



Conceptual model of working space for Agile (Scrum) project team



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ABSTRACT

IT project management according to the Agile principles will be less effective if the space where the teams work is not arranged properly. In this paper, a model of office space arrangement for the needs of teams using the Agile methodology is proposed. The main aim of the model is to support Scrum Teams in carrying out project tasks in a more efficient and effective way. The conceptual model is based on requirements that should be fulfilled by offices destined to have Agile (Scrum) working teams and can be adopted in any organization. The model has been implemented and validated.

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1. Introduction

Efficiency and flexibility in IT project management are nowadays not only a necessity, but also a duty. Currently, we can observe a high variability of IT requirements. Adaptability to customer needs is thus one of the factors that influence the final success of a project (Wysocki, 2009). Suggestions for an adequate improvement of IT project management were given by experienced practitioners in the *Manifesto for Agile software development* (agilemanifesto.org, 2001). One of the benefits of agile software development practices is the ability of software development teams to adapt to changing requirements from customers while identifying and reducing certain risks that arise during software development (Dingsøyr et al., 2012). Agile methods became in fact a weapon allowing the opening of new markets and helping to maintain relationships with current customers. Agile software development has been defined as a way of producing software that complies with the following rules (agilemanifesto.org, 2001):

- i People and interaction over processes and tools;
- ii Working software over comprehensive documentation;
- iii Customer collaboration over formal arrangements;
- iv Responding to change over following of the plan.

That is, while there is a lot of value in the items on the right, we value the items on the left more.

The most common method belonging to the Agile group is Scrum: 53% of Agile practitioners use Scrum in their projects ([Version One, 2014](#)). Due to the popularity of Scrum in IT project management the conceptual model of office space agreement proposed here is designed for the needs of teams managed in Scrum.

Scrum itself is not a strictly described method. It is rather a set of general procedures within which it is possible to use different types of processes and techniques ([Schwaber and Sutherland, 1991–2013](#)). Scrum is described in a number of scientific papers ([Dybå and Dingsøyr, 2008](#); [Dyba and Dingsøyr, 2009](#); [Holmström et al., 2006](#); [Moe et al., 2010](#); [Rising and Janoff, 2000](#); [Schwaber and Sutherland, 1991–2013](#)). The guidelines contained in the *Manifesto for Agile software development* and the rules contained in *The Scrum guide* ([Schwaber and Sutherland, 1991–2013](#)) require, if Scrum is to be implemented in an organization, several changes: in the organization of work; in the mentality of team members; in management style; in relations with customers; and also in the office layout. The high importance of the office layout in project management is confirmed in the existing research. ([Zhu and Zhu, 2013](#)) carried out a survey among 498 employees working in the technical services. The main goal of the survey was to investigate whether the physical office environment had an impact on the work. The majority of the respondents shared the opinion that the physical office environment had a significant impact on satisfaction (73%), privacy (72%), productivity (74%), communication (62%) and collaboration (56%). ([Lee, 2010](#)) defines the term 'office layout' as

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the way in which the arrangement and boundaries of workspaces are laid out.

The main purpose of this article is to propose a conceptual model of office space arrangement for the needs of IT project teams working according to the Scrum method, which will have a positive effect on the efficiency of the execution of Scrum projects. The model was implemented in a specific real-world project and team, where it was validated, but the aim of the authors was to obtain full scalability of the model. This means that it should be possible to adopt the model to the needs of project teams consisting of various numbers of Scrum Teams and teams with different numbers of Scrum Team members. The paper is structured as follows. The second section provides an overview of literature in the field of space arrangement for IT project teams in the context of Agile teams. The third section contains a systematic summary of the requirements necessary to design a model of office arrangement for a Scrum Team. In the fourth section the authors propose a general model of office space arrangement for Scrum Teams with the description of all components. The fifth section contains a description of the organization and its office in which the model was implemented. The sixth section describes the implementation of the model in the selected organization. Section 7 contains the validation of the implemented model in the context of improving IT project management in the examined organization, based on a single case study. Conclusions and discussion are contained in the eighth section.

2. Related work

In the literature, several papers exist related to the subject of office space fulfilling the needs of Agile project teams (Beck, 2000; Heerwagen et al., 2004; Sharp and Hugh, 2004). Mishra et al., (2012) and Cockburn, (2006) give several examples of the arrangements of the floor plan dedicated to the Agile methods. In both papers the authors highlight the important role that workspace plays in improving coordination, collaboration and communication.

Six lessons learned from the transformation are discussed in those papers. On the other hand, Mishra et al. 2012 studied and evaluated empirically the effect of different constituents of physical environment on communication, coordination and collaboration in Agile Teams. The study showed that an open working environment and a communal space are immensely helpful in collaboration.

Clarke and O'Connor (2012) and Chow and Cao (2008) mentioned physical working arrangements as factors that affect the software development process. Dagenais et al. (2010) identified main features that characterize the, what they call, project landscape; among them physical layout arrangement was identified (Santos et al., 2013), basing themselves on studies by Santos et al. (2015) and Santos et al. (2013), present practical indications for internal knowledge sharing in Agile Teams. Five language patterns are defined and described. The patterns refer to the space used by Agile Teams. The plans for the arrangement of office space, along with examples of implementation, are presented.

Grapenthin et al. (2015) report dropping down the ratio of late-discovered tasks in the development process from the average of 26% to that of 5%, achieved through the introduction of an interaction room (Book et al., 2012; Grapenthin et al., 2013). An interaction room is a physical room that is outfitted to visualize and facilitate the discussion of key aspects of the information system: surrounding a conference table, the walls of the room are covered with large sketches of models describing those system aspects that are most critical for the success of the project. Cases of real Scrum projects presented in (Grapenthin et al., 2015) suggest that increasing communication among all stakeholders of a project leads to a more reliable identification of the tasks to be performed in a sprint.

D'Mello and Eriksen (2010) describe the office arrangement in a global software organization in India. The authors highlight multicultural aspects of the organization and write that the office was organized around several bays or open-plan structures in order to maximize space, reduce hierarchy differences and increase opportunities for social exchange. (Kirwan, 2000) outlines a framework for the understanding of human factors in a socio-technical system. The author shows several relationships between human factors and safety, design and operations. Among the different ergonomic functions to be implemented in each socio-technical system he lists several civil engineering/architecture functions (the workplace concept, the space size, the layout of rooms, the windows and lighting, etc.).

The literature review conducted for the purposes of this study also covered the literature items dealing with the phase of adapting the organization to the Agile project management method, during which, in our opinion, the problem of space rearrangement should be seriously considered. In almost all the publications about this phase in small and large organizations the aspect of office space rearrangement is not mentioned at all (Block, 2011; Gandomani et al., 2013; McHugh et al., 2012; Paasivaara and Lasseinius, 2011; Schatz and Abdelshafi, 2005; Sienkiewicz and Maciaszek, 2011; Srinivasan and Lundqvist, 2009). Drury et al. (2012) identified six decision obstacles in Agile Teams and provide a detailed description of them. The research material includes a case study of the phase of the organization's adaptation to the Agile method. However, the authors do not consider the aspect of the physical office space. Kettunen (2009), in his practical tips on the transformation of organizations towards the use of Agile methods, mentions the need to move people around and sees the need to provide, in terms of space, constant access to the Product Owner. However, he does not make these tips more precise. Hajdiab and Taleb (2011) acknowledge that in the adopting phase it is necessary to solve the IT project team location problem, but no further details are given. Duka (2013) mentions that during the transformation of an organization toward the use of the Agile methods changes in the appearance of offices were made. Several small individual offices had been replaced by one open space. Despite the initial resistance of the employees, it was finally agreed that thanks to the changes the communication had been improved.

Hallikainen (2011) describes the transformation of a workspace from one dedicated to the Waterfall (traditional) model to one that fulfils the needs of Scrum Teams. The concept presented in (Hallikainen, 2011) is developed to geographically separated teams (and is thus not directly applicable to the problem treated in this paper, which concerns co-located teams). The work in a multisite environment should be supported by common round tables and the teams should share information via whiteboards, flip charts and information radiators. Rizvi et al. (2015) conducted a systematic literature review (from 2007 until 2012) on distributed Agile software development. Their review aimed to study organizations' adoption of distributed Agile software development. Hallikainen (2011) highlighted the importance of having an infrastructure for communication and collaboration that address the challenges of distributed Agile software development.

The authors of the present paper also reviewed popular science and industry reports both on designing office space and Agile methods. Cheng (2015), in training material, shows the characteristics of office space adopted for Scrum. Several web pages (Comfortablyscrum, 2015; Saddington, 2011; Velocity Counts, 2014; Zotin, 2013) and present ready-made office space solutions for Agile Teams based on their tips for Agile office layout. (MITIE, 2013) published a guide presenting several aspects of creating, delivering and managing an Agile working environment, starting by reaching an agreement upon initial strategic objectives, up to running the new environment. Examples of organizations harvesting gains in

productivity and profitability from a successful introduction of an Agile working environment are presented.

Knoll (2013) offers insights gathered from 38 leading organizations across nine industries into the nature of successful collaboration. His study presents a view of the future of creating and planning of successful spaces that encourage productive exchanges and connections between people and technology. Also, other reports and case studies (**CABE, 2005; Colliers, 2013; Cisco Systems, 2007; Freeman and Knight, 2009; GSA, 2006; Knoll, 2012**), relating to the arrangement of innovative office space layout have been published but none of them describe the space dedicated to Scrum or Agile teams.

Agile methods focus on team collaboration through frequent face-to-face communication (**Beck, 2000**). Many aspects of collaboration and communication are important in an Agile Team physical layout, but due to the limitation on the size of the paper, the authors have decided not to include this thematic area and focus only on the main theme of this paper.

3. Model assumptions

This section contains the inputs that the authors of the present paper based themselves on while creating the conceptual model proposed further on. The first subsection describes the process of designing the model. The second subsection describes the theoretical features (requirements) of a conceptual model of office space arrangement for the needs of Agile (Scrum) Teams. In the second subsection the authors present the health and safety requirements for office space with which the proposed model should be consistent.

3.1. Process of model designing

The developed model was based on the knowledge, literature research and experience of the authors of this paper in the areas of IT project management, Agile project management methods and office design. As indicated in **Section 2**, the scientific literature hardly provides any suggestions on the subject, so the work to be done was highly innovative.

In the process of designing the model the authors used an interactive architecture approach (IAA) (**Parsaei et al., 2015**). In IAA, mutual relations between the factors, groups and systems affecting the design process are analysed. The final design is the result of a relative balance of mutual interactions among these factors, groups and systems (**Toh and Miller, 2015**). Such an approach is used to enhance the creative idea development in the early phases of the design (**Kulkarni et al., 2013**). The authors held a series of design workshops. During several workshops, the following stages were carried out: understanding and recognizing the problem and problem aspects, analysing the information, synthesis, decision-making, implementation, evaluation. During the first workshops (until the analysing stage) the relations between designer, client, user, legislator and also internal and external constraints were recognized. The next step established a set of unique features in accordance with the design problem. The features are presented in the next section and are based on literature research and the experience of the authors. Subsequently the synthesis and decision-making stage was conducted. The results of these stages are presented as the conceptual model – in **Section 4**. The aim of the synthesis was to attempt to move forward and create a solution for the problem (**Lawson, 2008**). The next stage was evaluation; this evaluated the proposed solutions against the identified set of features. This evaluation was based on the case study (informal individual interviews and participating observation), and its results are presented in **Section 7**. The main axis of the IAA is a comprehensive interaction

with various aspects of the design, since design problems have many different aspects (**Parsaei et al., 2015**).

