fletcher & Griffiths, 2020). Besides their actual responsibility, leaders of virtual teams have to ensure that all challenges related to communication and technology get solved (Hacker et al., 2019).

### *2.2.3 National diversity*

Companies recognize the increasing global competition (Rahman et al., 2018). Thus, to be able to take advantages of globalization and to compete against others, these companies have to adapt and to implement their own global organizational strategy (Ozguler, 2016). By national diversity Gibson and Gibbs mean the cultural differences within these multicultural organizations (Gibson & Gibbs, 2006). As the name suggests, these organizations bring together a diverse set of cultural backgrounds (Leonard, 2019). Culture can be described as "the collective programming of the mind which distinguishes the members of one human group from another" (Hofstede, 1981). It affects the attitude of each individual employee based on various behavioral conventions and artifacts as well as important geographical, ethnic, economic, and political influences (Abyad, 2017). This makes communication within global virtual teams more difficult (Liao, 2017). Hence, a high degree of multicultural competence is required by project managers who lead virtual teams (PMI, 2013) and particularly their tolerance and acceptance for diversity are important as they are responsible for employees from diverse cultures (Knap-Stefaniuk & Burkiewicz, 2020).

### *2.2.4 Structural dynamism*

The arrangements in virtual project teams are often dynamic and team members must be flexible when it comes to their responsibilities and relationships with each other. Often, people join during a project while others leave the team when their tasks are done. A consequence of these dynamic structural arrangements is an increase of uncertainties (Gibson & Gibbs, 2006), which puts a high burden on managers who lead virtual project teams. Especially when it comes to virtual leadership avoiding uncertainties is essential and the exchange between team members needs to be fostered (Deloitte, 2020). Complex development tasks cannot just be broken down into work packages and be executed independently without collaboration of separated individuals (Hoegl et al., 2011).

## *2.3. Teamwork quality in virtual teams*

Organizational leaders should not spend a vast amount of resources on more advanced technologies to improve the performance of virtual teams (Lurey & Raisinghani, 2001). It is more important to develop formal processes as well as a clear structure, and to agree on explicit primary objectives for the virtual teams to create a targeted collaboration.

Many people believe that knowledge sharing is associated with a loss of power but the research of Alsharo et al. (2017) proves that it positively influences the trust level and collaboration within virtual teams, which in turn significantly impacts upon their effectiveness. Social exchanges at the beginning of the collaboration help to generate trust (Jarvenpaa & Leidner, 1999), but as virtual teams usually collaborate remotely, there is a risk that the trust level decreases over time (Kauffmann & Carmi, 2017). In addition to trust in remote teams, the scope of virtual team management studies lies mainly on ICT and its significance for management, the leadership of remote teams as well as the effectiveness of virtual teams (Kukytė, 2021). Besides all principles mentioned, Hertel et al. point at the importance of sufficient performance feedback for each virtual team member (Hertel et al., 2005).

## *2.4. Conceptual model*

The objective of this work is to identify factors and circumstances which influence TWQ in virtual project teams and to develop a measuring instrument for these in a second step. During the literature review many articles and other sources have been found which concentrate on TWQ, virtual teams in general or TWQ in virtual teams but no research documentation has been found, which describes TWQ in virtual project teams or concretely pinpoints how to assess the concept within surveys.

Thus, based on the findings within existing literature a conceptual model has been developed, which can be found in Figure 1.

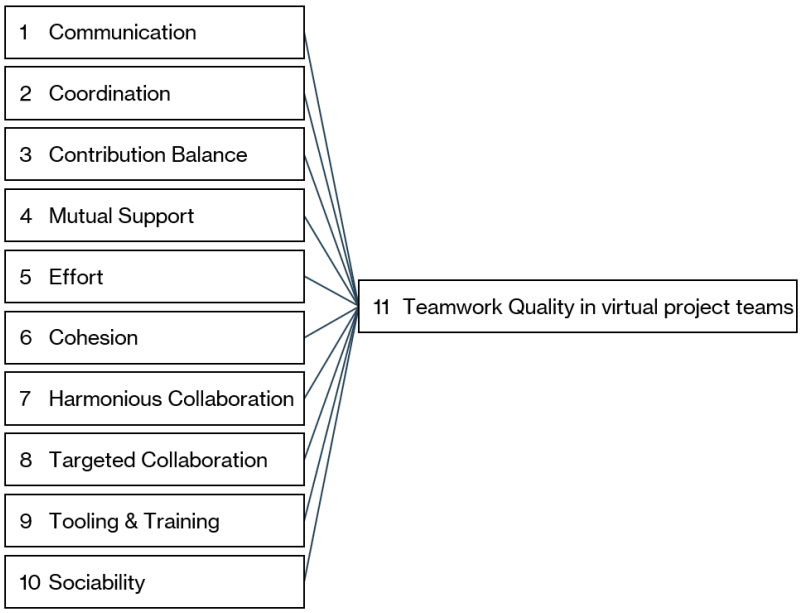


Fig. 1. Conceptual model

*Notes: The model shows ten predictors as well as the dependent variable Teamwork Quality in virtual project teams. All variables are assessed as latent constructs through several manifest items. The representation is simplified within the model for parsimony.*

The model consists of eleven different factors which are operationalized mainly based on previous literature. For each of the first ten factors (independent variables) three statements are formulated and used in an online survey (see section 3). The factors Communication (1), Coordination (2), Contribution Balance (3), Mutual Support (4), Effort (5) and Cohesion (6) are based on the construct of TWQ by Hoegl and Gemuenden (Hoegl & Gemuenden, 2001). The work done by Aram and Morgan in which they evaluated the role of project team collaboration in R&D performance (Aram & Morgan, 1976) is the foundation for the statements around Harmonious Collaboration (7). Lurey's and Raisinghani's article about best practices in virtual teams (Lurey & Raisinghani, 2001) provided three statements which are used for the eighth focus area called Targeted Collaboration, while the statements for Tooling and Training (9) come from Alsharo et al. who investigated the role of knowledge sharing and trust in virtual teams (Alsharo et al., 2017). For the area Sociability (10) input is given by a case study which investigated Teamwork Quality and Project Success in software engineering capstone courses at the university of Oslo (Almås, 2021).

