



Benefits of Card Walls in Agile Software Development: A Systematic Literature Review

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Abstract. Card walls are often used to visualize various aspects of the software development process. They are an essential and widespread agile practice. Despite the drawback of physical card walls, its digital version is often not considered a sufficient alternative. This paper aims to find the reason for this and suggests how to evolve digital card walls into a viable alternative. We conducted a systematic literature review and analyzed twenty-two studies. We identified which desirable effects agile teams get from card wall usage and derived a set of properties a card wall needs to achieve those effects. Furthermore, we suggested a typology of card walls to compare the benefits and challenges among them.

Keywords: Agile · Software development · Card wall · Task board · Scrum board · Information information radiator · Big visible chart · Systematic literature review

1 Introduction

Card walls play a central role when working in an agile team. According to the state of agile report [1], most agile teams use card walls for team collaboration and visualization of the project status. In this paper, the term *card wall* is used as a synonym for various kinds of boards to track and visualize the team's current work and progress. In the mentioned study, the usage of a Kanban board and a task board, in general, are the two highest-ranked tools in the analysis of agile tool usage. While there exists a variety of digital board solutions, which offer a wide range of inherent benefits, physical card walls are still widespread [2], and agile teams decide explicitly to use a physical card wall over a digital one [3, 4]. This raised the question of why agile teams still very often favor physical card walls over digital and what is necessary to make the digital solution more competitive with the physical ones. What makes the question especially interesting is the fact that the COVID-19 pandemic has served as a catalyst for the hybrid working trend, and many teams do not plan to come back in the office full-time [1]. This paper aims to describe how digital card walls need to be realized to offer the same benefits as a physical solution, especially concerning

hybrid-working. We examined the current state of research with a systematic literature review (SLR) to answer this question. Our main research question is:

RQ: How do digital card walls need to be implemented to be able to replace physical solution?

To answer this question and guide the SLR, we framed more granular research questions. First, we want to understand why and how agile teams use card walls. Understanding the benefits of applying this agile practice makes it possible to infer what characteristics are essential to replicate the desired experience. Second, we wondered why agile teams decided to use physical card walls instead of digital card walls. That means we wanted to understand the benefits and challenges of physical and digital card walls. This leads to the following two research questions.

RQ1: What makes card walls beneficial to agile teams?

RQ2: What are the challenges & benefits of physical/digital card walls?

The rest of the paper is structured as follows. The methodology of the SLR is described in Sect. 2, followed by the results in Sect. 3. In Sect. 4, the results are discussed with concrete suggestions about how digital card walls could be improved, and Sect. 5 contains the conclusions.

2 Research Method

We conducted a Systematic Literature Review (SLR) to answer the two research questions. We followed the recommended general steps for literature review [5–8]. After identifying the need for a systematic review, we derived the research questions. Then, we executed the search for relevant studies using a predefined search string to retrieve results from several databases. After cleaning up and eliminating duplicates, we screened the records and included studies based on the inclusion/exclusion criteria. Finally, we reviewed and analyzed the full text of the remaining studies. The described process is visualized in Fig. 1.

2.1 Search Process

We defined keywords to retrieve potentially relevant articles from the databases. To define the keywords, we looked at studies and non-scientific literature about agile software development and examined synonyms for describing card walls' usage in an agile context. The resulting keywords are shown below.

Agile: Agile, Scrum, Kanban, Scrumban, Extreme programming

Card wall: card wall, Scrum wall, Scrum board, status board, task board, story board, information radiator, Kanban board, wall board