During the workshops the authors extracted distinct groups – types of work environment features:

- a 'Social' includes features linked to the social and community aspects of the work environment.
- b 'Physical' includes features describing the physical appearance of the work environment.

All the features extracted during the workshops have been assigned to the two above-mentioned groups and will be described in the next section.

3.2. Workspace features

The authors of the present paper elaborated a list of features that should be fulfilled by a workspace designed for an IT project team following the Agile principles. The features are presented in **Table 1**. The table is composed of three columns. The 'Type' column contains the type of feature; the 'Feature' column contains the name of the feature; the 'Description' column contains a description and motivation for each feature and the source that was used to generate them.

3.3. Health and safety requirements

During the creation of the conceptual model the authors took into account the requirements of health and safety rules (**Chodorkowski, 2014**). As the health and safety requirements are location specific, the authors decided to introduce the requirements applicable in their country of origin (an EU country). Details may of course vary from country to country. Therefore, the health and safety requirements presented in this paper should be considered a representative example. In a room designed for work with computers, every employee should have a minimum of 13 m³ volume of free space, and a minimum of 2 m² of free floor space, while the height of the room should be at least 3 m (under some conditions 2.5 m). It can be assumed that the minimum floor space (including furniture) per job should not be less than 8 m². Workplaces should be designed in such a way that two minimal required distances are maintained: that between adjacent monitors (60 cm) and that between the employee and the rear adjacent monitor (80 cm). It is also recommended to place the monitor at a distance of less than 1 m from the windows, unless they are equipped with blinds (this was so in the case of the office in which the model was implemented).

4. Conceptual model of the arrangement of the work environment for an IT project team

This section provides a conceptual model for the arrangement of office space for the needs of Agile IT project teams managed in a Scrum framework. The first subsection presents the plans and the described model. The next subsection contains a description of all cell types included in the model. The last subsection describes the type of access to cells. To each cell type a suitable type of access is assigned.

4.1. Plans and described model

Fig. 1 presents a conceptual model of the arrangement of the work environment for the needs of the Agile (Scrum) Project Team. The model was designed for Project Teams consisting of more than one Development Team. The arrows in **Fig. 1** refer to the features marked beside. Assumptions for the conceptual model were formulated in **Section 3**. The conceptual model was based on a cellular

Table 1

Features of a conceptual model of the arrangement of the work environment for the needs of the Agile (Scrum) team.

Type	Feature	Description
Social	Supporting verbal communication.	<p>Diallo and Thuillier (2005) show the link between success and the quality of communication among members of the IT project team. Oral culture placing high value on face-to-face communications is one of the Agile project success factors (Chow and Cao, 2008). Project Team is a social system in which individuals perform tasks that are interdependent and where there are relationships between individuals and tasks. In order to operate efficiently, Scrum Teams require good verbal communication. The greatest flow of information in projects (79%) takes place in direct communication (face-to-face), then we have e-mail (17%) and telephone (4%) communication (Patel et al., 2006). The work environment should thus support interpersonal and direct contacts.</p>
Social	Presentation of information destined for the entire team in a continuous manner that does not require direct communication.	<p>Agile methods are distinguished by a continuous control of: requirements, design, solutions and testing (Dybå and Dingsøyr, 2008). The lower level of abstraction (complexity) of information being communicated in IT projects made the need for interpersonal knowledge exchange decrease (Melnik and Maurer, 2004). The information that should be communicated to the entire team should be presented in a continuous manner. Presentation of information should not interfere with the direct day-to-day communication taking place within the Development Team. The possibility of rearrangement and flexibility in creating the nearest space by the project team. The Development Team is a self-organizing team, within a given framework (Schwaber and Sutherland, 1991–2013). Self-organizing teams are free to decide how to do the work in the best way, so it is necessary to ensure their autonomy in creating the workspace.</p>
Physical	The ability to customize the space for the needs of the Scrum Team.	<p>The possibility of rearrangement and flexibility in creating the nearest space by the project team. The Development Team is a self-organizing team, within a given framework (Schwaber and Sutherland, 1991–2013). Self-organizing teams are free to decide how to do the work in the best way, so it is necessary to ensure their autonomy in creating the workspace.</p>
Physical	Providing an area for meeting dedicated to each Scrum Team.	<p>A meeting area should be provided, with enough space for all the team members and additional guests. Scrum requires daily short 15-minute meetings for the whole team, called Daily Scrum. During the meeting each team member answers three key questions:</p> <ul style="list-style-type: none">• What did I do yesterday that helped the Development Team to meet the Sprint Goal?• What will I do today to help the Development Team to meet the Sprint Goal?• Do I see any impediment that prevents me or the Development Team from meeting the Sprint Goal? <p>Stray et al. (2012) show that on average only 24% of the meetings are actually focussed on this task. It turned out that 35% of them are devoted to problem issues and to a search for possible solutions. Resolving problems is a desired practice. According to the Scrum rules it should follow the Daily Scrum. The team thus needs an area to discuss and solve problems. Therefore, the conference area should perform the functions of a work area where strategic, operational and tactical decisions on the project can be taken. It is necessary to also take into account the nature of other meetings required in Scrum, such as a Sprint Review and Sprint Retrospective.</p>
Physical/Social	Multiple team cooperation work environment.	<p>When multiple Scrum Teams are working on a single project there is a need for collaboration between them and their individual members. The environment should promote cooperation and communication, not only within one Development Team but also throughout the whole Project Team.</p>
Physical	Open-plan office.	<p>Open-plan offices ensure flexible spaces, allowing the office layout to be more sensitive to changes in the organization's size and structure. They offer a much greater ease of communication than fully enclosed private offices (Hedge, 1982; Sundstrom et al., 1982; Mishra et al., 2012). Open office areas have no partition walls or barriers restricting free movement between resources. Companies that have modified their business processes with the goal of encouraging collaboration (one of the key Scrum Principles), and have moved from private spaces to an open one, experienced a performance increase (as far as the speed and accuracy of work are concerned) of 440% on average (Majchrzak and Wang, 1996). Creating open workspaces facilitates informal information exchange (Santos et al., 2013) The scope of this feature refers to the office layout where the actual work on the project is done, with the exception of areas dedicated to training, conferences and social contacts.</p>
Physical	Neighbourhood window or artificial window.	<p>Having a window or a substitute (an artificial window) (Young and Berry, 1979) somehow buffers or compensates for the negative aspects of open-plan offices mentioned in the literature (Block and Stokes, 1989; Sundstrom et al., 1994), such as lower levels of visual and/or acoustical privacy or an increase in distractions and interruptions. An artificial widow is a substitute for a real window (it shows moving pictures of outdoor/nature scenes matched with nature sounds or music). It increases the long-term comfort and productivity of workers. Young and Berry (1979) rated it nearly as highly as an outside window.</p>
Social	Support informal information exchange.	<p>Campbell and Campbell (1988) define informal communication as a relatively unstructured information exchange that tends to occur in face-to-face encounters during 'off-task' moments. This kind of information exchange can help in transferring the knowledge between different Scrum Team members and support the building up of a team spirit. Rashid et al. (2006) state that informal communication is often seen as a way to strengthen organizational culture and interpersonal relations, and to share information. Scrum Team members find extensive personal exchange of knowledge to be a key requirement. Terje Karlsen et al. (2011) say that informal information exchange should be fulfilled through office space arrangement.</p>
Social	Support collective mind.	<p>Weick and Roberts (1993) provide the theory of collective mind. Collective mind can be defined as a pattern of interrelations between one's work processes and the work processes of other people. The system participants (in our case the Scrum Team) construct their actions in the understanding that the system consists of connected actions of themselves and others, and interrelate their actions within the system (McChesney and Gallagher, 2004). This means that if the team as a whole can carry out processes carefully, critically, consistently, purposefully, attentively, vigilantly, conscientiously, etc., each single person will also tend to do so.</p>

(continued on next page)

Table 1 (continued)

Type	Feature	Description
Physical	Cellular office arrangements.	Cellular accommodation (each Development Team and Product Owner Team has their own cell) with aggregated cells in stretched corridors should be achieved. Cellular office arrangements seem to create spatial networks, where in spite of the actual distance between individual persons everybody has a feeling of being located closely to everybody else (Sailer and McCulloh, 2012). Lee (2010) showed that people in low cubicles are significantly more satisfied with the ease of interaction with their co-workers than people in high cubicles are. Thus, we do not envisage high barriers either inside the cells or on their borders.
Physical	Additional relaxation room.	Brennan et al. (2002) recommend that additional relaxation rooms in the open-plan office (destined for private conversations, meetings and phone calls) should be provided. Hallikainen (2011) emphasizes the importance of common areas such as coffee lounges and conference rooms: they provide a spirit supporting fruitful discussions and even innovation.
Physical	Equivalence of all team members.	Berger and Webster (2006) state that teams have emergent social structures. Silver et al. (2000) show that the degree of team members' participation in decision-making is strongly related to their status in the group. More specifically, the team members who occupy higher levels in their respective organizations contribute ideas and opinions at higher rates than those holding lower positions – even if their ability and experience do not predispose them to make better decisions (Silver et al., 2000). The physical setting should not make individual members stand out. The office layout should support the principle of King Arthur's round table, emphasizing the equivalence of all the team members (King Arthur created the round table to prevent quarrels among his barons, none of whom would accept a lower place than the others (Kibler, 1991).

Source: own elaboration

structure inspired by honeycombs. The model includes five main cell types:

- i Conference cell;
- ii Social/kitchen cell;
- iii Chill out cell;
- iv Development team cell;
- v Product owner cell.

All the cell types are described below. All five cell types are a coherent combination of a honeycomb. The shape of the cells is not coincidental. (Hales, 2001) provided mathematical proof that a regular hexagonal design allows the space to be used optimally and material saved. Bees build hexagonal cells using a minimal amount of wax and create in this way a light but strong structure that enables them to use the available space in the optimal way and to store the largest possible amounts of honey. As office spaces have very high occupancy costs, it is important to choose a cell shape that allows them to be optimized.

The cells of selected types can be replicated or erased according to the cardinality of the Project Team (for example, in the case of projects with a larger/smaller number of Development Teams, the Development Team Cell can be replicated or erased).

4.1.1. Conference cell

Real-time knowledge sharing takes place when individuals communicate face-to-face, which is a decisive factor in creativity. One of the key factors that influence communication is the physical layout of workspace (Ullman and Boutellier, 2008). The Conference Cell is designed for knowledge exchange and its goal is to facilitate communication between different project stakeholders. During the project life cycle several series of meetings involving various members of the Project Team and various project stakeholders are carried out. In order not to disturb communication and work within the Development Team, and to ensure privacy during the meetings, it is necessary to create a separate cell for meetings.