To be able to measure the dependent variable Teamwork Quality as well, five additional statements were added to the survey. The first three address project time and budget compliance (Lurey & Raisinghani, 2001), as well as quality of teamwork during the project (Lindsjørn et al., 2016). They are based on statements the authors made in their surveys. The remaining two survey statements related to TWQ in virtual project teams concentrate on the overall satisfaction of stakeholders (Kobushko et al., 2020) and the opportunity to grow personally (Katzenbach & Smith, 2015). The latter one sees the personal growth as a result of delivering superior value while Kobushko et al. classify stakeholder satisfaction as a qualitative Key Performance Indicator.

## 3. Research strategy

The described conceptual model and a quantitative analysis, which is based on an online survey, are the foundation of this article. The survey used the items constructed above to test the developed model in terms of measurement and structure.

### *3.1. Choice of online survey*

A quantitative online survey is chosen as the data gathering instrument since this methodological approach enables the identification and summary of characteristics of a large sample. In addition, the anonymity allows respondents to answer openly and honestly. Evans and Mathur gathered the major strengths of online surveys in 2005 and updated their findings a few years later (Evans & Mathur, 2018). Like Evans and Mathur, the authors of this article share the opinion that the global reach and the speed/timeliness are major strengths of online surveys which benefit from an increasing number of PC, tablet, and smartphone users as well as from internet access which more than half of the world population has available.

Like other survey methods, this approach has drawbacks, too. For example, online surveys can be perceived as junk mail and are often impersonal (Evans & Mathur, 2018). Nevertheless, the advantages outweigh the weaknesses for the purpose of this study which motivates the decision to use an online survey and to reduce the known risks to a minimum (perception as trustable mail, personalization).

### *3.2. Survey design (data collection instrument)*

In total, the questionnaire consisted of 41 questions/statements, divided into three sections (Table 3). The first section contained six demographic questions (D1-D6) to learn more about the general background of the respondents. The second and third section were based on the conceptual model mentioned and entailed 30 statements (three per factor) about the independent variable (S1.1-S10.3) as well as five statements about the dependent variable (S11.1-S11.5).

Table 3. Overview of 41 questions/statements

| # | Item (Demographic question) |
|---|---|
| D1 | What is your age? |
| D2 | How many years of working experience do you have in virtual teams? |
| D3 | For which kind of industry do you work? |
| D4 | How many countries are usually involved in the projects you support remotely? |
| D5 | What kind of projects are usually managed remotely in your company? (multiple answers possible) |
| D6 | What is the main reason for virtual project teams in your organization? (open question) |

| # | Item (Statement about independent variable on 5-point Likert scale) | Factor |
|---|---|---|
| S1.1 | Project-relevant information was shared openly by all team members. | Communication |
| S1.2 | The team members were happy with the timeliness in which they received information from other team members. | Communication |
| S1.3 | The team members were happy with the usefulness of the information received from other team members. | Communication |
| S2.1 | The work done on subtasks within the project was closely harmonized. | Coordination |

| # | Item (Statement about independent variable on 5-point Likert scale) | Factor |
|---|---|---|
| S2.2 | There were clear and fully comprehended goals for subtasks within our team. | Coordination |
| S2.3 | The goals for subtasks were accepted by all team members. | Coordination |
| S3.1 | The team recognized the specific potentials (strengths and weaknesses) of individual team members. | Contribution Balance |
| S3.2 | The team members were contributing to the achievement of the team's goals in accordance with their specific potential. | Contribution Balance |
| S3.3 | Member contribution in our team was in balance. | Contribution Balance |
| S4.1 | The team members helped and supported each other as best they could. | Mutual Support |
| S4.2 | If conflicts came up, they were easily and quickly resolved. | Mutual Support |
| S4.3 | Our team was able to reach consensus regarding important issues. | Mutual Support |
| S5.1 | Every team member fully pushed the project. | Effort |
| S5.2 | Every team member made the project their highest priority. | Effort |
| S5.3 | Our team put much effort into the project. | Effort |
| S6.1 | All members were fully integrated in our team. | Cohesion |
| S6.2 | Our team was sticking together. | Cohesion |
| S6.3 | The members of our team felt proud to be part of the team. | Cohesion |
| S7.1 | When team members worked jointly on problems they tended to build on each other's ideas. | Harmonious Collaboration |
| S7.2 | When several team members discussed an issue, it was all right to comment or ask questions about anything one did not understand. | Harmonious Collaboration |
| S7.3 | After a disagreement over how the group should proceed everyone quickly picked up their part of the task activity. | Harmonious Collaboration |
| S8.1 | Team members were selected based on their individual talents and abilities to contribute to the team. | Targeted Collaboration |
| S8.2 | Team members regularly use phone and/or on-line computer conferences to share ideas. | Targeted Collaboration |
| S8.3 | The team had an established process for making decisions. | Targeted Collaboration |
| S9.1 | I have received training focused on performance improvement in virtual teams. | Tooling & Training |
| S9.2 | My virtual team was equipped with adequate tools and technologies to perform our tasks (SharePoint, ...). | Tooling & Training |
| S9.3 | The electronic methods (MS Teams, Zoom, ...) we used to communicate with each other were powerful. | Tooling & Training |
| S10.1 | I felt comfortable in the virtual working environment. | Sociability |
| S10.2 | The virtual working environment enabled me to get a good impression of my teammates. | Sociability |
| S10.3 | The virtual working environment allowed spontaneous informal conversations. | Sociability |

| # | Item (Statement about dependent variable on 5-point Likert scale) |
|---|---|
| S11.1 | When the team completed its work, it was generally on time. |
| S11.2 | When the team completed its work, it was generally within the budget. |
| S11.3 | I have been satisfied with the quality of teamwork during the project. |
| S11.4 | The overall feedback from project stakeholders / clients was positive. |
| S11.5 | I had the opportunity to personally grow during the project. |