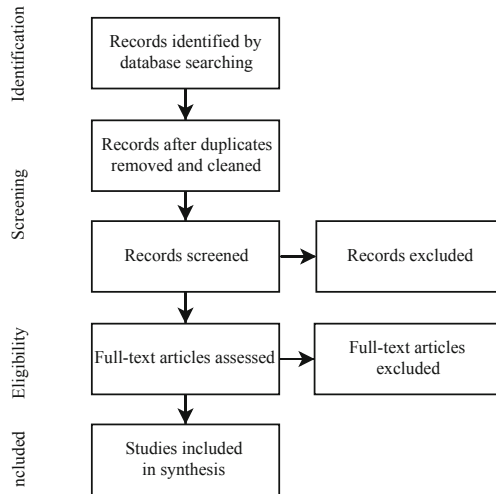


Fig. 1. Research methodology, adapted from PRISMA

Weidt and Da Silva recommend using six search engines to conduct an SLR [7]. However, Gusenbauer and Haddaway found that only three out of the stated six are suitable to be used as principal search engines [10]. Therefore, we used the following three search engines to search the literature for this study: ACM Digital Library¹, ScienceDirect², and Scopus³. Out of the identified keywords, we constructed the query string shown in Table 1. Table 2 shows the applied inclusion and exclusion criteria. The inclusion criteria define the topics we were looking for. If one or more of the criteria matched included a study. However, we excluded a study if one of the exclusion criteria matched.

2.2 Data Collection

We executed the search on April 10th, 2020. The initial search in the three databases returned 829 studies, from which 667 were candidates for further processing. Table 3 shows the results of every step in the identification process, and Fig. 2 shows the graphical representation of the search process⁴ First, we did the initial search using the defined query string. Then, if the search engine offered refinement filters, we applied these as a second step according to the listed exclusion criteria. Finally, we filtered the results manually in the third step and excluded obvious false positives like whole journals or books. The only deviation from the protocol was that ScienceDirect could not process the whole

¹ portal.acm.org.

² sciencedirect.com.

³ scopus.com.

⁴ Notice that the table contains more detail than the visualization, and the steps do not directly match.

Table 1. Search query to retrieve studies

```
(agile OR scrum OR kanban OR scrumban OR "extreme programming")
AND
(("scrum wall" OR "scrumwall" OR "scrum-wall" OR "scrum-board") OR
("scrum board" OR "scrumboard" OR "statusboard" OR "status board") OR
("status-board" OR "cardwall" OR "card-wall" OR "card wall") OR
("taskboard" OR "task-board" OR "task board") OR
("storyboard" OR "story-board" OR "story board") OR
("information radiator" OR "information-radiator") OR
("kanban board" OR "kanban-board" OR "kanbanboard") OR
("wallboard" OR "wall board" OR "wall-board"))
```

query string in one step. Therefore, we divided the query into three parts, merged the results, and removed duplicates.

Table 2. Inclusion and exclusion criteria.

Inclusion	Exclusion
<ul style="list-style-type: none"> • Card wall (digital or physical) • Communication • Visualization • Workspace • Process Monitoring/Project Management • Global/Large scale organizations • Distributed teams • Agile Practices/Adoption • Tools to support agile practices 	<ul style="list-style-type: none"> • Not written in English or German • Not domain agnostic or not Software Engineering domain • Not empirical e.g. no manuals or guides

In the resulting recordset, we extracted the following data from each study to use in the screening process: Title, Authors, Abstract, Keywords, source (journal or conference), and complete reference. We then retrieved the full article and extracted the following metadata for the articles that passed the screening.

- The type of research.
- The agile methodology, which was the subject of the investigation.
- The main topic of the research.
- If card walls were the main topic of the research.
- The contribution of the study to the research about card walls.

We reviewed the title, abstract, and keywords of every record for the screening process. Of the 667 initial records, we classified 77 as definitely or potentially matching the defined inclusion criteria and retrieved the full text. After assessing the complete text, we excluded 55 articles because they did not match the

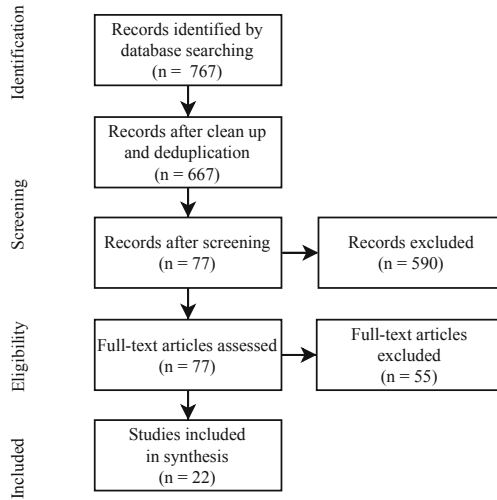


Fig. 2. Number of included/excluded records.

inclusion criteria or matched one of the exclusion criteria. Finally, we identified 22 articles to include in the synthesis (see Table 4). In 11 of the identified studies, the card wall is the research object. The other 11 studies have another main topic but contain important information for answering the research questions.