4.1.2. Social/kitchen cell

The Social/Kitchen Cell provides social and kitchen facilities for the needs of the Project Team. This is an area in which the team members can store their coats, umbrellas, etc. In this space there is a kitchen for the preparation of meals and hot drinks. The social/kitchen space is present in any kind of office space, regardless of the size and type of the organization.

4.1.3. Chill out cell

The problem of stress at work and stress-related problems have already been investigated for a long time (Geurts and Gründemann, 1999). The Chill Out Cell is a place where people can reduce the stress involved in their work. This is an area used for relaxation and rest from strenuous mental work. The cell also aims to support the organizational citizenship behaviours in the field of social/emotional support. According to (Yen et al., 2008), developing organizational citizenship behaviours is one of the key factors influencing software project success. The organizational citizenship behaviours have been defined by Niehoff (2005).

4.1.4. Development team cell

The cell is designed for the needs of the Development Team. In the cell, the daily work of the Development Team takes place, according to the Scrum Rules (Schwaber and Sutherland, 1991–2013). The cell is designed to host events such as: the Daily Scrum, the Sprint Retrospective, the Sprint Review, the Sprint Planning Meeting Part II (all meetings only with the participation of the Development Team). The cell contains tools (whiteboards) to present the Scrum artefacts such as Sprint Backlog etc. and to support small system design works. The Development Team members and the Scrum Master are located in this cell. Allen and Fustfeld (1975) showed that co-workers that were separated by more than 25 m walking distance had a significantly lower probability of communicating with each other than those co-located more closely together. As close collaboration between the members of the Development Team is one of the principles of Scrum, the distance between the desks of individual team members should not exceed 25 m. The Development Team Cell is a calm area in which team members can focus on the work. Therefore, the model does not specify any other area with this functionality.

4.1.5. Product owner cell

In this area the daily work of the Product Owner Team takes place. The cell is designed for meetings during which the Development Team members can discuss the technical details of various product requirements with the Product Owner Team. The cell contains tools (whiteboards) to present Scrum artefacts such as Product Backlog and Release Burndown Chart. It should also facilitate support system design works and clarification of requirements. As in the case of the Development Team Cell, the distance between employees in the cell should not be greater than 25 m.

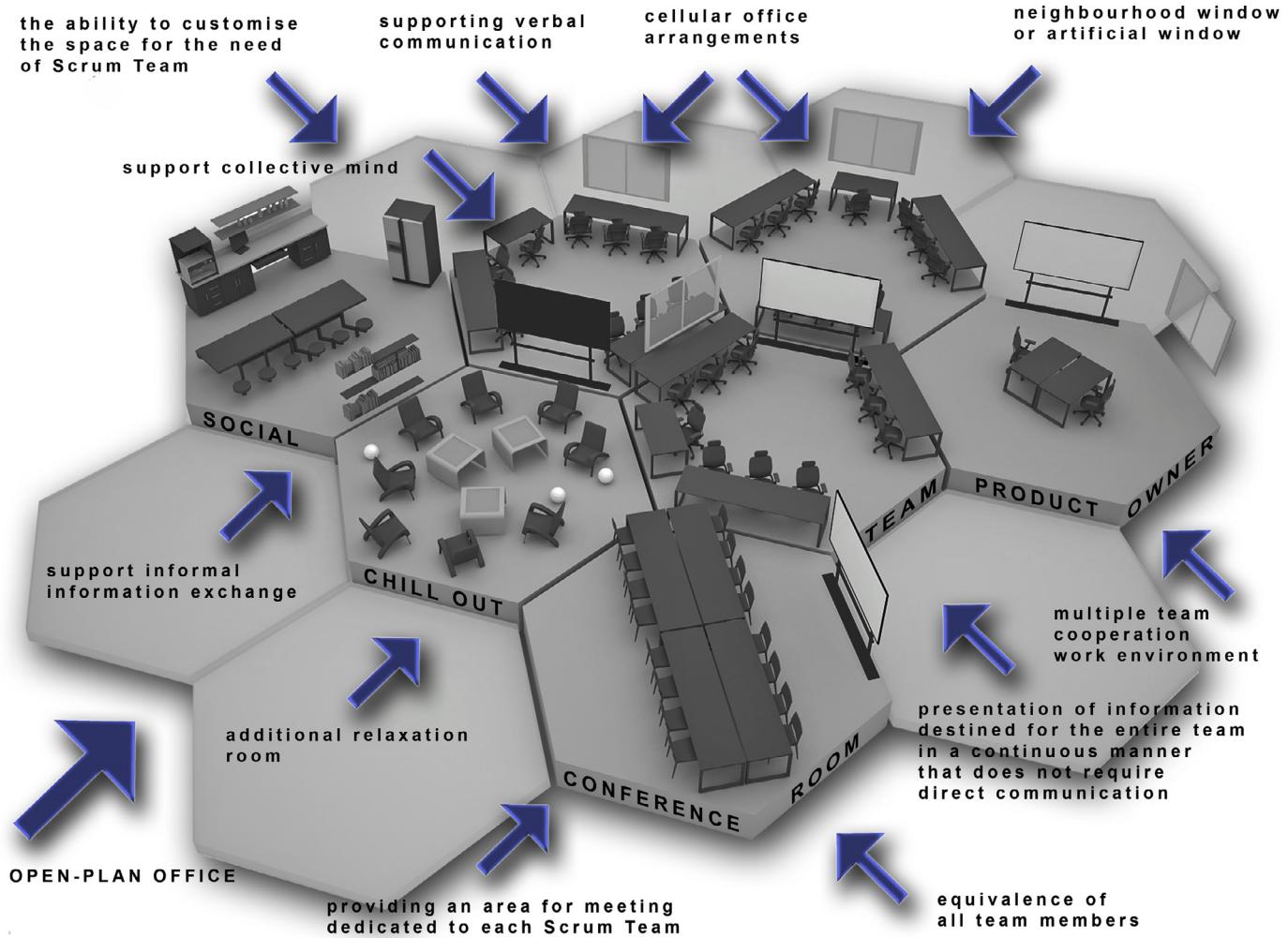


Fig. 1. 3-D conceptual model of the arrangement of the work environment for the Scrum team.

4.2. Access to the cells

The cells have two main types of access, which are presented in Fig. 2:

- Open/public for all of the Scrum Team (parts highlighted darkly);
- Limited/private for the Development Team (parts highlighted brightly).

4.2.1. Open/public

Open/public cell types include: the Conference Cell, the Social/Kitchen Cell, the Chill Out Cell, the Product Owner Cell and the subcell of the Scrum Master placed in the Development Team Cell. These are the places where the exchange of information between the Scrum Team members and the outside world happens. This information can be linked to the project tasks as well as be related to social aspects of the Project Team. The overall appearance of these cells, except for the subcell of the Scrum Master, should thus facilitate information exchange and creative thinking. The Chill Out Cell and Social/Kitchen Cell should boost the ability to purify thoughts after a considerable intellectual effort, which the team members undergo in the course of their daily work. The subcell of the Scrum Master is a place where external information merges with the internal working ecosystem of the Development Team. It is a boundary zone line for interactions between different teams and the ecosystem in which the work takes place.

4.2.2. Limited/private

Cells of the limited/private type include the Development Team Cell. This is the inner zone of information exchange related directly to the project tasks assigned to the Scrum Team. It provides privacy and calm for the Scrum Team. It should also be free of distractions affecting the team's work. All social relations not related to the work of the Scrum Team should take place outside of this cell. Meetings and arrangements between the different Scrum Teams (Scrum of Scrum) should take place in a dedicated Conference Cell. The work on the requirements and their clarification (with the exception of scheduled events) takes place in the Product Owner Cell.

5. Description of case study

The conceptual model of the work environment for IT project teams following Scrum was implemented in an organization operating in the telecommunications industry, in its R&D department. In the selected office the resources had already begun working with Scrum. Rearrangements of office layout had not been started yet and had been foreseen as one of the stages of the transition from a pure Waterfall model to the Agile methodology. For the selected organization it was clear that project management following the Agile principles will not be effective if the space is not arranged properly.

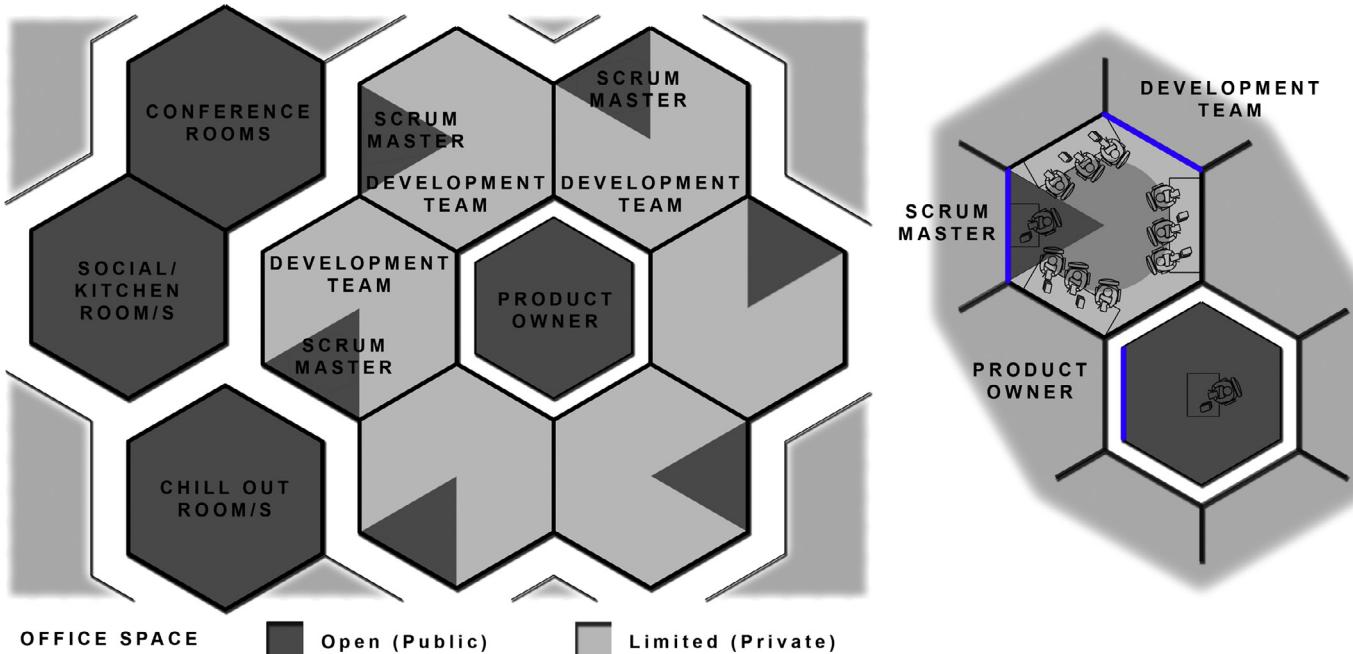


Fig. 2. Cells access types.

5.1. Project description

Although in the organization as a whole the transformation to the Agile methodology had already been initiated, the resources assigned to the project had not worked with Agile methods before. However, in the project considered in this case study they were supposed to use Scrum.

