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Thesis:
The impact of enforced remote working due to COVID-19 restrictions on Agile Software Development teams in Greece

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Abstract

In early 2020, the world as we knew it was about to change. The emergence of COVID-19 and its impact on all areas of life worldwide was rapid and forced the entire world to adapt to this new reality. The purpose of this thesis, is to investigate the impact of remote working, imposed out of necessity due to the COVID-19 pandemic, on teams working with Agile Software Development methodologies in companies based in Greece.

This study, conducted among Agile practitioners working for software development companies in Greece indicates that the application of agile principles and the conduction of agile ceremonies in this new context was not impacted, since most of the organizations had embraced lighter forms of remote working earlier. The use of communication and collaboration software tools helped the teams adapt faster to this new reality. Teamwork quality and performance remained in high levels, but the benefits of video conference and chats against face-to-face communication have been challenged. In this context, a new working model, known as hybrid, is already gaining popularity among the agile practitioners in Greece and their organizations.

Keywords: Agile, COVID-19, remote working, hybrid working

Περίληψη

Στις αρχές του 2020, ο κόσμος όπως τον γνωρίζαμε επρόκειτο να αλλάξει. Η εμφάνιση του COVID-19 και ο αντίκτυπός του σε όλους τους τομείς της ζωής ήταν ραγδαίος και ανάγκασε ολόκληρο τον κόσμο να προσαρμοστεί σε αυτή τη νέα πραγματικότητα. Σκοπός της παρούσας διπλωματικής εργασίας, είναι να διερευνήσει τις επιπτώσεις της απομακρυσμένης εργασίας, που επιβλήθηκε από ανάγκη λόγω της πανδημίας COVID-19, σε ομάδες που εργάζονται με μεθοδολογίες ευέλικτης ανάπτυξης λογισμικού σε εταιρείες που εδρεύουν στην Ελλάδα.

Αυτή η μελέτη, η οποία διεξήχθη μεταξύ επαγγελματιών που εργάζονται σε εταιρείες ανάπτυξης λογισμικού στην Ελλάδα, οι οποίες χρησιμοποιούν ευέλικτες τεχνικές, δείχνει ότι η εφαρμογή των ευέλικτων αρχών και η διεξαγωγή ευέλικτων τελετών σε αυτό το νέο πλαίσιο δεν επηρεάστηκε, δεδομένου ότι οι περισσότεροι οργανισμοί είχαν υιοθετήσει νωρίτερα ελαφρύτερες μορφές απομακρυσμένης εργασίας. Η χρήση εργαλείων λογισμικού επικοινωνίας και συνεργασίας βοήθησε τις ομάδες να προσαρμοστούν ταχύτερα σε αυτή τη νέα πραγματικότητα. Η ποιότητα και η απόδοση της ομαδικής εργασίας παρέμειναν σε υψηλά επίπεδα, αλλά τα οφέλη της τηλεδιάσκεψης και των συνομιλιών έναντι της πρόσωπο με πρόσωπο επικοινωνίας αμφισβητήθηκαν. Σε αυτό το πλαίσιο, ένα νέο μοντέλο εργασίας, γνωστό ως υβριδικό, κερδίζει ήδη δημοτικότητα μεταξύ των ευέλικτων επαγγελματιών στην Ελλάδα και των οργανισμών τους.

Λέξεις-κλειδιά: Agile, COVID-19, απομακρυσμένη εργασία, υβριδική εργασία

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1. Introduction

The forced transition to a strict teleworking model for many workers in many professional sectors, due to the COVID-19 pandemic, could not leave the software development teams unaffected. Most of the organizations in this sector, due to the nature of work, which is mostly computer-based, adapted relatively quickly and with minimum difficulty compared to other sectors, as many of them were already implementing some teleworking policies. This was applied either with some form of remote teams or as an additional benefit, to promote work-life balance, but its implementation out of necessity due to the pandemic changed the way workers perceived it, since it was no longer considered a benefit but a need (Carillo et al., 2020).