### *3.3. Sampling*

The online survey was created in Microsoft Forms and shared via e-mail as well as social media (LinkedIn). Members of virtual project teams were asked to answer the first six demographic questions and to specify on a five-point Likert scale, how much they agree/disagree with the 35 statements. Within eight weeks 211 people participated in the online survey, which implies a 6:1 (211:35) participant-to-variable ratio. This number fulfils the requirements for a minimum sample size as more than 200 replies have been received and a participant-to-variable ratio of at least 5:1 has been reached (Howard, 2016).

The demographics of the sample turned out as shown in Table 4.

Table 4. Demographics of quantitative study (survey)

| Question | Answers | Freq. | Percentage |
|---|---|---|---|
| **1. Age** | 25-34 | 15 | 7.1 |
| | 35-44 | 92 | 43.6 |
| | 45-54 | 65 | 30.8 |
| | 55-64 | 39 | 18.5 |
| | *Total* | *211* | *100.0* |
| **2. Working experience in virtual teams** | 1-3 years | 66 | 31.3 |
| | 4-6 years | 43 | 20.4 |
| | 7-9 years | 26 | 12.3 |
| | 10 years and more | 76 | 36.0 |
| | *Total* | *211* | *100.0* |
| **3. Industry, participants work for** | Aerospace | 1 | 0.5 |
| | Automotive | 17 | 8.1 |
| | Construction | 9 | 4.3 |
| | Education | 6 | 2.8 |
| | Electronics | 24 | 11.4 |
| | Energy | 11 | 5.2 |
| | Food & Beverage | 3 | 1.4 |
| | Government | 4 | 1.9 |
| | Health Care | 3 | 1.4 |
| | Hospitality | 1 | 0.5 |
| | Information Technology | 27 | 12.8 |
| | Manufacturing | 55 | 26.1 |
| | Marketing | 8 | 3.8 |
| | Transportation | 5 | 2.4 |
| | Others | 37 | 17.5 |
| | *Total* | *211* | *100.0* |

| Question | Answers | Freq. | Percentage |
|---|---|---|---|
| **4. Amount of countries usually involved in projects** | 1-2 | 67 | 31.8 |
| | 3-4 | 85 | 40.3 |
| | 5 and more | 59 | 28.0 |
| | *Total* | *211* | *100.0* |
| **5. Type of projects usually managed remotely in the company participant works for (multiple answers possible)** | Administrative (e.g., new accounting system) | 62 | 11.0 |
| | Business & Organizational Change (e.g., M&A) | 80 | 14.2 |
| | Construction (e.g., building a road) | 21 | 3.7 |
| | Events (e.g., trade fair) | 40 | 7.1 |
| | Facility (e.g., building decommissioning) | 8 | 1.4 |
| | Maintenance Planning (e.g., of a critical machine) | 27 | 4.8 |
| | Product Development (e.g., sensor) | 129 | 22.9 |
| | Research (e.g., feasibility study) | 75 | 13.3 |
| | Software Development (e.g., mobile app) | 93 | 16.5 |
| | Others | 28 | 5.0 |
| | *Total* | *563* | *100.0* |
| **6. Main reason for virtual project teams in participant's organization (open question)** | Non-co-located teams | 104 | 34.2 |
| | Subject matter experts not available on site | 53 | 17.4 |
| | Travel reduction (e.g., less travel time/costs, Co2 emission) | 44 | 14.5 |
| | COVID-19 (e.g., travel restrictions) | 39 | 12.8 |
| | Project speed (e.g., meetings quicker arranged) | 30 | 9.9 |
| | Mobile working (e.g., home office) | 15 | 4.9 |
| | Global responsibilities (e.g., global customers) | 14 | 4.6 |
| | Others (e.g., lower salaries, digitalization, flexibility) | 5 | 1.6 |
| | *Total* | *304* | *100.0* |

The age group 35-44 years has a high representation (almost 44%) compared to other age groups. A probable reason for this phenomenon is the need of higher education and working experience of employees joining project teams (Silvius & de Graaf, 2019), which would explain the relatively low amount of participants between 25 and 34 years. In addition, many participants replied to a social media campaign on LinkedIn which promoted the survey. Based on LinkedIn's potential advertising reach it is known that professionals who are 55 years and older are less active on LinkedIn compared to users between 35 and 54 years (Kemp, 2022). Almost 75% of all survey replies can be attributed to this latter age group.

The experience groups (based on time spent in virtual teams) can be split into three classes. More than one third (36%) of all participants works in virtual teams for more than ten years already. Roughly another third (32.7%) collaborates remotely between four to nine years and the last third (31.3%) started to work in virtual teams during the last three years. It can safely be assumed that Covid-19 is a key driver for this high number due to the change to mobile/home offices caused by the pandemic situation.

Most participants (26.1%) work for manufacturing companies, followed by IT- (12.8%) as well as electronics- (11.4%) companies and collaborate mainly remotely (40.3%) with 2-3 additional countries during their projects. Product- and Software development projects are conducted most often virtually (39.4%), followed by business & organizational change projects (14.2%) as well as research projects (13.3%).