Before starting the work, all the resources were prepared for the transformation. Each employee was trained in the field of Scrum. Three teams participated in the project: two European ones (two different locations) and one Asian. For all of the three teams it was the first project managed according to the Scrum technology. The organization's management had decided to locate the teams in the European office for the duration of three sprints (one sprint takes 15 working days). Each team had nine members and a dedicated Scrum Master. In the project, a Product Owner Team also participated, consisting of four resources.

After the duration of three sprints, two teams – one Asian and one European – were supposed to return to the home locations and continue the work on the project in a distributed and virtual environment. The office layout arranged according to the model proposed in this paper will be used by other teams working on future projects.

5.2. Office description

The office, before the rearrangement, was designed according to the open-plan office rules (Fig. 3). The total area of the office was 458.9 m². The office is located on one floor of an office building. The office consists of two conference rooms (48.0 m²), one meeting room (10.1 m²), one office used by the management and one used by the Administration Department (the two latter offices have a total area of 41.8 m²) and a social space (39.0 m²). The workspace for the employees is 256.0 m² in size. The office layout before the rearrangement is shown in Picture 1.

The top right, top left and bottom left corner of Picture 1 show a view of the main office space. The bottom right corner shows a view of one of the conference rooms.

5.3. Office zoning

In order to arrange the workspace so that it supports the Agile IT project team in carrying out project tasks in a more efficient and effective way, the office was divided into two parts. One part was adapted to the needs of the Scrum Team. In the second part of the office no changes were introduced – this part was used by a team working on other projects (not according to the Agile methodology, but according to the Waterfall model). Fig. 3 shows the distribution of the floor plan into the two parts. The part highlighted brightly was destined for the Scrum methodology, the darker part for the Waterfall model. Organization managers insisted on utilizing, in the first place, resources (desks, cabinets, furniture, chairs, etc.) already available in the building. The rearrangements were scheduled for immediately before the first sprint. All the members of the project team had been working in the office (in different periods of time) prior to the reorganization.

6. Description of the model implementation

The rearrangement of the office was implemented using the conceptual model as a basis. The office plan after the rearrangement is shown in Fig. 4.

A statistical summary of the newly arranged space is given below. All the statements are related to the area designated for the purposes of the Scrum Team (Fig. 4):

- i The average (SW, CR, MR) area per project team member (34)=6.2 m²;
- ii The average social/chill (S+CA) area per project team member=1.2 m²;
- iii The average working area per project team member=4.5 m²;
- iv The average distance of all the desks from the window=2.27 m;
- v The average not mentioned (WW, A, R, T, CO, TR) area per project team member=5.4 m².

The next subsection contains a detailed description of the implementation of the conceptual model.

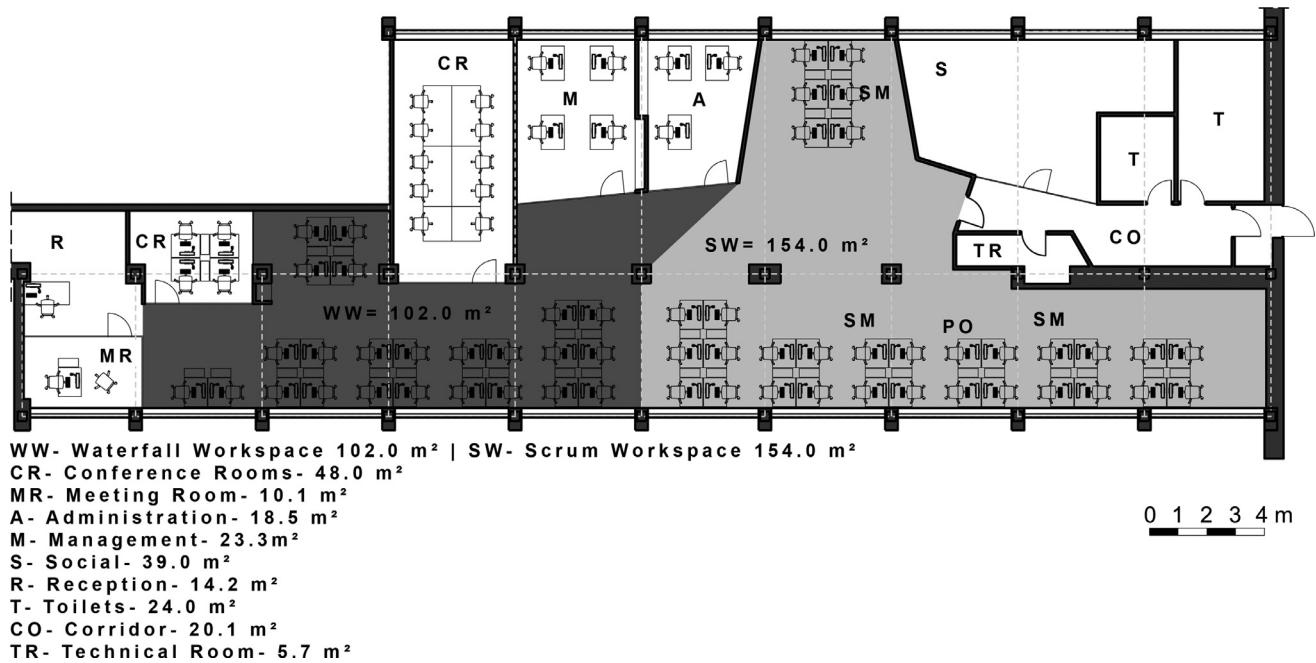


Fig. 3. A view of the divided office. Source: own elaboration.

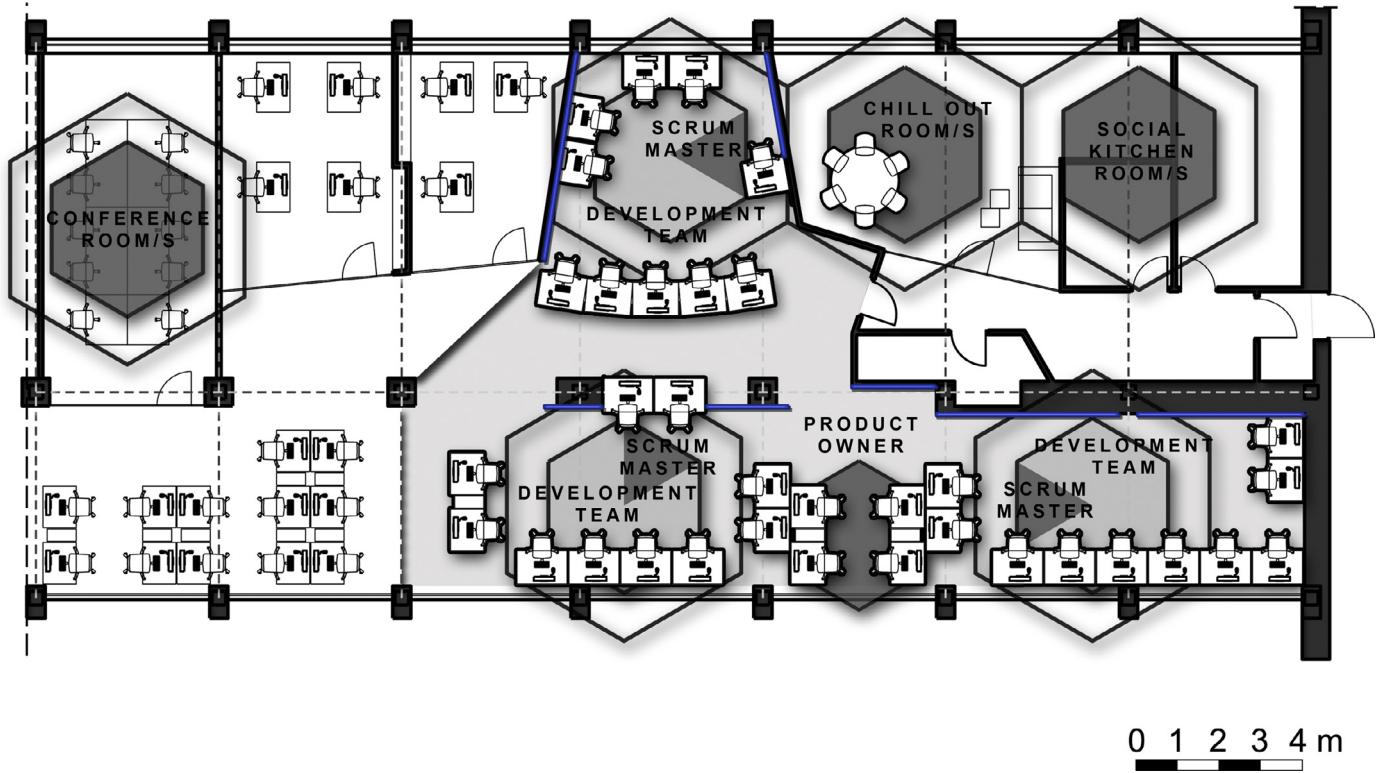


Fig. 4. The office space after the implementation of the theoretical model.

6.1. Fulfilling workspace features

This subsection describes how all the features defined in Table 1 were implemented. The implementation of all the features is described through presentation of the changes made in the project environment. The changes are documented in the form of additional, revised plans of the office. The authors also documented additional changes proposed by the project team.

6.1.1. Supporting verbal communication

The cellular arrangement of the office facilitates direct communication within the team. The effort needed to establish verbal communication between team members was reduced. Each member of the Scrum Team is now within the sight of the other members. He/she can easily go (a short distance) to his/her team partner and ask a question at a moment convenient for both of them. Kraut et al. (1990), as a result of questionnaire studies, show a positive impact of physical proximity on supporting frequent