In this industry, Agile Software Development (ASD) methodologies have also been applied for several years. These methodologies, according to their fundamental principles, advice co-location and in-person collaboration among the members of a team (Mancl & Fraser, 2020). Important success factors of a team working with agile methodologies are also intercommunication, direct relationship and collaboration with the clients and stakeholders, evolution, and self-organization of the team (Neumann et al., 2021). For an organization to benefit from the advantages of agile methodologies, it must adapt to the new characteristics that are mandated by teams working in a telecommuting context (Marek et al., 2021). However, the remote working model doesn't fully comply with the main principles of agile methodologies (Mancl & Fraser, 2020).

Other fundamental elements of ASD is responsiveness to change and adaptability, principles that should be applied in the context of such a major change as the pandemic. Agility coexists with uncertainty, which is unavoidable in organizations using agile methodologies (da Camara et al, 2020). In addition to the above, the factors that affect the experience and efficiency of employees within the context of teleworking, positively or negatively, as well as the tools used to replace face-to-face communication and the sharing of tasks within team members should be considered (Marek et al., 2021).

The purpose of this research is to investigate the impact of the enforced teleworking due to the pandemic of COVID-19 on the application of agile methodologies in software development teams in the Greek market. Since the change caused by the pandemic has already started rapidly changing the world of ASD and the subject under study is relatively new, the literature

around the topic is limited, therefore there is currently no other known research, aiming specifically to the Greek market.

There are six chapters in this thesis. Chapter 2 describes Agile methodologies and how they are applied, and focuses on Scrum, the most popular framework. Chapter 3 describes the most popular working models for software development, regarding the location of the team members. Chapter 4 presents a brief history of COVID-19 and some important dates in Greece. Chapter 5 presents the research methodology that was used while the results are presented in Chapter 6. The discussion of the results is available on Chapter 7.

2. Software Development Life Cycle Models

A representation of a software process in a simplified way, is called Software Development Life Cycle or SDLC model. Sommerville (2016) presented the most popular SDLC models (or process models) from an architectural view, by focusing on the process but skipping its details. These models can be used to describe different approaches, depending on the context they are applied.

These models are:

- Waterfall
- Incremental development
- Integration and configuration

There are many factors that can affect the decision of the proper SDLC model that will meet the needs of the software to be developed. The majority of software products are nowadays build using incremental models, while safety-critical applications are more likely to use waterfall, since they require a lot of analysis and the proper documentation in place before developing. Integration and Configuration is mostly used to business systems, where new functionality is being integrated to an existing system.

It is also very common, to start with a general model, and use features from other models to meet the needs of the software to be developed.

2.1. The waterfall model

The waterfall model is plan-driven, meaning that all the activities of the process should be planned and scheduled before the implementation starts. The waterfall model is represented by a number of stages that each one cascades to the other, as depicted in Figure 1.

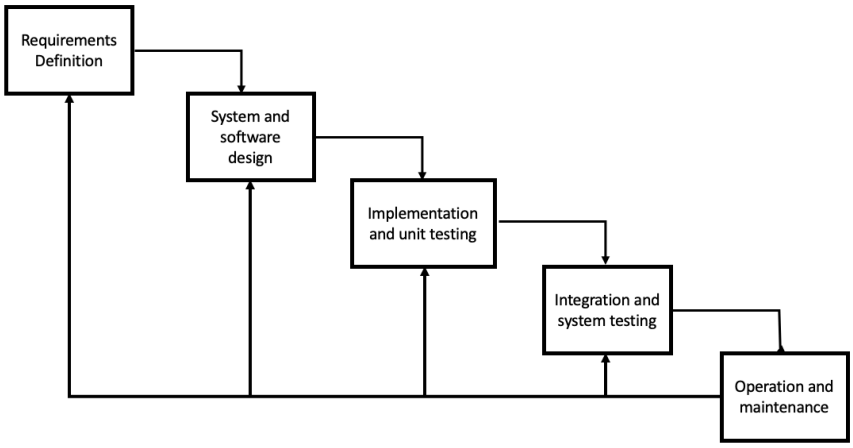

Figure 1: The Waterfall Model

The stages of the waterfall model are described below:

1. *Requirements analysis and definition*: The system's goal, services and constraints are described, then analyzed in detail, creating the specifications of the system.
2. *System and software design*: The HW/SW requirements are allocated and abstractions and relationships are described. This is where the system architecture is established.
3. *Implementation and unit testing:* A set of software programs and their respective unit tests are created, to verify that all units meet their specifications.
4. *Integration and system testing:* Individual units are integrated and tested as a whole to ensure conforming to requirements. When this step is completed, the software can be delivered to the customers.
5. *Operation and maintenance:* This stage involves correcting not previously discovered errors, system unit improvements and discovery of new requirements. This is the phase with the longest life cycle.

Each phase of the model is completed with a document (or more) that needs to be signed off before the next phase begins. This may not be suitable for software development that information must pass from one phase to the other, where feedback is required.

If a change is identified during the development process, the documentation should be updated, and the necessary customer approval must be given. This leads to several delays and can have many side effects, that finally may lead to errors and extra work. Software development requires more flexibility in order to support changes during development. Critical systems with many security and safety aspects, large systems developed by several companies and embedded systems that depend heavily on hardware are better to be developed using the waterfall model.

In an environment where the requirements change quickly and the communication between the team should take place in an informal manner, then an incremental development model, using agile methodologies should be preferred.

2.2. Incremental development

Developing an initial part and getting feedback from stakeholders and users in order to evolve the software, until the final version is developed, is the basic idea of incremental development. As seen in Figure 2, the activities of specification, development and validation are close, with constant feedback coming and going from one to another. This approach is nowadays the most popular for software products development and can be either plan-driven or agile, or in some cases a mixture of those two.

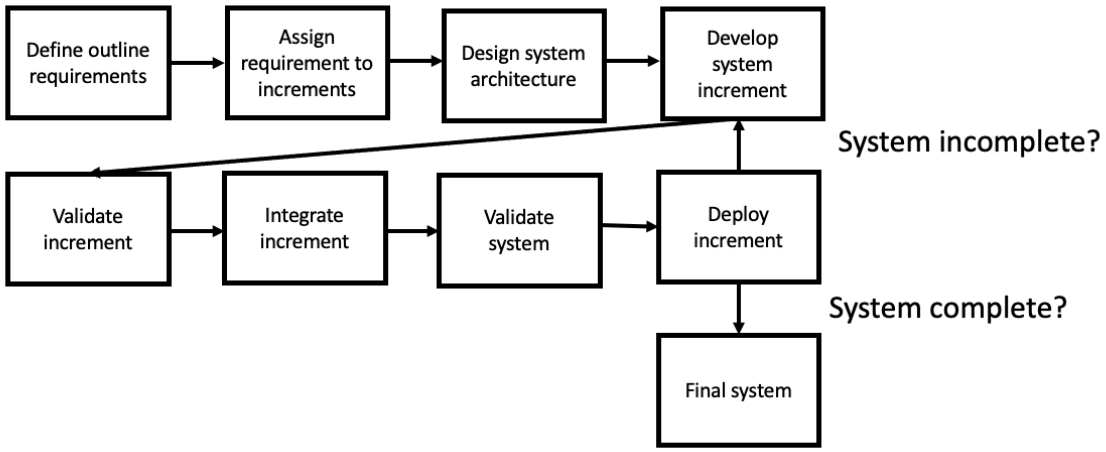

Figure 2: Incremental development

Incremental development is mostly used for systems that have frequent changes to their requirements, and thus it is a fundamental element of agile software development methodologies. Incremental software development can help us solve problems while the product is developed, making it a cheaper and easier way to make changes to the software, compared to the waterfall model.

Usually, the most important parts of the software are included in the early increments of the product, and extra functionality is added as the development progresses. This approach gives the opportunity to the end user to evaluate the product relatively early and verify that this is what was required. If there are changes to be made, they can de incorporated to the product early in the development cycle.