When the survey participants were asked for the main reasons for virtual project organizations, 34.2% mentioned the global presence of the company, while 17.4% stated missing subject matter experts on site. Another 14.5% named travel restrictions (time/cost savings and reduction of CO2 emissions) and 12.8% declared Covid-19 and the lockdown(s) as main reasons. In general, demographics indicate a balanced sample without bias in any specific direction.

### *3.4. Analysis*

The aim of this paper is twofold. First, to identify the factors and circumstances which influence Teamwork Quality in virtual project teams and second, to develop a measuring tool for the identified factors. To evaluate structural relations and to assess the quality of the measurement instrument, replies to the survey statements were changed into numeric values ranging from 1 to 5 (1 for strongly disagree, 5 for strongly agree). Next to descriptive analyses, an Explorative Factor Analysis (EFA) was carried out with SPSS (Version 29). First, it was done for all eleven concepts (ten independent and one dependent construct) individually to investigate if factors can be created out of the items suggested to belong to each concept. In a next step, identifying the underlying structure of the items of the independent variables, following the "intervalistic school" of Likert scales, was focused upon (Carifio & Perla, 2008). The purpose of the EFA is to group the independent variables which correlate the most into factors capturing common variance. The selected method for the EFA was Principal Axis Factoring and a Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy as well as Bartlett's Test of Sphericity were done. The minimum value for the Measure of Sampling Adequacy is 0.5 and variables with a lower value should be excluded from the EFA (Kaiser & Rice, 1974; Weiber & Mühlhaus, 2014). If the Bartlett's Test result is $p<0.05$, it is significant and means that a factor analysis can be carried out (Shrestha, 2021). Varimax was the chosen rotation method for the EFA.

While this analysis was a first step to explore the validity of the factors identified within the literature, a reliability analysis using Cronbach's Alpha was carried out alongside to check for internal consistency as well. Cronbach's Alpha should be 0.7 or higher to ensure a good reliability (Weiber & Mühlhaus, 2014).

In addition, a Confirmatory Factor Analysis (CFA) was done using a Structural Equation Model (SEM) in AMOS (Version 29). As a full SEM consists of both a measurement and a structural part, the CFA is employed first before correlating the resulting latent constructs with the dependent measure of TWQ. Most important criteria which were tested are the Root Mean Square Error of Approximation (RMSEA) (Hu & Bentler, 1999), CMIN/DF (Chi-square divided by Degrees of Freedom), and Baseline Comparisons like Normed Fit Index (NFI), Tucker-Lewis-Index (TLI) and Comparative Fit Index (CFI) (Weiber & Mühlhaus, 2014). They allow to evaluate how well a model fits. RMSEA should be $\leq 0.08$, CMIN/DF should be $\leq 3.0$ and NFI, TLI as well as CFI should be $\geq 0.9$ (Weiber & Mühlhaus, 2014).

## 4. Findings

This section focuses on descriptive statistics of the statements presented as well as the results from EFA, CFA and the SEM.

### *4.1. Descriptive statistics*

Mean and standard deviation of the 30 independent variables can be found in Table 5. Here, it can be seen that out of the statements regarding communication an open sharing of information (S1.1) scores highest with a mean of 4.05, while the other two statements, timing (S1.2) and usefulness (S1.3), rank lower.

Statement S8.2, which states that members of virtual project teams regularly use phones or online meetings to share ideas, reaches the highest mean score ($M = 4.20$) of the targeted collaboration factors. This suggests that members of virtual teams do not shy away from using these tools and that the available ICT satisfies employee's needs. On the other hand, the mean evaluation ($M = 2.64$) of received trainings focusing on performance improvement in virtual teams (S9.1) is ranked lowest out of all three items capturing training as well as out of all 30 statements presented.

Table 5. Mean and standard deviation for independent variables

| # | Statement (Independent variable) | Mean | Std. Deviation |
|---|---|---|---|
| S1.1 | Project-relevant information was shared openly by all team members. | 4.05 | 0.692 |
| S1.2 | The team members were happy with the timeliness in which they received information from other team members. | 3.82 | 0.730 |
| S1.3 | The team members were happy with the usefulness of the information received from other team members. | 3.85 | 0.666 |
| S2.1 | The work done on subtasks within the project was closely harmonized. | 3.63 | 0.803 |
| S2.2 | There were clear and fully comprehended goals for subtasks within our team. | 3.70 | 0.737 |
| S2.3 | The goals for subtasks were accepted by all team members. | 3.71 | 0.710 |
| S3.1 | The team recognized the specific potentials (strengths and weaknesses) of individual team members. | 3.60 | 0.932 |
| S3.2 | The team members contributed to the achievement of the team's goals using their specific potential. | 3.87 | 0.779 |
| S3.3 | Member contribution within our team was in balance. | 3.43 | 0.888 |
| S4.1 | The team members helped and supported each other as best they could. | 4.04 | 0.739 |
| S4.2 | If conflicts came up, they were easily and quickly resolved. | 3.35 | 0.884 |
| S4.3 | Our team was able to reach a consensus regarding essential issues. | 3.92 | 0.600 |
| S5.1 | Every team member fully pushed the project. | 3.33 | 0.922 |
| S5.2 | Every team member made the project their highest priority. | 3.09 | 0.884 |
| S5.3 | Our team put much effort into the project. | 3.90 | 0.696 |
| S6.1 | All members were fully integrated in our team. | 3.53 | 0.901 |
| S6.2 | Our team was sticking together. | 3.61 | 0.794 |
| S6.3 | The members of our team felt proud to be part of the team. | 3.63 | 0.797 |
| S7.1 | When team members worked jointly on problems, they tended to build on each other's ideas. | 3.93 | 0.676 |
| S7.2 | When several team members discussed an issue, it was all right to comment or ask questions about anything one did not understand. | 4.14 | 0.723 |
| S7.3 | After a disagreement over how the group should proceed, everyone quickly picked up their part of the task activity. | 3.64 | 0.752 |
| S8.1 | Team members were selected based on their talents and abilities to contribute to the team. | 3.54 | 1.006 |
| S8.2 | Team members regularly used phone and/or online computer conferences to share ideas. | 4.20 | 0.800 |
| S8.3 | The team had an established process for making decisions. | 3.51 | 0.907 |
| S9.1 | I have received training focused on performance improvement in virtual teams. | 2.64 | 1.115 |
| S9.2 | My virtual team was equipped with adequate tools and technologies to perform our tasks (SharePoint, ...). | 4.10 | 0.774 |
| S9.3 | The electronic methods (MS Teams, Zoom, ...) we used to communicate with each other were powerful. | 4.19 | 0.707 |
| S10.1 | I felt comfortable in the virtual working environment. | 3.97 | 0.864 |
| S10.2 | The virtual working environment enabled me to get a good impression of my teammates. | 3.37 | 1.012 |
| S10.3 | The virtual working environment allowed spontaneous informal conversations. | 3.26 | 1.255 |