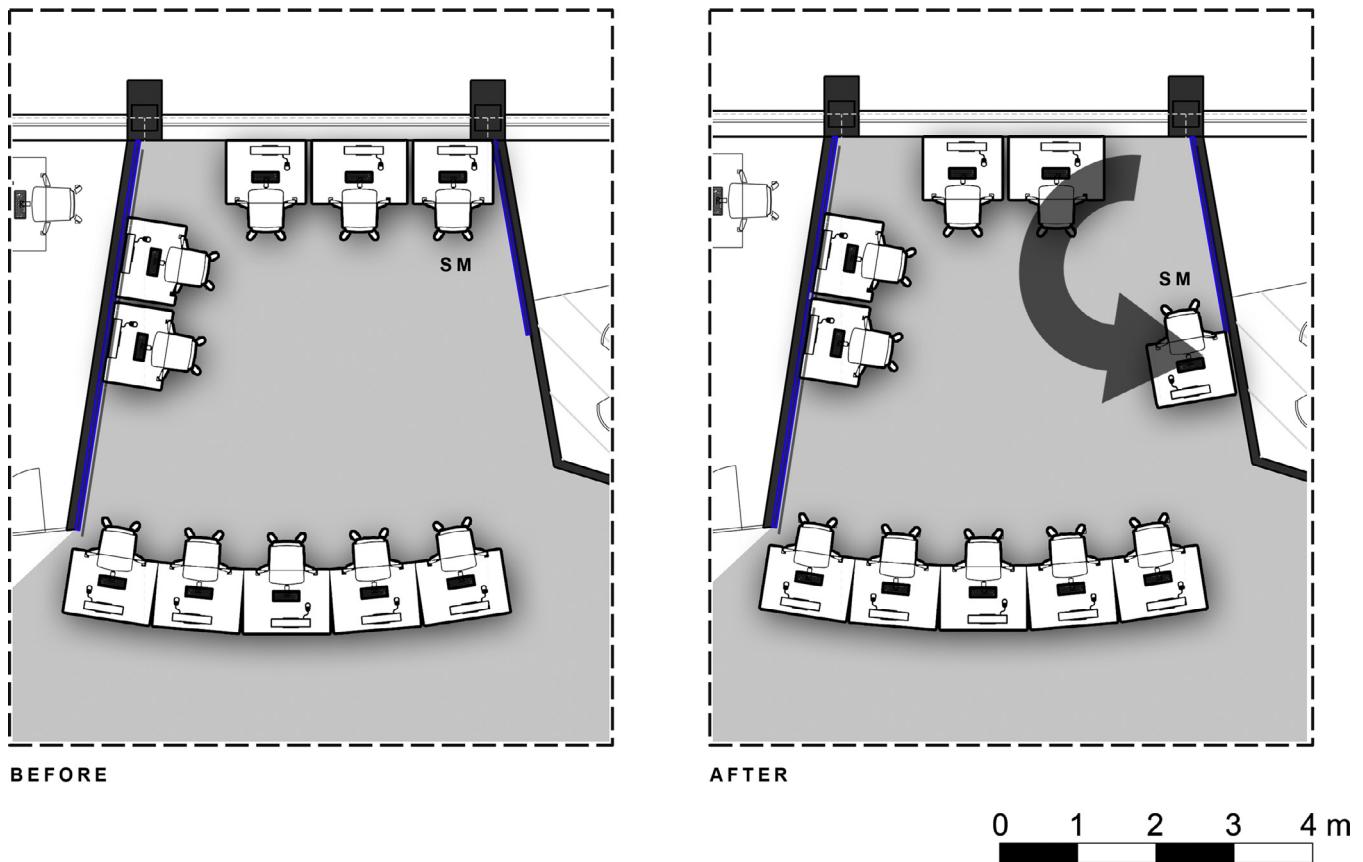


Fig. 5. Initial proposal and the change proposed by the development team. Source: own elaboration.

conversations that are vital to the planning and definitional phases of projects.

6.1.2. Presentation of information destined for the entire team in a continuous manner that does not require direct communication

This feature was successfully implemented by providing additional whiteboards for each team (including the Product Owner team). Each team can use two whiteboards and a large conference card, directly attached to the walls. One of the tables is used as the Scrum Board (Sprint Backlog). The second board is used for the communication of additional information, the necessary design work and work planning. It is also used during the Retrospective Meeting.

6.1.3. The ability to customize the space to the needs of the Scrum team

All Scrum Team members were informed that it is possible for them to change the work environment. Most of the furniture items and some of the boards have wheels. In this way the possibility of customizing the office plan was made attainable. One of the teams took advantage of the possibility of office plan customization. They rearranged the workstation dedicated to the Scrum Master in a different way. **Fig. 5** shows this modification. During the Retrospective Meeting the team justified the change pointing out the '*need to protect the team from people outside distracting the team*'. With the modified location, the Scrum Master better served the team, protecting them against external interferences.

6.1.4. Providing area for meeting dedicated to each Scrum team

Thanks to the arrangement of desks (in the Development Team Cell), assembled in a circular plan, with the chairs turned to the centre of the circle and the monitors adjacent to the outer edge

of the circle, an additional space inside the circle was gained. The team used this space, equipped with whiteboards, for meetings. This area was also used for the Retrospective Meeting and the Sprint Planning Meeting. **Fig. 6** presents the areas for meetings dedicated to each Scrum Team marked in dark.

6.1.5. Multiple team cooperation work environment

All the Scrum Teams were located in one office. The arrangement of cells provided free access for all the team members to the common space and the Product Owner Cell. Sharing common spaces facilitated collaboration, thanks to the possibility of a quick and easy contact between the members of the project team.

6.1.6. Open-plan office

Despite the separation of cells and the determination of their usage, the office was still an open-plan one. No partition walls or barriers restricting free contact between resources were created. This office plan allows free physical access to all the cells. The continuity of visual contact (each team member can easily see what is happening in all the other cells) was guaranteed. The exceptions were the areas designated for conferences and the social facilities. Barriers such as walls were there before the rearrangement phase and because of the structural limitations of the building they could not be removed.

6.1.7. Neighbourhood window or artificial window

Each member of the project team was located in the immediate vicinity of a window. The average distance of all the members of the project team from the closest window was 2.27 m. Thanks to the favourable plan of the office space, there was no need to install artificial windows. All the workstations had access to natural daylight.

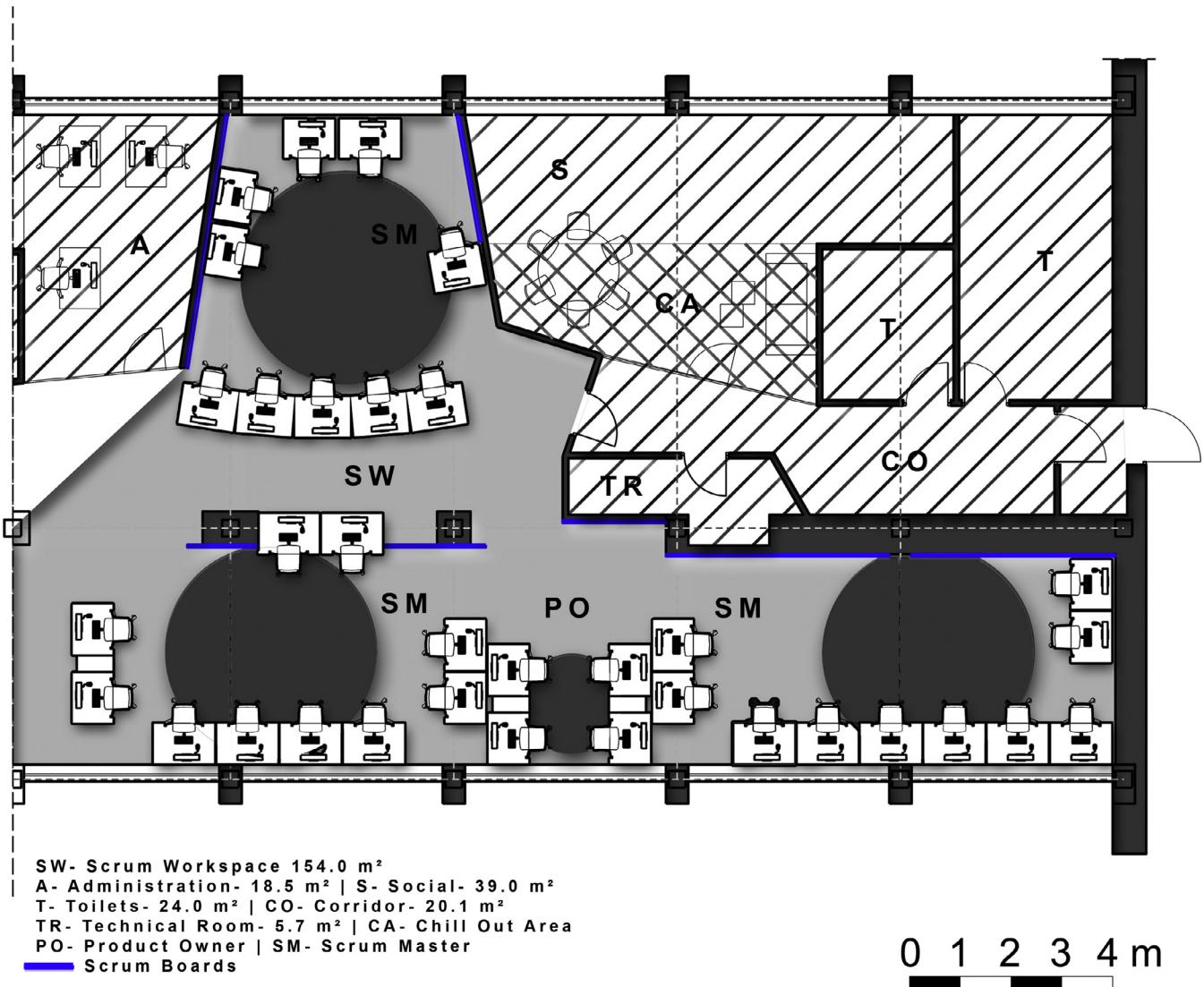


Fig. 6. Area for meetings dedicated to each Scrum team. Source: own elaboration.

6.1.8. Support informal information exchange

Special cells were dedicated to the purpose of social chats and social informal information exchange. Because of the exposure to stress in the project, in the dedicated areas we observed an increasing number of informal relationships between the members of the project team. These areas and what was happening in them facilitated the building of a team spirit. It also had a positive impact on interpersonal relationships.

6.1.9. Support collective mind

This aspect was achieved thanks to the placement of the Development Team in one dedicated cell, which allowed a better exchange of knowledge and information in the field of users' stories implemented by the team. During the work on the project we observed spontaneous exchange of knowledge between different developers. The team better understood the work of individual developers and gained some knowledge of various aspects of software development. We anticipate that this process will be intensified with the progress of work related to the project.

6.1.10. Cellular office arrangement

A cellular office arrangement was implemented. In the new office layout, five cells dedicated to the needs of various aspects of

software development were created (Fig. 4). Due to the existing architectural barriers (load-bearing walls, doors, etc.) there was no possibility of isolating two cells (Social/Kitchen Cell and Chill Out Cell). They were both placed in one room (old kitchen), but nevertheless the authors tried to separate the two cells to some extent, by placing furniture, books, etc.

6.1.11. Additional breakout room

An additional breakout room (for all the resources in the office) was created in the social space.

6.1.12. Equivalence of all team members

The equivalence of all the team members was achieved by planning the Development Cell in such a way that all the workstations were placed in a circle. One of the Scrum Teams, however, decided to disrupt this form, relocating the position of the Scrum Master. This modification, however, does not interfere with the assumptions of the model, because it facilitates the teamwork, protecting it against the influence of external factors.