There are three main advantages of this model over the waterfall model:

3. Requested changes require less cost to be implemented
4. Frequent and easier customer feedback
5. Early delivery of smaller parts of the functionality and thus earlier value to the customers

There are also some problems when incremental development is used:

1. If the new system replaces an existing system, the new functionality is likely to change the user's experience with the product
2. It's difficult to identify common facilities required by most of the increments, since the requirements are not clear until the implementation starts
3. Procurement issues may arise, since there is not a clear system specification from the beginning.

Incremental approach is not recommended for large software systems that are either dependent on hardware or require a lot of team working from different places or systems with advanced criticality in regards of safety or security.

2.3. Integration and configuration

In software development, there are cases that some parts of the software can be reused to support the needs of another software components, with some modification and integration with the new software part.

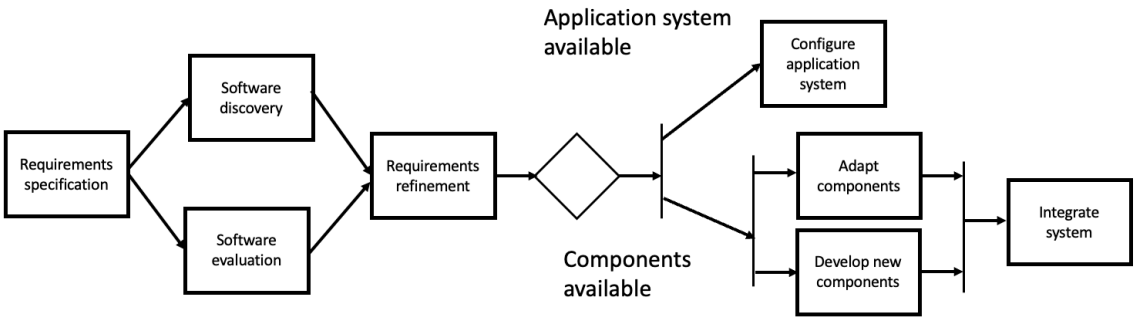

Figure 3: Integration and configuration approach

Such reusable components often are:

1. Software applications, usually stand-alone, that can be used in specific environments.
2. More than one objects that constitute a collection that can be integrated with a larger development framework.
3. Some web services that are created to meet specific service standards

The stages of integration and configuration process, as depicted in Figure 3 are:

1. Requirements specification : Gathering of the initial requirements with brief description.
2. Software discovery and evaluation: Research on the proper software and evaluation that it meets the needs of the system
3. Requirements' refinement: Check for possible modification of the reusable component
4. Application system configuration: Configure the application to meet the needs of the new system
5. Component adaptation and integration: Modification of the reusable components and development of new ones, before integrating to the system.

One of the main benefits of this approach, is that it reduces the needs for software development, and thus reducing risks and costs and speeds up the delivery of software. Regarding its disadvantages, the organization and the development team has limited control on the requirements of the component so they must compromise which may reduce the overall satisfaction of the end users by not meeting their actual needs.

3. Agile Software Development

With the idea to define the values and principles to create better software, a group of seventeen scientists and experts introduced in 2001 the term "agile methods" to computer science, through the *Manifesto for Agile Software Development* or as it is largely known, the Agile Manifesto (Beck, K, et al., 2001), which is described in detail on Chapter 2.1. A collection of practices and frameworks, based on a set of values and principles that are expressed in the Agile Manifesto are included under the umbrella of ASD (Agile Alliance, 2019).

ASD is widely used by organizations that produce software, since it assures early delivery of high-quality software, while it supports responsiveness to change of requirements. It is based on iterative development, as described in Chapter 2.2. Traditional software product development methodologies, such as the waterfall model, focus on the end result, i.e., what will reach the customer-consumer when the process of its creation is completed. In this case, there is always the risk that the final product will not be the one that will ultimately satisfy the end user, for a few reasons, as described in Chapter 2.1. ASD is based on the continuous delivery of increments of an initial product, with the aim of delivering value to the end consumer faster, but also more frequently. To achieve this, one or more frameworks and methodologies are used, which vary depending on the type of project and the organization implementing them. Some of the principles that underlie ASD are continuous software delivery, adaptive design, and an evolutionary approach to software development (aha.io, 2021).