A more appreciated mean value is the one for the comfort level in the virtual environment (S10.1). This statement belongs to the sociability dimension and reaches a mean of 3.97 which confirms that many members of virtual project teams feel comfortable in their current situation. Nevertheless, in terms of opportunities for informal conversations in the virtual working environment (S10.3) opinions differ, which causes the highest standard deviation (SD = 1.255) of the whole survey.

As far as the dependent variable is concerned (Table 6), the first statement (S11.1) gets the lowest mean value (M = 3.49) and has a standard deviation of 0.819, which indicates that many virtual projects are delayed.

Most positively evaluated is the opportunity to grow personally (S11.5) during the virtual projects (3.98).

Table 6. Mean and standard deviation for dependent variables

| # | Statement (Dependent variable) | Mean | Std. Deviation |
|---|---|---|---|
| S11.1 | When the team completed its work, it was generally on time. | 3.49 | 0.819 |
| S11.2 | When the team completed its work, it was generally within the budget. | 3.52 | 0.745 |
| S11.3 | I was satisfied with the quality of teamwork during the project. | 3.77 | 0.773 |
| S11.4 | The overall feedback from project stakeholders / clients was positive. | 3.86 | 0.710 |
| S11.5 | I had the opportunity to personally grow during the project. | 3.98 | 0.807 |

### *4.2. Developing and testing the structure*

To develop and test the reliability as well as the validity of the conceptual model, initially an EFA was performed to find factors underlying the 30 statements presented within the survey. Afterwards the internal consistency of items belonging to one common factor according to the EFA results was investigated using Cronbach's Alpha.

#### *4.2.1 Explorative Factor Analysis*

As mentioned in section 3.4, an EFA is done for all eleven concepts individually to explore if factors can be created out of the items suggested. Table 7 presents the results of the individual EFAs. In most cases the KMO lies between 0.6 and 0.7 which is named mediocre (Kaiser & Rice, 1974). For concept 9 the KMO is slightly below 0.6 and for concept 11 the value lies above 0.8, which Kaiser classifies as meritorious. The results of Bartlett's test of sphericity for all concepts are below $p < 0.001$ which means all concepts are correlated.

Table 7. Explorative Factor Analysis (Extraction Method: Principal Axis Factoring)

| Concept | KMO | Bartlett's Sig. | Factors with Eigenvalue >1 | Factor Ranking (Factor Matrix) |
|---|---|---|---|---|
| 1 (S1.1 - S1.3) | 0.675 | <.001 | 1 (1.921) | 1.3 (.746), 1.1 (.660), 1.2 (.631) |
| 2 (S2.1 - S2.3) | 0.673 | <.001 | 1 (1.899) | 2.2 (.721), 2.3 (.675), 2.1 (.618) |
| 3 (S3.1 - S3.3) | 0.645 | <.001 | 1 (1.904) | 3.2 (.834), 3.1 (.654), 3.3 (.540) |
| 4 (S4.1 - S4.3) | 0.630 | <.001 | 1 (1.758) | 4.2 (.786), 4.3 (.547), 4.1 (.527) |
| 5 (S5.1 - S5.3) | 0.656 | <.001 | 1 (1.988) | 5.1 (.799), 5.2 (.778), 5.3 (.539) |
| 6 (S6.1 - S6.3) | 0.635 | <.001 | 1 (2.034) | 6.2 (.950), 6.1 (.635), 6.3 (.593) |
| 7 (S7.1 - S7.3) | 0.666 | <.001 | 1 (1.844) | 7.3 (.697), 7.1 (.639), 7,2 (.613) |
| 8 (S8.1 - S8.3) | 0.603 | <.001 | 1 (1.530) | 8.2 (.639), 8.3 (.472), 8.1 (.442) |
| 9 (S9.1 - S9.3) | 0.574 | <.001 | 1 (1.674) | 9.1 (.723), 9.2 (.718), 9.1 (.316) |
| 10 (S10.1 - S10.3) | 0.679 | <.001 | 1 (2.006) | 10.2 (.812), 10.3 (.672), 10.1 (.647) |
| 11 (S11.1 - S11.5) | 0.806 | <.001 | 1 (2.811) | 11.3 (.767), 11.4 (.758), 11.1 (.736), 11.2 (.660), 11.5 (.423) |

For each of the eleven concepts there is one factor with an Eigenvalue >1, which means all factors could be calculated as envisaged. The factor ranking shows the factor loadings, which underline the importance of each item for the respective factor (e.g., for the first factor, item 1.3 is ranked highest with a loading of 0.746 followed by 1.1 and 1.2).