Table 3. Number of records from identification including source.

Database	Number of records			
	Initial	After refinement	After cleaning	Unique
ACM	484 ^a	406 ^b	390	667
ScienceDirect	121	110 ^b	97	
Scopus	287 ^c	251 ^d	242	
Total	892	767	729	

^a We searched “The ACM Guide to Computing Literature” database

^b Include only periodicals, proceedings, and journals

^c Search all text fields

^d Include only English or German, conference papers or articles

2.3 Data Analysis

To answer our research questions, we were interested in the seen and experienced effects when working with the boards and the feedback from the users. Thus, we did not consider explanations about a methodology or practice taken from

Table 4. Studies included in the synthesis.

Id	Author/Study	Date	Agile Methodology	Main topic	Main topic card wall	Contribution to card wall research
S1	Ahmad et al. [11]	2018	Kanban	Kanban in SWE	No	Experience report
S2	Annosi et al. [12]	2020	Scrum/Kanban	Organizational learning	No	Experience report
S3	Anwar et al. [13]	2016	Scrum	Agile adoption	No	Experience report
S4	Azizyan et al. [2]	2011	Agile	Scrum tools	Yes	Tool usage
S5	Bakke & Agnar [14]	2019	Lean	Agile adoption	No	Experience report
S6	Bastarrica et al. [3]	2018	Agile	Agile adoption	No	Experience report
S7	Eckhart & Feiner [15]	2016	Scrum	Scrum tools	Yes	Requirements to card walls
S8	Hajratwala & Nayan [16]	2012	Scrum	Card wall usage	Yes	Requirements to card walls
S9	Hunt et al. [17]	2007	Agile	Workspace	No	Experience report
S10	Katsma et al. [18]	2013	Scrum	Card wall usage	Yes	Requirements to card walls, challenges with card wall, tool usage
S11	Kropp et al. [19]	2017	Scrum	Digital card wall	Yes	Requirements to card walls
S12	Liechti et al. [20]	2017	Agile	Actable Metrics	No	Benefits of physical card walls
S13	Mishra et al. [21]	2012	Agile	Workspace	No	Impact of card walls
S14	Nakazawa & Tanaka [22]	2016	Kanban	Digital Kanban Board	Yes	Impact of card walls
S15	Perry [23]	2008	Agile	Digital and physical card walls	Yes	Requirements to card walls, prod & cons of digital and physical
S16	Pikkarainen et al. [24]	2008	Agile	Agile practices	No	Impact of card walls
S17	Rola et al. [4]	2016	Scrum	Workspace	No	Impact of card walls, Benefits of physical card walls
S18	Rubart [25]	2014	Scrum	Digital card wall	Yes	Experiment with digital card wall
S19	Rubart & Freykamp [26]	2009	Scrum	Digital card wall	Yes	Benefits of physical card walls, requirements of digital card wall
S20	Sharp & Robinson [27]	2008	XP	Card wall usage	Yes	Impact of card walls, Benefits of physical card walls
S21	Sharp et al. [28]	2009	Agile	Physical artefacts	Yes	Requirements to Card Walls
S22	Wiklund et al. [29]	2013	Scrum	Agile adoption	No	Requirements to Card Wall (different boards)

a guide or recommendation. Instead, we looked for studies with interviews, surveys, observations, and experience reports. We applied an inductive data driven approach to develop thematic categories. We did this by scanning the identified literature for statements that help answer our research questions and highlighted those statements. That means, statements about benefits, challenges or the way of working with regards to card walls. In the next step, we worked out categories for the statements per research question and finally condensed the categories. The results are shown in tables 5 - 10, and presented and discussed in the next section. For RQ1, we did not distinguish between physical and digital card walls since we were interested in the general benefits of card walls. For RQ2, the type of card wall was considered to be able to list the benefits and challenges depending on the card wall type.

3 Results

In this section, we present the results of the SLR and the answers to the research questions. It is divided into two sections, one devoted to each research question.

3.1 RQ1: What Makes Card Walls Beneficial to Agile Teams?

Table 5 lists the benefits grouped by category why agile teams use card walls and also references the reporting literature⁵. The here listed benefits concern general benefits that are seen and experienced from card walls independent of their nature (physical or digital boards). On one side, the benefits concern visibility aspects of the board (visualization, always-on, transparency). On the other side, team aspects like decision making and communication, for example. In the following, the categories are explained in detail.