Requirement gathering, analysis, design, coding, testing, partial delivery of implemented software and customer feedback are included in the agile software life cycle. Faster development time equals customer satisfaction which is at highest priority in the process. The Agile Process Software Development Life Cycle is depicted in Figure 1 (Sharma et al., 2012).

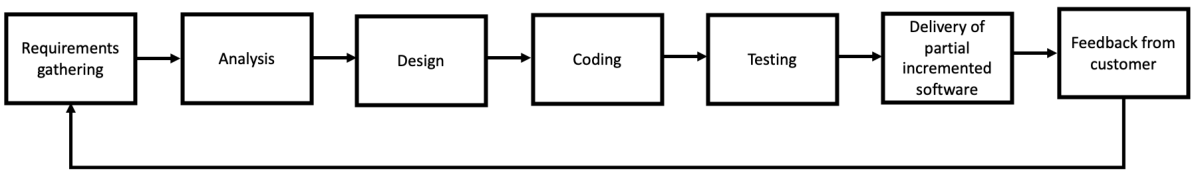

Figure 4: Agile Software Development Life Cycle

It is important to note, however, that in addition to some basic features and sets of rules offered by each approach, agile methodologies are equally based on several concepts without which it is difficult to implement and succeed. Examples are the application of modern leadership concepts, project management processes, supporting tools and knowledge sharing through best practices. Their implementation and success are a matter for the whole organization, not

just the software development teams that will use them, as their adoption and support is mainly a matter of changing mindsets (Stober & Hansmann, 2010).

ASD is based on a few methods and techniques, which will be discussed in the following chapters. Most of them are based on iterative development in small steps and focus very much on team collaboration. Teams are self-organized and decentralized, and ideally can cover end-to-end functionality. They are autonomous enough to be able to complete the work without external interference. The need to assemble all these methods and techniques under a common umbrella led to the creation of the Agile Manifesto, the document that is the cornerstone of agile.

2.1. Manifesto for Agile Software Development

The Agile Manifesto placed the team at the centre of the software production process and promoted speed, adaptability, responsiveness to change and face-to-face collaboration as the key characteristics of this new approach. This document has been the foundation upon which a number of frameworks have been created. There are several variations and methodologies based on the basic idea of agile, but the most popular framework is Scrum, which has been adopted by many IT organizations worldwide. Scrum is going to be presented in more detail in Chapter 2.4.

2.1.1. Agile Values

Agile is based on four core values, that are described in the Agile Manifesto as:

> *We discover better ways to develop software by doing it and helping others do it. Through this work we have gained value:*
>
> - *Individuals and interactions over processes and tools*
> - *Working software over comprehensive documentation*
> - *Customer collaboration over contract negotiation*
> - *Responding to change over following a plan*

As stated in the manifesto, although the authors acknowledge the importance on the items listed on the right, they value more the items on the left. These values, and the principles that support them, do not constitute a framework of rules, but rather are used to describe the philosophy of agile. Response to change is placed in the foreground, as is communication between the team and stakeholders, emphasizing to the extent that their relationships and interaction are of particular importance (Schön et al., 2015). In addition, one of agile's main

pillars, is the participation of customers in the process of creating and improving a product. The team works directly with the customer or a customer representative to maintain a backlog and prioritize it. Also, the customer is the one to accept the features and thus evaluate the working software (Appelo, 2011).

Delivering value through working software, rather than spending time to create documentation that in case of being rejected by the customer, could be of no use. Working software is the artifact that provides value to the customer, and this is the main goal of an ASD team (Madi et al., 2011). Approaching software development with an agile mindset, it is good to live the values and the principles that follow and use them in a certain context to help figure out the right things (Agile Alliance).

2.1.2. Agile principles

To support the values of agile, the authors identified twelve principles that should be followed by agile practitioners. The principles, as presented in the manifesto are:

No	Principle
1	Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.
2	Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.
3	Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.
4	Business people and developers must work together daily throughout the project.
5	Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.
6	The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.
7	Working software is the primary measure of progress.
8	Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.
9	Continuous attention to technical excellence and good design enhances agility.
10	Simplicity--the art of maximizing the amount of work not done--is essential.
11	The best architectures, requirements, and designs emerge from self-organizing teams.
12	At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.