7. Validation of model

A case study was applied as a research method to validate the proposed model. This method is of particular usefulness, especially



Picture 1. The office layout before the changes: a view of the main work area and one conference room.

in the field of management (Rees and Porter, 2002). We used a classic single case study according to the definition in (Dyer and Wilkins, 1991). Single case studies are valuable in situations when the analysed problem is often encountered in practice, but there is no access to more cases due to the novelty of the problem and the organization's reluctance to be subject to such research. This is the situation we are facing here: the problem of office arrangement for Agile project management is a new problem and the organizations concerned are rarely ready to participate in scientific experiments, especially as the Agile approach is perceived as practice based and practice driven. In the single case study, concerning a big international IT organization, there was just one Project Team working in the proposed office arrangement (the organization did not agree to have two teams working simultaneously, in two different office arrangements). It was the first time that the team worked according to the Scrum methodology. Two data and information collection methods were applied in the research:

- Participating observation: one of the authors was an external coach/expert supporting the Scrum implementation in the project. The observation was designed on the basis of the studies of Dalton (1960), presented by Dyer and Wilkins (1991), as a single case study analysis pattern¹;

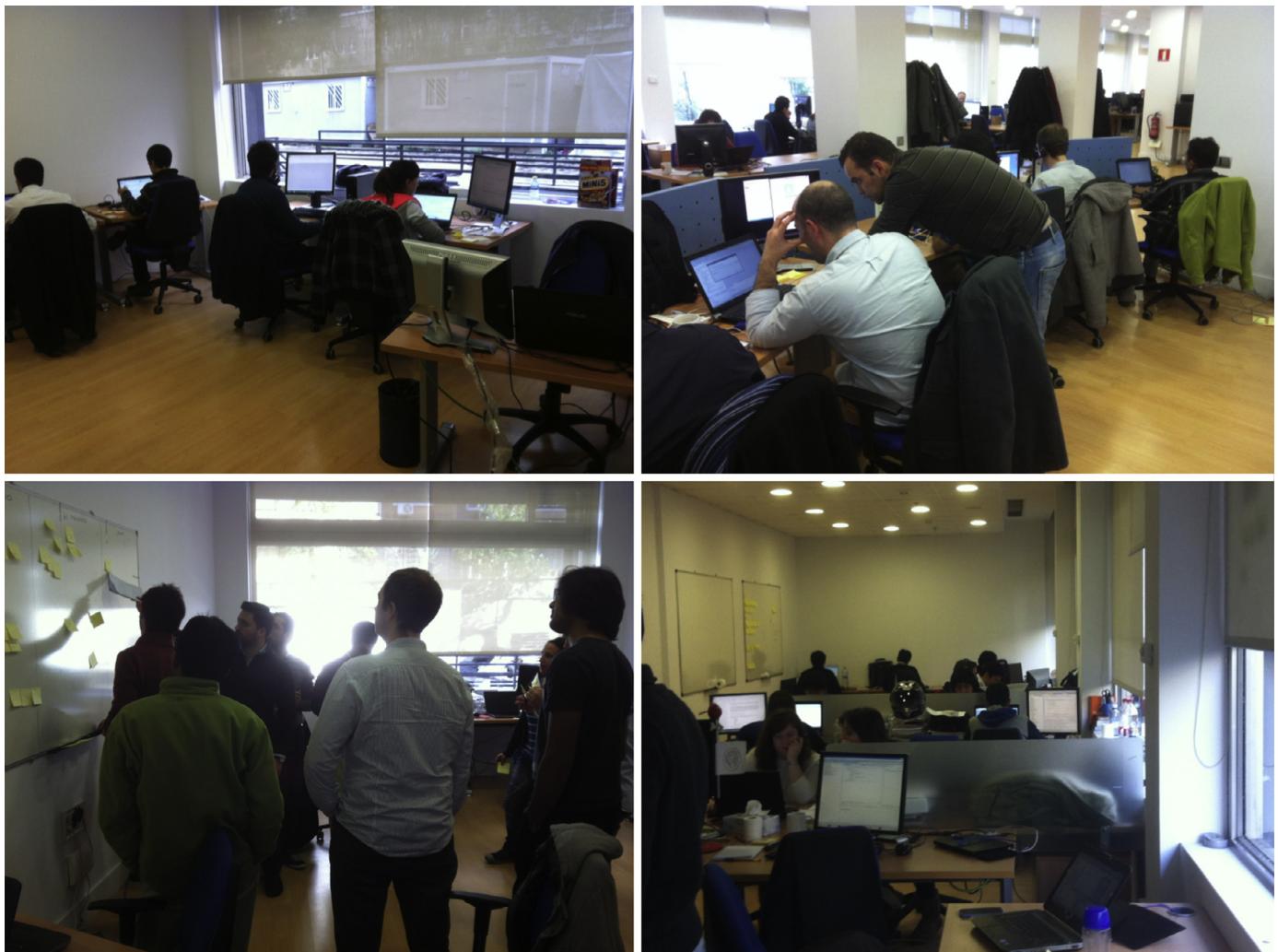
¹ Dalton's study has become a pattern for many researchers, as well as for the research presented in this paper. The authors have done everything that was legally

- Informal individual interviews with the project team members concerning the implementation of the conceptual model of office space arrangement (more formal opinion-gathering methods were not allowed by the organization).

The interviews with the Scrum Team member started three weeks after the implementation of the model. Scrum Team members were asked to express their opinions about the new layout of the office and its influence on project management, project realization, project communication etc. Project team members were not aware that they were subject to a research (only the higher management was aware of it). Thanks to this fact and thanks to the lack of formal hierarchical relations between the project team members and the interviewer it can be assumed that the comments are very sincere.

This kind of acquisition of research material may raise ethical concerns. The research was inspired by Dalton (1960), whose paper aroused discussions concerning ethics. One of the central issues that Dalton (1960) addresses in his study is the unofficial use of a company's resources. There is a considerable debate as to whether it was ethical to obtain data by using the method of covert observation. In the case of the research presented in our paper, the process of gathering data for the organization was known to the

possible and that was not harmful to the organization or any of its employees to get the most profound understanding of the studied phenomenon.



Picture 2. Office layout after the change. Source: own elaboration.

higher management; only the members of the project team did not know about the experiment. If they had, this would have influenced the quality of the information gathered. Before one of the authors left the organization, all project team members were informed that they had taken part in a scientific research. The author also answered all their questions related to the conducted experiment. Any data enabling the identification of the research participants have been removed. In our opinion, ethical concerns are very important in extreme cases (Zimbardo et al., 1973; Milgram, 1963; Tudor, 1939; Watson and Rayner, 1920), when in fact the potential for ethical transgression is much higher than in our research (Bryman and Bell, 2015). The office layout after the rearrangement is shown in **Picture 2**.

The top left corner of **Picture 2** shows the Development Team Cell and its ability to customize the office plan to the needs of the Scrum Team: it is a customization introduced by one of the teams, the Scrum Master's place being relocated (see Fig. 5). The top right corner of **Picture 2** shows the office layout after the change – it is a view of the Development Team cell. The bottom left corner of **Picture 2** shows a part of the Development Team Cell designed to host events (in the picture we can see one of the Development Teams during a daily stand-up meeting). This part presents the implementation of the feature 'neighbourhood window or artificial window' as well. The bottom right corner of **Picture 2** shows a view of the Development Team Cell and the Product Owner Cell.

In the background, whiteboards used for the presentation of information destined for the entire team in a continuous manner can be seen.

Below we present subjective opinions of individual team members.

TM – [Team member] # 1 ...All this rearranging of office space was for us a clear signal that after the training we will really start a new way of project management in the organization...

The process of rearrangement of the office space was designated as a phase of transforming the department to the Agile mode. This approach proved to be appropriate. With the start of work on a new project, managed according to the new method (Scrum), the project team began their work in a new environment. The members of the project team did not participate in the arrangement of the office plan. It was done during a weekend. The team members were asked on a Friday afternoon to secure their private goods. On Monday (the date of the start of the new project) the resources started to work in a new office layout. A part of the first day of the project was spent getting used to the new space. It took about one to two hours and was associated with the preparation of positions and giving them a personal appearance (hanging pictures, transferring private property, etc.). The new arrangement of the office constituted a good beginning of the project. The change in the arrangement of the office strengthened the kick-off

of a new project. The moment of implementation of the model (in the starting phase of the project) seemed to have been well chosen.

TM # 2 ...Since we started to work on the new project, I have been feeling more a part of the team; previously I had poor access to information, probably because I'm new here [a new resource in the organization], and I did not really understand why I'm doing my tasks. Now I have better contact with the other members of the team and finally I know who I'm working with so that the flow of information is more convenient and faster ...

This opinion shows how important it is to build common goals, a team spirit and a good information exchange framework. This soft aspect of project management was achieved through the creation of dedicated cells for the Development Teams. [Sheffield and Lemétayer \(2013\)](#) mention that co-location of project team members is one of the key factors associated with the success of software development projects. We think that this is not only grouping the project team members in one location, but also creating a dedicated work area in which direct physical contact between the project team is facilitated, which counts. As this opinion is subjective in character, it is hard to say to what extent the impact on building team spirit and the improvement in information exchange were consequences of the principles of the Agile methods ([agilemanifesto.org, 2001](#)) and to what extent they were due to the new arrangement of the office space – especially as none of the team members had known Scrum before.

TM # 3 ...I appreciate this change. All the persons with whom I work every day are in my neighbourhood. When I have a question I don't need to get up from my chair to get access to them. I just have to turn around and drive to him/her on my chair...

The arrangement of the Development Team Cell and the Product Owner Cell in which the resources are seated in a circle facilitates the free movement of team members. We observed that while working the resources often sat next to each other and worked together. This kind of activity is called Pair Programming. Programming in pairs was popularized and used as one of the techniques in the Extreme Programming method ([Arisholm et al., 2007](#)). Although it is not a mandatory technique for Scrum Teams, team members often use it ad hoc (instantaneously, not continuously and optionally). The area in which Scrum Teams work should facilitate this habit. Thanks to the cell structure the resources can do this without having to get up and walk to their co-workers.

TM # 4 ... For me the most useful change is the whiteboards. It's amazing how they can improve the work. I do not know why we had been working for such a long time without them...

Before the rearrangement of the office there had been two whiteboards there: a small one in the management office and a large one in the conference room. Neither was mounted on the walls (they were standing close to them). According to our observations, the whiteboards had been used very rarely. For the purpose of the rearrangement of the office space seven additional whiteboards were ordered. All the new and old boards were installed. The team members quickly started to use the whiteboards as a channel for continuous information exchange and for assistance in the design work related to the elements of the system being developed in the project. Each team also ran its Scrum Board on a whiteboard. The teams were free to choose a tool to monitor the progress of the project. They abandoned electronic tools such as JIRA ([Sarkan et al., 2011](#)) and chose the whiteboards and posting deck. The Scrum Team members explained their choice in the following way: '*It is a much more pleasant and enjoyable method*' and '*At least we do not forget to update the table each day*'. Installation

of the whiteboards allowed the implementation of the feature 'Presentation of information destined for the entire team in a continuous manner that does not require direct communication'. Whiteboards are used as a carrier of information for project progress and current project issues. Consequently, their use supports continuous communication in the Development Team. This way of presenting information does not interfere with the direct day-to-day communication taking place within the Development Team. This statement correlates with [Whittaker and Schwarz \(1999\)](#), who found that the way in which the schedule is presented has a major impact on coordination problems. A large wallboard – rather than devices using electronic technologies – located in the public area encourages a greater responsibility, commitment and more frequent updating. Its material properties encourage a more reflective planning. [Whittaker and Schwarz \(1999\)](#) report that the whiteboard promoted group interaction; it also enabled collaborative problem solving, as well as informing individuals about the local and global progress of the project. A positive impact of whiteboards on communication (non-verbal and face-to-face) has been shown by [Mishra et al. \(2012\)](#), [Mangano and Van Der Hoek \(2012\)](#), [Cherubini et al. \(2007\)](#).

8. Discussion and conclusions

Office layout can be of major social and economic consequence for all companies, as a large number of employees spend a significant amount of time in the office space. The quality of office spaces and their layout has an effect on the health, comfort, satisfaction and productivity of office workers ([Mahdavi and Unzeitig, 2005](#)).