Table 5. Benefits of card wall usage.

Id	Category	Reporting studies
C1	Attention of team	[15, 18, 27]
C2	Collaboration and communication	[4, 15, 18, 21, 22]
C3	Decision making	[11, 24]
C4	Focus	[12, 23, 24]
C5	Gathering place	[15, 18, 25, 27]
C6	Knowledge dissemination	[4, 13, 21, 22]
C7	Up to date information	[4, 22, 23, 27]
C8	Physical interaction	[4, 17, 18, 27]
C9	Progress tracking	[3, 4, 12, 18, 20, 24]
C10	Transparency	[11, 12, 14, 24]
C11	Visualize work	[11, 12, 16, 17, 23, 27, 29]
C12	WIP control	[11, 16, 22]

C1-Attention of team: The act of updating the card wall, i.e., walking to the card wall and interacting with it, raises the attention of other team members and thus helps to keep the team up to date [15, 27]. Furthermore, a large wall, placed in a central place, which is always “on” catches everyone’s attention by itself [18].

⁵ The following Excel sheet shows the extracted segments of the studies and the assigned codes, which were later used to build the categories <https://1drv.ms/x/s!ApmGN3k-vuH11YAjDWOzMovfryHukQ>.

- C2-Collaboration and communication: The visible interaction with the card wall encourages open communication and collaboration in the team [15,18]. Moreover, as there is only one single interface to the tool, it acts as a central meeting point and leads to more face-to-face communication [18].
- C3-Decision making: With the visual nature and up-to-dateness, the card wall supports decision making like prioritization, dependencies, and resource allocation [11,24].
- C4-Focus: In ceremonies like the daily stand-up, which are held in front of the wall, the team is more focused on talking about the currently relevant tasks [23]. Additionally, the usage of a card wall helps to keep focused on the tasks that one is working on [12,23]. In one study, it was reported that the card wall helps to increase the visibility of common short-term goals [24].
- C5-Gathering place: The card wall becomes a gathering place, either to hold discussions [15] or also because ceremonies like daily stand-ups are held in front of it [25,27].
- C6-Knowledge dissemination: It was reported that the card wall helps with knowledge dissemination even with no further explanation [13]. As a result of shared knowledge and understanding, redundancy and the overlapping of work are minimized [21]. With a broader view, team members are encouraged to grab tasks that are less related to them themselves [22]. Card walls support knowledge dissemination by the fact that they are used to communicate besides the cards, which represent tasks to work on [4].
- C7-Up to date information: Several studies reported that the team members were motivated to keep the information on a card wall up to date [4,22,23,27].
- C8-Physical interaction: The physical interaction with the card wall leads to a good feeling, which is a source of motivation. One aspect of the good feeling arises due to the visibility of the action by the team and the immediate feedback [4,17,18]. There were also other interactions mentioned which are related to the card wall. For example, the cards are pulled away from the wall when working on them, signifying responsibility. Furthermore, a card sometimes acts as a kind of token. Team members are pulling it from the wall and holding it while they are talking about it in daily stand-up meetings [27].
- C9-Progress tracking: As all activity which the team currently works on is visible on the card wall and up to date, it makes it an excellent tool for tracking the progress [3,4,12,18,20,24].
- C10-Transparency: The wall is placed at a prominent and visible place. Thus, the work and progress are transparent to everyone in the room. Furthermore, all tasks and their assignment are visible at a glance, which also makes transparent who currently works on which tasks [11,12,14,24].
- C11-Visualize work: The aspect that a card wall is designed to visualize the work is considered a significant benefit. The mentioning of visualization as a benefit or instrument in a broad range of studies reflects this [11,12,16,17,20,22,23,27,29].
- C12-WIP control: The card wall helps the team to track the current work in progress [11,16]. Due to the visual nature of presenting the cards, it becomes

evident if there is too much work in progress, even without explicitly defining a work-in-progress limit [22].

The results show that card walls generally play an important role in agile team collaboration, especially concerning serving as an information radiator and for common decision-making.