### *4.2.2 Cronbach's Alpha*

Also, Cronbach's Alpha is examined for each of the eleven concepts individually. Concepts 4, 7, 8 and 9 have a Cronbach's Alpha <0.7 which indicates that especially for the latter ones no internally consistent factors can be constructed. This impression is supported by low inter-item-correlations (see Table 8).

Table 8. Reliability analysis (Cronbach's Alpha for each concept)

| Concept | Cronbach's Alpha | Inter Item Correlation |
|---|---|---|
| 1 (S1.1 - S1.3) | 0.717 | 0.416 - 0.493 |
| 2 (S2.1 - S2.3) | 0.708 | 0.416 - 0.487 |
| 3 (S3.1 - S3.3) | 0.703 | 0.352 - 0.546 |
| 4 (S4.1 - S4.3) | 0.639 | 0.287 - 0.431 |
| 5 (S5.1 - S5.3) | 0.744 | 0.419 - 0.622 |
| 6 (S6.1 - S6.3) | 0.757 | 0.375 - 0.603 |
| 7 (S7.1 - S7.3) | 0.686 | 0.391 - 0.446 |
| 8 (S8.1 - S8.3) | 0.509 | 0.207 - 0.302 |
| 9 (S9.1 - S9.3) | 0.541 | 0.227 - 0.520 |
| 10 (S10.1 - S10.3) | 0.739 | 0.434 - 0.546 |
| 11 (S11.1 - S11.5) | 0.796 | 0.218 - 0.625 |

Taken together, the preliminary EFA and Reliability analyses suggest that the concepts 1, 2, 3, 5, 6, 10 and 11 serve as reliable and valid measurement instruments. However, this implies that the conceptual model described in section 2.4 cannot be used as presented and needs to be optimized. For this purpose, further explorative analyses were done.

## *4.3. Validity check*

After EFA and Cronbach's Alpha were carried out on concept level, both steps were repeated for the complete set of 30 independent items. The KMO measure of sampling adequacy is 0.892 and Bartlett's Test of Sphericity shows $p<0.001$ which means it is significant and an EFA for all variables can be carried out.

SPSS extracts seven factors, even though the seventh factor has an Eigenvalue of 1.005 only. Table 9 shows how the items load upon these seven different factors which are labeled Communication and Coordination (factor 1), Personal Commitment (factor 2), Team Balance and Mutual Support (factor 3), Result Orientation (factor 4), Social Fellowship (factor 5), Collaboration Equipment (factor 6) and Cohesion (factor 7).

As can be seen, seven factors representing possible predictors of TWQ arise. As the seventh factor includes one item only, it will be excluded from further confirmatory analyses.

Cronbach's Alpha for each identified factor lies between $\alpha= 0.731$ and $\alpha= 0.795$. For factor 6, a questionable reliability of $\alpha= 0.679$ results. Thus, a solution of five valid and reliable factors can be concluded after this exploratory stage.

Table 9. Rotated Factor Matrix

| Factor | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| **Factor 1: Communication & Coordination** | | | | | | | |
| S1.1 - Project-relevant information was shared openly by all team members. | .503 | | | | | | |
| S1.2 - The team members were happy with the timeliness in which they received information from other team members. | .566 | | | | | | |
| S1.3 - The team members were happy with the usefulness of the information received from other team members. | .523 | | | | | | |
| S2.1 - The work done on subtasks within the project was closely harmonized. | .533 | | | | | | |
| S2.2 - There were clear and fully comprehended goals for subtasks within our team. | .517 | | | | | | |
| S2.3 - The goals for subtasks were accepted by all team members. | .402 | | | | | | |
| **Factor 2: Personal Commitment** | | | | | | | |
| S5.1 - Every team member fully pushed the project. | | .625 | | | | | |
| S5.2 - Every team member made the project their highest priority. | | .819 | | | | | |
| S5.3 - Our team put much effort into the project. | | .367 | | | | | |
| S6.1 - All members were fully integrated in our team. | | .378 | | | | | |
| S6.3 - The members of our team felt proud to be part of the team. | | .372 | | | | | |
| **Factor 3: Team Balance & Mutual Support** | | | | | | | |
| S3.1 - The team recognized the specific potentials (strengths and weaknesses) of individual team members. | | | .559 | | | | |
| S3.2 - The team members contributed to the achievement of the team's goals using their specific potential. | | | .504 | | | | |
| S3.3 - Member contribution within our team was in balance. | | | .432 | | | | |
| S4.1 - The team members helped and supported each other as best they could. | | | .382 | | | | |
| S4.2 - If conflicts came up, they were easily and quickly resolved. | | | .343 | | | | |
| S8.1 - Team members were selected based on their talents and abilities to contribute to the team. | | | .496 | | | | |
| **Factor 4: Result Orientation** | | | | | | | |
| S4.3 - Our team was able to reach a consensus regarding essential issues. | | | | .389 | | | |
| S7.1 - When team members worked jointly on problems, they tended to build on each other's ideas. | | | | .600 | | | |
| S7.2 - When several team members discussed an issue, it was all right to comment or ask questions about anything one did not understand. | | | | .609 | | | |
| S7.3 - After a disagreement over how the group should proceed, everyone quickly picked up their part of the task activity. | | | | .490 | | | |

| Factor | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| **Factor 5: Social Fellowship** | | | | | | | |
| S10.1 - I felt comfortable in the virtual working environment. | | | | | .604 | | |
| S10.2 - The virtual working environment enabled me to get a good impression of my teammates. | | | | | .687 | | |
| S10.3 - The virtual working environment allowed spontaneous informal conversations. | | | | | .635 | | |
| **Factor 6: Collaboration Equipment** | | | | | | | |
| S8.2 - Team members regularly used phone and/or online computer conferences to share ideas. | | | | | | .481 | |
| S9.2 - My virtual team was equipped with adequate tools and technologies to perform our tasks (SharePoint, ...). | | | | | | .720 | |
| S9.3 - The electronic methods (MS Teams, Zoom, ...) we used to communicate with each other were powerful. | | | | | | .648 | |
| **Factor 7: Cohesion** | | | | | | | |
| S6.2 - Our team was sticking together. | | | | | | | .789 |
| **No assignment to a specific factor (as loading too small)** | | | | | | | |
| S8.3 - The team had an established process for making decisions. | | | | | | | |
| S9.1 - I have received training focused on performance improvement in virtual teams. | | | | | | | |

### *4.4. Confirmatory Factor Analysis*

As EFA and Cronbach's Alpha do not take errors of measurement into consideration (Weiber & Mühlhaus, 2014), a SEM was built in AMOS and a CFA was done to confirm the five factors obtained in section 4.3.