The architectural layout design is a fundamental activity in which the designer/architect has to arrange compartments in a layout design (a dimensioned geometric schema) in such a way that it satisfies specific requirements ([Regateiro et al., 2012](#)). Different types of office work have different requirements. IT projects are linked to a very specific type of office work, especially those managed by means of the Agile method (Scrum). Special features of Agile Project Management, especially with respect to communication and information exchange forms, frequency and actors, as well as roles in the project teams, make Agile Project Management office arrangement a complicated and complex task.

In this paper the requirements for an office space to be appropriate for an effective Agile Project Management have been grouped and described. On top of that, a conceptual model of the office layout of an Agile (Scrum) managed project has been proposed. The solutions proposed here are thought of as a tool for achieving a higher project management performance via changes in project team members' behaviours and work efficiency ([Danielsson and Bodin, 2008](#)).

The proposed model is presented by means of sketches and plans allowing its application to different offices. It was implemented in a real-world organization that carries out big international projects, employs resources from all over the world and had decided to implement the Scrum methodology. However, the limitations associated with the implementation of the model in a real IT project did not allow a qualitative analysis to be performed (e.g. based on Key Performance Indicators) nor a comparative one in order to measure the efficacy of these changes. On the other hand, for practitioners managing a large number of IT projects in the organization concerned it was clear that an effective usage of Scrum would not be possible without an appropriate office space rearrangement, but they did not have a common view on what the space should look like. In spite of the limits of the validation methods applied it can be said that the model was positively validated: the project team members noticed a series of improvements achieved through the implementation of the

conceptual model, which supports them in carrying out their daily project duties.

One aspect that cannot be omitted here is the Hawthorne effect induced by the adoption of the Scrum methodology. [Landsberger \(1958\)](#) defines the Hawthorne effect as a short improvement in performance caused by the fact that the workers were observed at their work. Originally the research by [Landsberger \(1958\)](#) was designed and conducted, in 1924–34, to demonstrate the effect of the physical work environment on workers' productivity. Having analysed the gathered data, Landsberger concluded that it is not the physical environment, but social relations, that shape the organization's results.

This effect was called the 'Hawthorne effect' and is defined as a psychological phenomenon, consisting in the belief that an improvement in human behaviour or performance is produced as a result of increased attention on the part of superiors, clients or colleagues. The authors of this paper are aware that three major factors might have influenced the enthusiastic statements of the Scrum Team members:

- the introduction of the Scrum framework;
- the rearrangement of the office space;
- increased attention on the part of the superiors, the Agile coach and the colleagues working in the organization but not in accordance with the Agile methods.

However, [Zhong and House \(2012\)](#) revisit the conclusions of the Hawthorne studies and revitalize interest in the influence of the physical work environment on diverse organizational outcomes.

It is impossible to separate the three factors in the performed study, although the statements formulated in the interviews concentrated on the office space arrangement. Further research should include designing a long-term study in another organization, in order to monitor the long-term effects of space rearrangement alone and the evolutionary (using statistical metrics) effects on project management effectiveness. It would also be important to compare the work of Scrum teams in an office arranged according to the proposal here and in an office that has not been rearranged.

To sum up, the authors of the present paper are persuaded, in spite of the limits in the validation methodology, that the proposal elaborated here will have a positive effect on the management and everyday execution of all Agile managed IT projects. The proposed model can be used both in areas already occupied by employees and in newly opened offices, regardless of the size of the organization. It can be regarded as a set of good principles to use in the arrangement of office space for Scrum Teams.

References

- [agilemanifesto.org](#). (February, 2001). Manifesto for agile software development. Retrieved 04/24, 2014, from <http://agilemanifesto.org/>
- [Allen, T., Fustfeld, A., 1975. Research laboratory architecture and the structuring of communications. R&D Manage. 5 \(2\), 153–164.](#)
- [Arisholm, E., Gallis, H., Dybå, T., Sjøberg, D., 2007. Evaluating pair programming with respect to system complexity and programmer expertise. IEEE Trans. Softw. Eng. 33 \(2\), 65–86.](#)
- [Beck, K., 2000. Extreme Programming Explained: Embrace Change. Addison-Wesley Longman Publishing Co., Inc, Boston, MA, USA.](#)
- [Berger, J., Webster, M.J., 2006. Expectations, status and behavior. In: Burke, P.J. \(Ed.\), Contemporary Social Psychological Theories. Stanford University Press, Stanford, pp. 268–300.](#)
- [Block, L.K., Stokes, G.S., 1989. Performance and satisfaction in private versus nonprivate work settings. Env. Behav. 21 \(3\), 277–297.](#)
- [Block, M., 2011. Evolving to agile: a story of agile adoption at a small SaaS company. In: Proceedings - 2011 Agile Conference, Agile 2011. Salt Lake City, UT, USA, pp. 234–239.](#)
- [Book, M., Grapenthin, S., Gruhn, V., 2012. Seeing the forest and the trees: focusing team interaction on value and effort drivers. In: Proceedings of the ACM SIGSOFT 20th International Symposium on the Foundations of Software Engineering \(FSE '12\). New York, NY, USA. ACM Article 30.](#)
- [Brennan, A., Chugh, J., Kline, T., 2002. Traditional versus open office design: a longitudinal field study. Env. Behav. 34 \(3\), 279–299.](#)
- [Bryman, A., Bell, E., 2015. Business Research Methods, fourth ed. Oxford University Press, Oxford.](#)
- [CABE. \(2005\). The impact of office design on business performance](#)
- [Campbell, J.P., Campbell, R.J., 1988. Productivity in Organizations: New Perspectives From Industrial and Organizational Psychology, first ed. Jossey-Bass Publishers, San Francisco.](#)
- [Cheng, R.K. Agile office space.](#)
- [Cherubini, M., Venolia, C., Deline, R., Ko, A., 2007. Let's go to the whiteboard: How and why software developers use drawings. In: Conference on Human Factors in Computing Systems - Proceedings, pp. 557–566.](#)
- [Chodorkowski, S.. BHP obowiązujące na stanowisku biurowym.](#)
- [Chow, T., Cao, D., 2008. A survey study of critical success factors in agile software projects. J. Syst. Softw. 81 \(6\), 961–971.](#)
- [Cisco Systems, 2007. Office Design Case Study: How Cisco Designed the Collaborative Connected Workplace Environment. Cisco Systems, Inc. All.](#)
- [Clarke, P., O'Connor, R.V., 2012. The situational factors that affect the software development process: towards a comprehensive reference framework. Inf. Softw. Technol. 54 \(5\), 433–447.](#)
- [Cockburn, A., 2006. Agile Software Development, the Cooperative Game, second ed. Pearson Education, Boston, USA.](#)
- [Colliers. \(2013\). Generation Y space planning and the future of workplace design. Comfortablyscrum. Collaborative workspaces: a virtual tour of my office.](#)
- [Dagenais, B., Ossher, H., Bellamy, R., Robillard, M., de Vries, J., 2010. Moving into a new software project landscape. In: Proceedings of the 32nd ACM/IEEE International Conference on Software Engineering, vol. 1. New York, NY, USA. ACM, pp. 275–284.](#)
- [Dalton, M., 1960. Men who manage. Admin. Sci. Q. 5 \(2\), 323–326.](#)
- [Danielsson, B.C., Bodin, L., 2008. Office type in relation to health, well-being, and job satisfaction among employees. Env. Behav. 40 \(5\), 636–668.](#)
- [Diallo, A., Thuillier, D., 2005. The success of international development projects, trust and communication: an African perspective. Int. J. Proj. Manage. 23 \(3\), 237–252.](#)
- [Dingsøyr, T., Nerur, S., Balijepally, V., Moe, N., 2012. A decade of agile methodologies: towards explaining agile software development. J. Syst. Softw. 85 \(6\), 1213–1221.](#)
- [D'Mello, M., Eriksen, T.H., 2010. Software, sports day and sheera: culture and identity processes within a global software organization in india. Inf. Org. 20 \(2\), 81–110.](#)
- [Drury, M., Conboy, K., Power, K., 2012. Obstacles to decision making in agile software development teams. J. Syst. Softw. 85 \(6\), 1239–1254.](#)
- [Duka, D., 2013. Adoption of agile methodology in software development. In: 36th International Convention on Information and Communication Technology, Electronics and Microelectronics, MIPRO 2013 - Proceedings. Opatija , Croatia, pp. 426–430.](#)
- [Dybå, T., Dingsøyr, T., 2008. Empirical studies of agile software development: a systematic review. Inf. Softw. Technol. 50 \(9–10\), 833–859.](#)
- [Dyba, T., Dingsøyr, T., 2009. What do we know about agile software development? Softw. IEEE 26 \(5\), 6–9.](#)
- [Dyer, W., Wilkins, A., 1991. Better stories, not better constructs, to generate better theory: a rejoinder to eisenhardt. Acad. Manage. Rev. 16 \(3\), 613–619.](#)
- [Freeman, K., Knight, C., 2009. Ambius White Paper Enrich the Office and Engage Your Staff: Why Lean is Mean No. 2. Ambius University, Buffalo Grove, USA.](#)
- [Gandomani, T., Zulzalil, H., Ghani, A., Sultan, A., 2013. Important considerations for agile software development methods governance. J. Theor. Appl. Inf. Technol. 55 \(3\), 345–351.](#)
- [Geurts, G., Gründemann, R., 1999. Workplace stress and stress prevention in europe. In: Kompier, M., Cooper, C. \(Eds.\), Preventing Stress, Improving Productivity. European Cases Studies in the Work Place. Routledge, London, pp. 9–32.](#)
- [Grapenthin, S., Book, M., Gruhn, V., Schneider, C., Völker, G., 2013. Reducing complexity using an interaction room: An experience report. In: SIGDOC 2013 - Proceedings of the 31st ACM International Conference on Design of Communication, pp. 71–76.](#)
- [Grapenthin, S., Poggel, S., Book, M., Völker, G., 2015. Improving task breakdown comprehensiveness in agile projects with an interaction room. Inf. Softw. Technol. 67, 254–264.](#)
- [GSA, 2006. Innovative Workplaces: Benefits and Best Practices. General Services Administration, Washington, DC 20405: U.S.](#)
- [Hajjdiab, H., Taleb, A., 2011. Adopting agile software development: issues and challenges. Int. J. Manag. Value Supply Chains 3 \(2\), 1–9.](#)
- [Hales, T.C., 2001. The honeycomb conjecture. Discrete Comput. Geom. 25 \(1\), 1–22.](#)
- [Hallikainen, M., 2011. Experiences on agile seating, facilities and solutions: multi-site environment. In: Proceedings - 2011 6th IEEE International Conference on Global Software Engineering, ICGSE 2011. Helsinki, Finland, pp. 119–123.](#)
- [Hedge, A., 1982. The open-plan office, a systematic investigation of employee reaction to their work environment. Env. Behav. 14 \(5\), 519–542.](#)
- [Heerwagen, J., Kampschroer, K., Powell, K., Loftness, V., 2004. Collaborative knowledge work environments. Build. Res. Inf. 32 \(6\), 510–528.](#)
- [Holmström, H., Fitzgerald, B., Ågerfalk, P., Conchúir, E., 2006. Agile practices reduce distance in gloral software development. Inf. Syst. Manage. 23 \(3\), 7–18.](#)
- [Kettunen, P., 2009. Adopting key lessons from agile manufacturing to agile software product development-a comparative study. Technovation 29 \(6–7\), 408–422.](#)
- [Kibler, W.W., 1991. Round table. In: Lacy, N.J. \(Ed.\), The New Arthurian Encyclopaedia. Garland, New York, p. 391.](#)
- [Kirwan, B., 2000. Soft systems, hard lessons. Appl. Ergon. 31 \(6\), 663–678.](#)
- [Knoll, I., 2012. Activity Spaces: A Variety of Spaces for a Variety of Work No. 1\)White Paper. Knoll, Inc., New York.](#)