3.2 RQ2: What Are the Challenges and Benefits of Physical/digital Card Walls?

With this research question, we wanted to analyze the benefits and challenges of physical and digital card walls and why teams still often prefer physical over digital card walls.

Table 6. Card wall types

Id	Type	Kind	Description
T1	Paper	Physical	Physical wall with paper and cards on it.
T2	Paper & Audio photo/Video	Physical	T1 but its shared/documented with video and/or photo.
T3	Software	Digital	Software which helps keep track of the task but with no special visualization nor physical appearance.
T4	Software with virtual card wall	Digital	T3 but replicating the visual appearance of a physical card wall.
T5	Software with non-interactive vertical screen	Digital	T4 but permanently displayed on a big visible screen.
T6	Software with interactive vertical screen	Digital	T5 but interactive screen, e.g., drag and drop the virtual cards

The benefits and challenges depend on the kind of card wall. Different types of digital card walls must be distinguished. Therefore, we created the typology of different card wall types shown in Table 6. This typology is based on the studies identified in this SLR, which aimed to replicate the aspects of the physical card wall: Scrumpy [15], Kanban Tool [22], Multi-touch-scrum task board [25], Cooperative Task Board [26], and aWall [19]. Furthermore, the usage scenarios from Katsma et al. [18] are taken into account. Unfortunately, it was impossible to extract the concrete used card wall type from the analyzed reports. The

Table 7. Reported benefits of physical card walls.

Id	Category	Subcategory
PB1	Physical presence	Big and visible [16, 20, 23]
		Publicly available [13, 19, 23]
		Meeting place [13, 18, 23, 28]
		Availability [18, 23, 27]
		Attraction outside of team [13]
		Place for extra information [19]
PB2	Usability	Easy to modify [19, 27]
		No process pre-defined [15, 28]
		Ease of use [18, 23, 28]
PB3	Physical interaction	Responsibility [19, 27]
		Communication Frequency [21, 23]
		Motivation [17, 18, 23, 24]
PB4	Overview	Makes sloppy tracking visible [4, 23]
		Focused [19, 23]
		Good overview [19]
PB5	Cost	Cheap [18, 23]

Table 8. Reported challenges of physical card walls.

Id	Category	Subcategory
PC1	Physical presence	Fixed location [18, 19]
		Sharing is hard [15]
		Cards can get lost [17, 28]
PC2	Lack of automation	Keep up to date is hard [13]

included studies often do not contain enough details about what kind of tool the teams used. There are often statements like a “scrum tool” or a “digital task board”, which do not even allow to make a reasonable guess about the used card wall type. Thus, for the analysis of the challenges and benefits, we generally distinguish between physical and digital card walls.

Tables 7, 8, 9 and 10 list the summarized benefits and challenges of physical and digital card walls. The sub-categories are not explained further, as they are granular enough to be understandable on their own (see the footnote 9).

One of the main benefits of a physical card wall is its physical nature by itself: standing in the room draws attention, makes it visible to everybody, and fosters transparency. Another important aspect mentioned is its ease of use and haptic behavior (Table 7).

The advantage mentioned above of the physical nature is at the same time reported as one of the biggest challenges. Its physical presence is restricted to the

place where it is standing (Table 8). The lack of automation covers the aspect of missing traceability or missing support of digital intelligence.

Table 9. Reported benefits of digital card walls.

Id	Category	Subcategories	
DB1	Location independent	Available at multiple locations	[18,19,23]
DB2	Automation	Reporting	[15,18]
		Tracability	[19]
		Can archive data	[18,23]
		Integration with other tools	[23]
		Automatic adjustments of cards	[15]

One of the main reported benefits of digital, typically Web-based, card walls is its location independence together with its digital support like traceability, archiving, and integration possibilities (Table 9). Amongst the most often reported challenges is the complexity of the systems, which makes them very hard to use, and the missing overview (Table 10).

Table 10. Reported challenges of digital card walls.

Id	Category	Subcategory
DC1	ICT	Possible outage [15,23]
		Shifts focus from interactions to tools [23]
DC2	Ease of use	Inefficient overview [15]
		Too many features [19]
		Training required [23]

4 Discussion

In this section, the findings of the research questions are discussed, and the paper’s main question is addressed.