Table 1: Agile Principles

These principles are the foundation of agile, describe the whole philosophy behind its creation and capture its essence. There have been many attempts to review and update these principles, but no new edition of the Manifesto for Agile Software Development has been published.

In an effort to compare the principles against other definitions around ASD and agility in general, Laanti et al. (2013) analyzed the points of emphasis of each agile principle as follows:

Principle	Emphasis
1	• Customer satisfaction • Continuous delivery • Value • Early delivery
2	• Adaptability • Competitiveness • Customer benefit
3	• Frequent deliveries
4	• Collaboration
5	• Motivated individuals • Good environment • Support • Trust
6	• Efficiency • Communication
7	• Measure progress via deliverables
8	• Sustainability • People
9	• Focus on technical excellence
10	• Simplicity • Optimize work
11	• Self-organization
12	• Built-in improvement of efficiency and behavior

Table 2: Agile Principles points of emphasis

2.2. Agile Frameworks

Under the umbrella of ASD, many frameworks that can serve different needs for the organizations that use them are included. Some frameworks focus on the flow of work, others on the processes while over the last years, scaling agile frameworks, started to emerge to support the need of scaling agile on an enterprise level.

Although there are many more frameworks used to apply ASD techniques, Table 3 gathers some of the most popular agile Frameworks according to the 15th State of Agile report (digital.ai, 2021). Short descriptions for each framework and its main contributors is provided.

Framework	Description	Contributors
Scrum	A framework for developing, delivering, and sustaining products in a complex environment.	Ken Schwaber, Jeff Sutherland
XP (Extreme Programming)	Extreme Programming (XP) was created in response to problem domains whose requirements change.	Kent Beck, Robert Cecil Martin
Kanban	Expanded set of ideas—workflow visualization, work item types, cadence, classes of service, specific management reporting, and operations reviews—defines the Kanban Method.	Taiichi Ohno
ScrumBan	A methodology combining hybrids of Scrum and Kanban, originally designed as a way to transition from the one framework to the other.	Corey Ladas
Lean Startup	A methodology for developing businesses and products that aims to shorten product development cycles and rapidly discover if a proposed business model is viable.	Eric Ries
sAFE (Scaled Agile Framework)	A set of organization and workflow patterns intended to guide enterprises in scaling lean and agile practices.	Scaled Agile, Inc.
Scrum@Scale	A way of scaling scrum based on the fundamentals of scrum and complex adaptive systems theory.	Jeff Sutherland
Enterprise Scrum	A broader and more generic framework, which can be parameterized and applied in different ways.	Mike Beedle
LeSS	A framework for scaling scrum to multiple teams who work together on a single product	Bas Vodde

Table 3: Popular Agile Frameworks

2.3. Scrum

Scrum is by far the most popular agile framework (digital.ai, 2021). A definition of Scrum comes from its creators, Jeff Sutherland and Ken Schwaber, who were among the seventeen signatories of the Manifesto for Agile Software Development:

"Scrum is a framework for developing and sustaining complex products".

The idea of Scrum was born in the early 90s and followed by the publication of “The Scrum Development process” paper by the two authors in 1995, that took place at Object-Oriented Programming, Systems, Languages & Applications (OOPSLA) Conference, in Austin, Texas.

After the release of the Agile Manifesto in 2001, and the publication of various books related to the subject, on 2009 Sutherland & Schwaber published the first version of the Scrum Guide, that has become the standard for Agile practitioners that use the Scrum framework. Several revisions followed over the years, to meet the ever-changing domain of ASD with the latest being published in 2020 (Verheyen, 2020).