- Knoll, I.. Creating collaborative spaces that work a performance-based approach to successful planning.
- Kraut, R., Egido, C., Galegher, J., 1990. In: Galegher, J., Kraut, R., Egido, C. (Eds.), Patterns of contact and communication in scientific research collaboration (IntellectualTeamwork, ed.). Lawrence Erlbaum Press, Hillsdale, NJ.
- Kulkarni, C., Dow, S., Klemmer, S., 2013. Early and repeated exposure to examples improves creative work. In: Leifer, L. -, Plattner, H. -, Meinel, C. - (Eds.), Design Thinking Research. Springer International Publishing, Germany, pp. 49–62.
- Landsberger, H.A., 1958. Hawthorne Revisited : Management and the Worker : Its Critics, and Developments in Human Relations in Industry. Cornell University, Ithaca, N.Y.
- Lawson, B., 2008. How Designers Think : The Design Process Demystified. Elsevier/Architectural, Oxford; Burlington, MA.
- Lee, Y.S., 2010. Office layout affecting privacy, interaction, and acoustic quality in LEED-certified buildings. *Build. Env.* 45 (7), 1594–1600.
- Mahdavi, A., Unzeitig, U., 2005. Occupancy implications of spatial, indoor-environmental, and organizational features of office spaces. *Build. Env.* 40 (1), 113–123.
- Majchrzak, A., Wang, Q., 1996. Breaking the functional mind-set in process organizations. *Harvard Bus. Rev. September-October 1996 Issue*, 93–99.
- Mangano, N., Van Der Hoek, A., 2012. The design and evaluation of a tool to support software designers at the whiteboard. *Autom. Softw. Eng.* 19 (4), 381–421.
- McChesney, I.R., Gallagher, S., 2004. Communication and co-ordination practices in software engineering projects. *Inf. Softw. Technol.* 46 (7), 473–489.
- McHugh, M., McCaffery, F., Casey, V., 2012. Barriers to Adopting Agile Practices When Developing Medical Device Software. Springer, Heidelberg, Berlin, Germany.
- Melnik, G., Maurer, F., 2004. Direct verbal communication as a catalyst of agile knowledge sharing. In: Proceedings of the Agile Development Conference, ADC 2004. Washington, DC, USA, pp. 21–31.
- Milgram, S., 1963. Behavioral study of obedience. *J. Abnorm. Soc. Psychol.* 67 (4), 371–378.
- Mishra, D., Mishra, A., Ostrowska, S., 2012. Impact of physical ambiance on communication, collaboration and coordination in agile software development: an empirical evaluation. *Inf. Softw. Technol.* 54 (10), 1067–1078.
- MITIE, 2013. Making Agile Working Work for You. Strategy Guide. MI, London, UK.
- Moe, N., Dingsøyr, T., Dybå, T., 2010. A teamwork model for understanding an agile team: A case study of a scrum project. *Inf. Softw. Technol.* 52 (5), 480–491.
- Niehoff, B.P., 2005. A theoretical model of the influence of organizational citizenship behaviors on organizational effectiveness. In: Turnipseed, D. (Ed.), New Research in Organizational Citizenship Behaviors. Nova, New York, pp. 385–397.
- Paastraava, M., Lassenius, C., 2011. Scaling scrum in a large distributed project. In: International Symposium on Empirical Software Engineering and Measurement. Banff, Alberta, Canada, pp. 363–367.
- Parsaee, M., Motealleh, P., Parva, M. Interactive architectural approach (interactive architecture): An effective and adaptive process for architectural design, HBRC Journal, Available online 4 March 2015, <http://dx.doi.org/10.1016/j.hbrcj.2015.01.001>. <http://www.sciencedirect.com/science/article/pii/S1687404815000036>.
- Patel, C., Lycett, M., Macredie, R., De Cesare, S., 2006. Perceptions of agility and collaboration in software development practice. In: Proceedings of the Annual Hawaii International Conference on System Sciences, vol. 1. Koloa, Kauai, HI, USA.
- Rashid, M., Kampschroer, K., Wineman, J., Zimring, C., 2006. Spatial layout and face-to-face interaction in offices - a study of the mechanisms of spatial effects on face-to-face interaction. *Env. Plann. B Plann. Des.* 33 (6), 825–844.
- Rees, D., Porter, C., 2002. The use of case studies in management training and development. part 1null. *Ind. Comm. Train.* 34 (1), 5–8.
- Regateiro, F., Bento, J., Dias, J., 2012. Floor plan design using block algebra and constraint satisfaction. *Adv. Eng. Inf.* 26 (2), 361–382.
- Rising, L., Janoff, N.S., 2000. The scrum software development process for small teams. *Softw. IEEE* 17 (4), 26–32.
- Rizvi, B., Bagheri, E., Gašević, D., 2015. A systematic review of distributed agile software engineering. *J. Softw. Evol. Process* 27 (10), 723.
- Saddington, P.. Best way to set up your agile office – is an open office right?.
- Sailer, K., McCulloh, I., 2012. Social networks and spatial configuration-how office layouts drive social interaction. *Soc. Netw.* 34 (1), 47–58.
- Santos, V., Goldman, A., de Souza, C., 2015. Fostering effective inter-team knowledge sharing in agile software development. *Emp. Softw. Eng.* 20 (4), 1006–1051.
- Santos, V., Goldman, A., Guerra, E., Souza, C., Sharp, H., 2013. A pattern language for Inter/team knowledge sharing in agile software development. In: Development. 20th Conference on Pattern Languages of Programs (PLoP), p. 21.
- Santos, V., Sharp, H., Goldman, A., & Souza, C. (2013). Tacit knowledge socialization in agile software development: An enhanced inter/team knowledge sharing conceptual model.paper submitted to the information and software technology journal, special edition on human and social aspects (awaiting first assessment). Unpublished manuscript.
- Sarkan, H., Ahmad, T., Bakar, A., 2011. Using JIRA and redmine in requirement development for agile methodology. In: 2011 5th Malaysian Conference in Software Engineering, MySEC 2011, Johor Bahru, Malaysia, pp. 408–413.
- Schatz, B., Abdelshafi, I., 2005. Primavera gets agile: A successful transition to agile development. *IEEE Softw.* 22 (3), 36–42.
- Schwaber, K., & Sutherland, J. (1991st–2013th ed.). The scrum guide the definitive guide to scrum: The rules of the game. Retrieved 04/2014, 2014, from www.scrum.org
- Sharp, H., Hugh, R., 2004. An ethnographic study of XP practice. *Emp. Softw. Eng.* 9 (4), 353–375.
- Sheffield, J., Lemétayer, J., 2013. Factors associated with the software development agility of successful projects. *Int. J. Proj. Manage.* 31 (3), 459–472.
- Sienkiewicz, L., Maciaszek, L., 2011. Adapting scrum for third party services and network organizations. In: 2011 Federated Conference on Computer Science and Information Systems, FedCSIS 2011, Szczecin, Poland, pp. 329–336.
- Silver, S., Troyer, L., Cohen, B., 2000. Effects of Status on the Exchange of Information in Team Decision-Making: When Team Building isn't Enough. Emerald Group Publishing Limited, Bradford, United Kingdom.
- Srinivasan, J., Lundqvist, K., 2009. Using agile methods in software product development: a case study. In: ITNG 2009 - 6th International Conference on Information Technology: New Generations. Las Vegas, Nevada, USA, pp. 1415–1420.
- Stray, V., Moe, N., Aurum, A., 2012. Investigating daily team meetings in agile software projects. In: Proceedings - 38th EUROMICRO Conference on Software Engineering and Advanced Applications, SEAA 2012, Cesme, Izmir, Turkey, pp. 274–281.
- Sundstrom, E., Herbert, R., Brown, D., 1982. Privacy and communication in an open-plan office. *Env. Behav.* 14, 379–392.
- Sundstrom, E., Town, J., Rice, R., Osborn, D., Brill, M., 1994. Office noise, satisfaction, and performance. *Env. Behav.* 26, 195–222.
- Terje Karlsen, J., Hagman, L., Pedersen, T., 2011. Intra-project transfer of knowledge in information systems development firms. *J. Syst. Inf. Technol.* 13 (1), 66–80.
- Toh, C., Miller, S., 2015. How engineering teams select design concepts: a view through the lens of creativity. *Des. Stud.* 38 (0), 111–138.
- Tudor, M., 1939. An Experimental Study of the Effect of Evaluative Labeling on Speech Fluency Unpublished master's thesis, University of Iowa.
- Ullman, F., Boutellier, R., 2008. Physical layout of workspace: a driver for productivity in drug discovery. *Drug Discov. Today* 13 (9–10), 374–378.
- Velocity Counts. Building an ideal agile team workspace.
- Version One, 2014. 8'th Annual Survey The State of Agile Development No. 8. Versionone Inc, Alpharetta, GA, USA.
- Watson, J.B., Rayner, R., 1920. Conditioned emotional reactions. *J. Exp. Psychol.* 3 (1), 1–14.
- Weick, K.E., Roberts, K.H., 1993. Collective mind in organizations: heedful interrelating on flight decks. *Admin. Sci. Q.* 38 (3), 357–381.
- Whittaker, S., Schwarz, H., 1999. Meetings of the board: the impact of scheduling medium on long term group coordination in software development. *Comput. Supported Coop. Work Int. J.* 8 (3), 175–205.
- Wysocki, R.K., 2009. Effective Project Management: Traditional, Agile, Extreme.
- Yen, H., Li, E., Niehoff, B., 2008. Do organizational citizenship behaviors lead to information system success?: Testing the mediation effects of integration climate and project management. *Inf. Manage.* 45 (6), 394–402.
- Young, H.H., Berry, G.L., 1979. The impact of environment on the productivity attitudes of intellectually challenged office workers. *Hum. Fact.* 21 (4), 399–407.
- Zhong, C., House, J., 2012. Hawthorne revisited: Organizational implications of the physical work environment. *Res. Org. Behav.* 32 (0), 3–22.
- Zhu, L., Zhu, L., 2013. The physical office environment in technical services in ARL libraries. *Libr. Coll. Acqu. Tech. Serv.* 37 (3–4), 124–137.
- Zimbardo, P.G., Haney, C., Banks, W.C., 1973. A study of prisoners and guards in a simulated prison. *Naval Res. Rev.* 30, 4–17.
- Zotin, A.. How to make agile office space better (in 11 simple steps).