4.1 RQ1: What Makes Card Walls Beneficial to Agile Teams?

The first question aims to answer why teams even use card walls. Analyzing the retrieved studies resulted in twelve categories that reflect the stated reasons. Looking at the categories, each category is either a benefit of the card wall itself or an effect of using the card wall. The categories often influence each

other and whether a card wall has the stated benefits heavily depends on how it is implemented. So to precisely answer this research question, more details about the causes and effects (why they are beneficial vs. how they are beneficial) would be required. Most of the studies do not explain in very detail how the card wall was implemented and used; also, most studies were not conducted experimentally. Although it is possible to make some inferences, e.g., that the team's attention is an effect of the physical interactions, it is not sure if this is the only effect or if there are some other interactions. However, the analysis seems to show that the location of a card wall has an important effect. For example, if a card wall is placed in its own room and other team members cannot see an individual's interaction with the card wall, this will not raise any attention, and thus, it will not increase the communication frequency. On the other side, if the card wall is put in a shared office room, its permanent visibility and the visibility of the interactions of others seem to be very beneficial for agile teams.

4.2 RQ2: What Are the Challenges & Benefits of Physical/digital Card Walls?

The analysis shows that each approach has its strength and weaknesses. The pure physical nature of physical card walls brings many benefits, especially serving as an information radiator and a meeting point. On the other side, digital solutions add a lot of new functionality to card walls due to their digital nature, which supports the teams in many aspects. A major benefit concerns the support for distributed work, especially in today's distributed world. We found that a binary classification between physical and digital card walls is not appropriated and defined six different types of card walls. Furthermore, it must be considered that the software used for a digital card wall also has a considerable influence. A digital card wall does not inherently offer all the stated benefits, it also depends on the specific software and which features it offers. Nonetheless, digital card walls seem to suffer from their high complexity.

4.3 How Do Digital Card Walls Need to Be Implemented to Offer the Same Benefits as a Physical Solution?

This question must especially also be seen under the aspect of the new hybrid work style. We will have more and more distributed and dispersed teamwork, a mixture of multiple teams distributed worldwide, and team members working at home. Card walls, as the major collaboration tool for agile teams, must be able to support such teams as efficiently and effectively as possible.

The two research questions formulated to guide the SLR were intended to gather the necessary knowledge to answer the main question of this paper. RQ1 resulted in a set of categories from which we derived the following properties, which lead to the benefits of card walls.

- Physical artifact
- Placed in a central location

- Big and visible
- Always available and visible to everyone
- Physical interaction necessary for task update
- Visualization instrument

Two aspects cannot be influenced by the card wall itself but need to be considered by a team implementing a card wall.

- Reflect the real process/state of work of the team.
- What is not on the wall does not exist.

RQ2 revealed that the card wall type T6 “Software with interactive vertical screen” has the most significant potential to replicate the benefits of a physical card wall. A digital card wall of type T6 can potentially have all the properties to be considered. Therefore, the stated benefits and challenges need to be addressed when implementing the software for the digital card wall. However, it is essential always to remember that the desired effects may result from specific properties. That also means that some stated challenges of physical card walls and benefits of digital card walls should not be addressed because this has a potentially harmful influence on the experience, which is necessary to replicate the benefits of a physical card wall. For example, the benefits stated for digital card walls are: available at multiple locations, interaction with other tools, and automatic adjustment of cards. Those three benefits could lead to a situation where a visible physical interaction with the card wall is not necessary anymore. However, this visible physical interaction seems to be a card wall property that leads to benefits. There are also certain aspects that are either not solvable by the current technology, available or contradictory. Thus, there are always certain trade-offs. An example of a contradiction is traceability (only possible with a defined process) vs. no pre-defined process. An example of an inherent problem with the current state of technology is that the risk of an outage with a digital card wall is higher than that one of a physical one.

The potential of type T6 was already mentioned by Sharp et al. in their paper “The role of physical artefacts in agile software development: Two complementary perspectives” [28], but they also point out the fact that it is important to be able to replicate the social context, not only the purely functional nature of a card wall. This is in line with the findings of this SLR because it was shown that it is not sufficient just to solve the mentioned challenges to replicate the experience. Further research should clarify which properties are critical to replicate the social context around a digital card wall and how they can be implemented while maintaining the desired advantages of digitalization.