To build up the measurement part of the SEM stepwise, all latent factors are tested separately first. This enables the detection of factors which might influence the model fit of the CFA negatively in advance.

Factor 1 is not able to fulfil the model fit requirements. Even after adding two item-correlations none of the fit criteria can be fulfilled. Also factor 5 and 6 struggle to reach the expected thresholds. Factor 2 (Personal Commitment), factor 3 (Team Balance & Mutual Support) and factor 4 (Result Orientation) on the other hand show sufficient fit indices. For these three factors, all loadings are significant, too. Taking these three latent factors as basis, a measurement model is constructed. The resulting measurement is depicted in Figure 2.

The final model consists of the mentioned three factors (F2, F3, F4) plus their items and their associated errors of measurement (E1-E15). Some of the item-correlations suggested by AMOS are implemented (depending on the meaningfulness of the proposal, content wise) and can be found in the SEM above (curved arrows).
As there is a multicollinearity between the three latent factors, they were merged into a higher-order latent construct. This latent variable is called "Willingness to succeed" as it mirrors the statements of factor 2, 3 and 4. All three latent factors load significantly upon this construct and fit measures pinpoint towards a suitable measurement model. Within the full SEM a path relating the factor "Willingness to succeed" to TWQ is suggested.

CMIN/DF for the complete SEM is 1.745 while 0.06 is the value for RMSEA, meaning both requirements are fulfilled (see section 3.4). Two of the Baseline Comparison Indices meet the prerequisite of ≥0.9 (TLI is 0.903 and CFI is 0.917), while NFI is a bit lower but close (0.828).

Finally, a reliability analysis is added for the newly constructed higher order latent construct "Willingness to succeed". This analysis confirms a good internal consistency (α= 0.795).

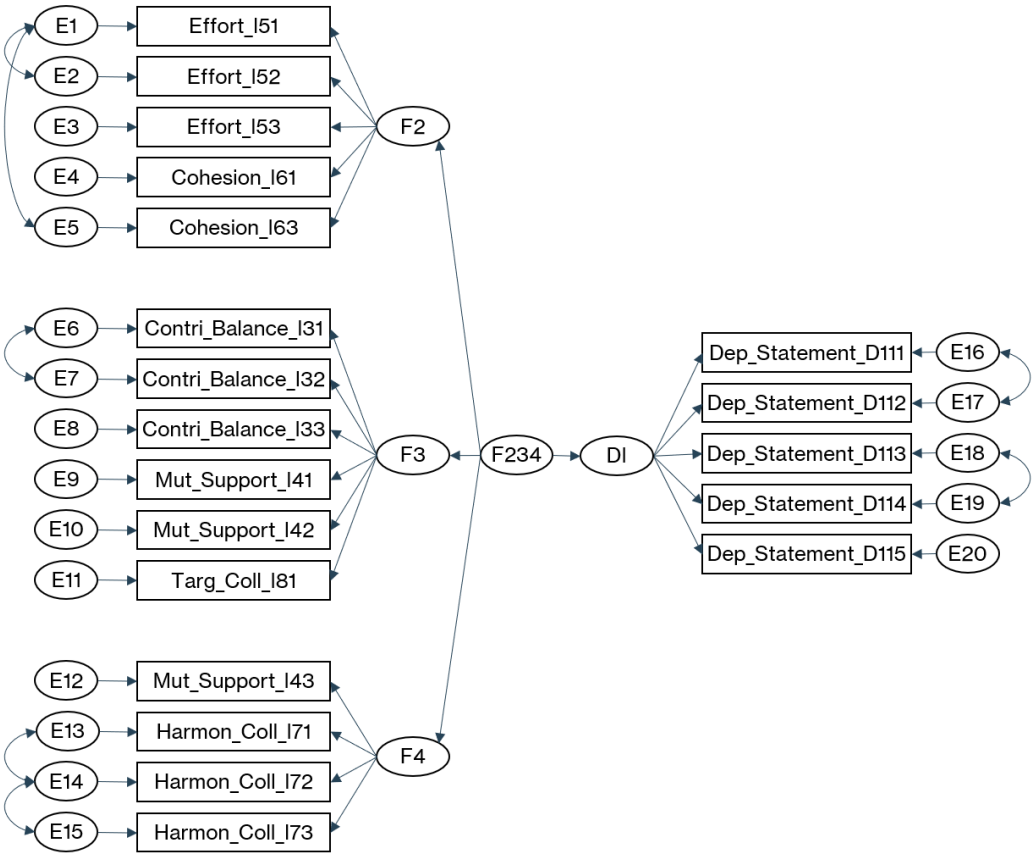


Fig. 2. Structural Equation Model

### *4.5. The three factors which affect TWQ in virtual teams*

As mentioned within the previous section, there are three factors which provide good results in the EFA, reliability analysis and CFA. The first one is labelled "*Personal Commitment*". It relates to the operational readiness of the project team members and how much they identify themselves with the team and the project. Model Fit values can be found in Table 10.