4.4 Limitations

This study has several limitations related to the methods and the corpus of studies. First, this review summarizes research results in a field with a rapidly changing technological landscape. The oldest studies included are from the year

2008. The benefits of a card wall may not change, but the tools available to build digital solutions are. Second, despite the systematic approach, the body of literature discovered may not be exhaustive. We may not include important literature with our methodology, and we did not consider gray literature. Third, there were no experimental or quasi-experimental studies on this topic. Hence all stated causality must be seen as a hypothesis that needs to be checked. Furthermore, as the studies mainly were qualitative case studies with small sample sizes, they are subjective and may not be transferable to other fields or teams.

5 Conclusion

We created twelve categories that show the benefits arising from card wall usage in general. Additionally, we summarized the benefits and challenges of physical and digital card walls. An important finding is that the desired benefits of card walls depend on specific properties. Hence, the benefits are only achievable by considering those properties. This is independent of the nature of the card wall, i.e., if it is a physical or a digital one. Those properties are essential to replicate the benefits of a physical card wall with a digital card wall. Another finding is that it is often unclear what is meant by talking about a “digital card wall”. Hence, we suggested a typology of card walls and used it to analyze the challenges and benefits differentiated. Although it is not always possible to classify every aspect clearly as a challenge or benefit because it depends on the viewpoint, it is clear which effects are desirable to replicate with a digital card wall. Bringing the results together showed that the most promising type of digital card wall so far may be the “Software with interactive vertical screen” as it has the potential of replicating most of the effects by imitating many aspects of a physical card wall. However, some aspects are impossible to imitate with digital card walls, with the currently available technology. Furthermore, some reported benefits and challenges, if implemented/solved, contradict the properties, which will potentially lead to the desired effects/experience of using the card wall.

Further research may clarify the hypothesis that a digital card wall of type “Software with interactive vertical screen” can replace a physical wall and replicate their effect while bringing some of the stated desired benefits and resolving all the technically resolvable challenges.

References

1. Digital.ai: State of Agile Report. Technical report, Digital.ai (2021)
2. Azizyan, G., Magarian, M.K., Kajko-Matsson, M.: Survey of agile tool usage and needs. In: 2011 AGILE Conference, pp. 29–38. IEEE, August 2011
3. Bastarrica, M.C., Espinoza, G., Marín, J.: Implementing agile practices: the experience of TSol. In: International Symposium on Empirical Software Engineering and Measurement, ESEM 2018, New York, Association for Computing Machinery (2018)
4. Rola, P., Kuchta, D., Kopczyk, D.: Conceptual model of working space for agile (Scrum) project team. *J. Syst. Softw.* **118**(C), 49–63 (2016)

5. MacDonald, J.: Systematic approaches to a successful literature review. *J. Can. Health Libr. Assoc./Journal de l'Association des bibliothèques de la santé du Canada* **34**(1), 46 (2014)
6. Kitchenham, B., Pearl Brereton, O., Budgen, D., Turner, M., Bailey, J., Linkman, S.: Systematic literature reviews in software engineering - a systematic literature review. *Inf. Softw. Technol.* **51**(1), 7–15 (2009)
7. Weidt, F., Neiva, Da Silva, L.D.S.: Systematic Literature Review in Computer Science - A Practical Guide. Technical Report November, Federal University of Juiz de Fora (2016)
8. Cook, D.A., West, C.P.: Conducting systematic reviews in medical education: a stepwise approach. *Med. Educ.* **46**(10), 943–952 (2012)
9. Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G.: Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med.* **6**(7), e1000097 (2009)
10. Gusenbauer, M., Haddaway, N.R.: Which academic search systems are suitable for systematic reviews or meta-analyses? Evaluating retrieval qualities of Google Scholar, PubMed, and 26 other resources. *Res. Synth. Methods* **11**(2), 181–217 (2020)
11. Ahmad, M.O., Dennehy, D., Conboy, K., Oivo, M.: Kanban in software engineering: a systematic mapping study. *J. Syst. Softw.* **137**, 96–113 (2018)
12. Annosi, M.C., Martini, A., Brunetta, F., Marchegiani, L.: Learning in an agile setting: a multilevel research study on the evolution of organizational routines. *J. Bus. Res.* **110**, 554–566 (2020)
13. Anwar, A., Kamel, A.A., Ahmed, E.: Agile adoption case study, pains, challenges & benefits. In: Proceedings of the 2nd Africa and Middle East Conference on Software Engineering, AMECSE 2016, New York, pp. 60–65. Association for Computing Machinery (2016)
14. Bakke, A.L., Johansen, A.: Implementing of lean - challenges and lessons learned. *Procedia Comput. Sci.* **164**, 373–380 (2019)
15. Eckhart, M., Feiner, J.: How scrum tools may change your agile software development approach. In: Winkler, D., Biffl, S., Bergsmann, J. (eds.) SWQD 2016. LNBIP, vol. 238, pp. 17–36. Springer, Cham (2016). https://doi.org/10.1007/978-3-319-27033-3_2
16. Hajratwala, N.: Task board evolution. In: 2012 Agile Conference, pp. 111–116. IEEE, August 8 2012
17. Hunt, J., Hume, T., Lozdan, D.: On rabbits, space and cards: moving towards an informative workspace. *Proc. AGILE* **2007**, 212–217 (2007)
18. Katsma, C., Amrit, C., van Hillegersberg, J., Sikkel, K.: Can agile software tools bring the benefits of a task board to globally distributed teams? In: Oshri, I., Kotlarsky, J., Willcocks, L.P. (eds.) Global Sourcing 2013. LNBIP, vol. 163, pp. 163–179. Springer, Heidelberg (2013). https://doi.org/10.1007/978-3-642-40951-6_10
19. Kropp, M., Anslow, C., Mateescu, M., Burkhard, R., Vischi, D., Zahn, C.: Enhancing agile team collaboration through the use of large digital multi-touch cardwalls. In: Baumeister, H., Lichter, H., Riebisch, M. (eds.) XP 2017. LNBIP, vol. 283, pp. 119–134. Springer, Cham (2017). https://doi.org/10.1007/978-3-319-57633-6_8
20. Liechti, O., Pasquier, J., Reis, R.: Beyond dashboards: on the many facets of metrics and feedback in agile organizations. In: 2017 IEEE/ACM 10th International Workshop on Cooperative and Human Aspects of Software Engineering (CHASE), CHASE 2017, pp. 16–22. IEEE, May 2017

21. Mishra, D., Mishra, A., Ostrovska, S.: Impact of physical ambiance on communication, collaboration and coordination in agile software development: an empirical evaluation. *Inf. Softw. Technol.* **54**(10), 1067–1078 (2012)
22. Nakazawa, S., Tanaka, T.: Development and application of kanban tool visualizing the work in progress. In: 2016 5th IIAI International Congress on Advanced Applied Informatics (IIAI-AAI), pp. 908–913, July 2016
23. Perry, T.: Drifting toward invisibility: the transition to the electronic task board. In: Agile 2008 Conference, pp. 496–500. IEEE, August 2008
24. Pikkarainen, M., Haikara, J., Salo, O., Abrahamsson, P., Still, J.: The impact of agile practices on communication in software development. *Empirical Softw. Eng.* **13**(3), 303–337 (2008)
25. Rubart, J.: A cooperative multitouch scrum task board for synchronous face-to-face collaboration. In: ITS 2014 - Proceedings of the 2014 ACM International Conference on Interactive Tabletops and Surfaces, pp. 387–392 (2014)
26. Rubart, J., Freykamp, F.: Supporting daily scrum meetings with change structure. In: Proceedings of the 20th ACM Conference on Hypertext and Hypermedia, HT 2009, pp. 57–61 (2009)
27. Sharp, H., Robinson, H.: Collaboration and co-ordination in mature eXtreme programming teams. *Int. J. Hum. Comput. Stud.* **66**(7), 506–518 (2008)
28. Sharp, H., Robinson, H., Petre, M.: The role of physical artefacts in agile software development: two complementary perspectives. *Interact. Comput.* **21**(1–2), 108–116 (2009)
29. Wiklund, K., Sundmark, D., Eldh, S., Lundqvist, K.: Impediments in agile software development: an empirical investigation. In: Heidrich, J., Oivo, M., Jedlitschka, A., Baldassarre, M.T. (eds.) PROFES 2013. LNCS, vol. 7983, pp. 35–49. Springer, Heidelberg (2013). https://doi.org/10.1007/978-3-642-39259-7_6

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