The second factor is called "*Team Balance & Mutual Support*" and captures the right composition of the team, considering individual strengths and weaknesses. Furthermore, team members should support each other, and everyone should be given the opportunity to make their contribution.

Factor 3 stands for "*Result Orientation*". As the title indicates, the focus rests upon goal-oriented collaboration (finding consensus, being open to other people's ideas, expressing honest opinions, etc.).

In turn, these three factors have an influence on the "*Willingness to succeed*". If, for example there is a high personal commitment or a high result orientation in the team, then the willingness to succeed is higher as well. And ultimately, the higher the willingness to succeed, the higher the TWQ.

Table 10. Model Fit Values

| | CMIN/DF | NFI | TLI | CFI | RMSEA |
|---|---|---|---|---|---|
| Threshold Value | <3.0 | ≥0.9 | ≥0.9 | ≥0.9 | <0.08 |
| Confirmed Factor 1: Personal Commitment | 1.273 | 0.979 | 0.990 | 0.995 | 0.036 |
| Confirmed Factor 2: Team Balance & Mutual Support | 1.204 | 0.962 | 0.989 | 0.993 | 0.031 |
| Confirmed Factor 3: Result Orientation | 0.192 | 0.998 | 1.031 | 1.000 | 0.000 |
| Confirmed higher-order latent variable "Willingness to succeed" | 1.745 | 0.828 | 0.903 | 0.917 | 0.060 |

## 5. Discussion

The purpose of this paper was the identification of factors affecting TWQ in virtual project teams as well as the exploration of their measurement. Summarizing the main findings of this paper, the conducted research discovered three factors, namely Personal Commitment, Team Balance and Mutual Support as well as Result Orientation, that are valid and reliable and that, taken together, capture the "Willingness to succeed" which in turn affects TWQ in the described virtual environment.

The results emphasize the importance of Personal Commitment to the project and the virtual project team. From co-located teams it is already known, that a high project commitment positively influences team member motivation to spend all available efforts on the project (Buvik & Tvedt, 2017). Hence, it should be fostered and used as a leverage for project teams and successful project results (Tremblay et al., 2015). Due to the identified importance of personal commitment towards the virtual project (team) it could make sense to extend important goals and values for co-located to virtual project teams. These could for instance be the provision of a clear project vision or the emphasis on how the project contributes to the prosperity of the company (Lee, 2021).

Amongst others the second factor focusses on Team Balance, which stands for a balanced team composition on one hand and for a balanced team member contribution on the other hand. The first point is ensured by paying attention to qualifications when selecting team members (Lurey & Raisinghani, 2001). Related to the second point, it should be the aim of every organization to motivate team members to share knowledge and experiences with the team, but in addition, it needs to be ensured that contribution is in balance (Hoegl & Gemuenden, 2001). Besides Team Balance the second factor also takes Mutual Support into account. Samuel and Mathew pointed at the importance of Mutual Support for work performance among co-located team members already (Samuel & Matthew, 2021) and the research carried out here confirms the significance for virtual project teams, too.

The importance of "Result Orientation" as an additional key factor is no surprise, as project teams have clear goals (e.g. related to quality, time and cost) in their project mandate, which is approved by senior management (PMI, 2013). If results are delivered as expected in the project mandate, the project is considered a success (Zid et al., 2020). This applies to all projects and does not depend on whether the teams are co-located or working remotely.

Despite literature pointing towards additional relevant predictors within the context of TWQ, represented by the ten constructs pictured within the conceptual model, the analyses of this paper could not verify their reliability and validity. Given that many authors focusing on TWQ have done so without checking the validity of their measurement tools, this paper provides a novel contribution to future work within this research field. The research aims of identifying relevant predictors and developing a valid measurement tool have thus been met. Scholars and companies focusing on TWQ should hence use the manifest items related to TWQ, Personal Commitment, Team Balance and Mutual Support as well as Result Orientation developed here to assess TWQ and influencing factors.

## 6. Conclusion

Virtual project teams offer advantages like the ability to include experts from other regions or countries, to allow productivity around the clock seven days per week, to reduce environmental impact and costs due to less travel, and to share knowledge globally and across organizational borders (Dulebohn & Hoch, 2017). On the other hand, it is more difficult to build up and to keep the level of trust and engagement within virtual project teams, as the team members meet rarely and communicate mainly through ICT. Therefore, the aim of this paper was to answer the question *Which factors predict Teamwork Quality in virtual project teams and how can they be measured?* An EFA based on an online survey has been conducted, followed by a Reliability Analysis and CFA to develop a measuring tool for TWQ in virtual project teams and to investigate which influencing factors companies should focus upon, if their project teams are not co-located.

Even though the topic of this paper is of current interest and fulfils the academic requirements, a survey with any sample always has limitations with regards to reliability. It should be mentioned that it is not possible to clearly retrace the exact background of the survey participants, and under which conditions they work, as it was an open questionnaire for people working remotely in project teams. Therefore, participants might interpret the same statement differently or define key terms such as "trust" in a different way. It should also be pointed out that all items were collected using a Likert scale with the same scaling, which can lead to method bias (DeVellis & Thorpe, 2021). It is therefore recommended for future studies to use different survey instruments or a variation to prove whether the results hold up.

However, this work represents a good basis and can be a motivator for researchers to carry out more targeted investigations with focus on further testing of the three identified factors, perhaps with explicit attention on specific cultures, leadership styles or project types.

The contribution of this paper is that it delivers empirical data related to TWQ in virtual project teams and that it closes a gap as no research has been carried out with focus on these two variables. Now, leaders are capable to maximize the "Willingness to succeed" and consequently they are able to positively influence Teamwork Quality in practice. Thanks to the developed measuring tool the three identified factors can be tracked and, by using trends, even be forecasted.

## Declarations

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