Scrum’s foundations are empiricism, meaning that knowledge comes from experience and decision making is based on observations and lean thinking, meaning waste reduction and focus on what is essential. The main pillars of Scrum are (Sutherland & Schwaber, 2020):

- **Transparency:** The work must be visible to everyone
- **Inspection:** The agreed goals are inspected for variances or problems
- **Adaptation:** In case of deviation. The process is adjusted

2.3.1. Scrum Values

Living the following values, is essential for a Scrum Team to successfully use Scrum:

- **Commitment:** Commitment to achieve the goals and support each other
- **Focus:** Make progress towards the goals
- **Openness:** Be open about the work and its challenges
- **Respect:** Respect each other and being respected
- **Courage:** Do the right thing, work on tough problems

2.3.2. Scrum Team

The core of this framework is the scrum team, which consists of the Developers, who are responsible for the proper creation and operation of the software, the Product Owner, who is responsible for the product the team is working on and setting its priorities, and the Scrum Master, who is responsible for the efficient operation of the team, protecting it from external factors, and the proper and efficient application of Agile principles. The Scrum Master may have more than one team under their supervision (Saleh et al., 2019).

2.3.3. Scrum Events

Scrum consists of four events, and a container event that is called Sprint. The Sprint have a fixed length of one month or less and starts right after the conclusion of the previous one.

- Sprint Planning

The Sprint starts with the **Sprint Planning**, where the work to be performed for the Sprint is discussed and agreed. The Sprint Planning is timeboxed to a maximum of 8 hours, depending on the length of the Sprint. The outcome of the Sprint Planning, is the Sprint Backlog, which consists of the Sprint Goal, the Backlog Items selected and the plan for their delivery.

- Daily Scrum

The **Daily Scrum** is a short event, timeboxed to 15', that takes place at the same time and place to reduce complexity. At this event, the Developers discuss progress towards the Sprint Goal.

- Sprint Review

The **Sprint Review** is an event where the team meets with the stakeholders to present the result of their work and discuss progress towards the Product Goal and what comes next. This event is timeboxed to a maximum of four hours, for a one month sprint.

- Sprint Retrospective

The Sprint ends with the **Sprint Retrospective**, where the team discusses what went well during the last sprint, what issues were identified and what actions could the team take in order to solve them, in an effort to increase effectiveness and quality. The Sprint Retrospective is timeboxed to three hours for the longest sprint duration (Sutherland & Schwaber, 2020).

2.3.4. Scrum Artifacts

Scrum Artifacts are designed to help everyone interested to have all information available at any point. The artifacts are:

- Product Backlog

Is a list of items that are needed for the improvement of the product. The items on this list are candidates for the next sprint planning, after they have been refined by the team and sized properly by the team. The commitment of the Product Backlog is the Product Goal that describes the future state of the product, providing the Scrum Team with a long term objective.

- Sprint Backlog

The Sprint Backlog consists of the Product Backlog items that have been selected for the sprint, the Sprint Goal and the plan of delivery. The Developers are responsible for planning and delivering the items committed and update the backlog in order to achieve the Sprint Goal. The Sprint Goal is agreed during the Sprint Planning and is used to create coherence and focus on the team.

- Increment

An Increment is a step towards achieving the Product Goal. The Increment should be usable in order to provide value and be additive to prior increments so that all work together. The commitment of the Increment is the Definition of Done, meaning that each Product Backlog Item must meet the quality measures defined by the product in order to be considered an Increment. If a Product Backlog Item doesn't meet the Definition of Done, it cannot be released. The Scrum Team should follow the organization's standards for the Definition of Done and if there is not one established, create its own (Sutherland & Schwaber, 2020).

2.4. Agile in Greece

According to the 14th State of Agile Development report on the implementation of agile methods by IT and software development companies, 95% of the survey participants said that the organizations in which they work implement agile methods (digital.ai, 2020). In recent years, following the global trend, organizations in Greece are adopting agile methodologies for software development. From big multinational organizations like Vodafone, Nokia, OpenBet, Accenture to Greek successful companies like Alpha Bank, Kaizen Gaming, Beat, Viva Wallet, Intracom, Intrasoft, Agile Actors, Advantage FSE, efood and many more, Agile has become the standard for software development.

A job search in LinkedIn, the largest professional network in the world, with the terms "agile" and "Greece", returns more than 1300 results. More specifically, in March 2022 there were 1380 results for job descriptions containing the term "agile" in Greece, while narrowing down the search to more specific agile job titles, 34 positions for Scrum Master and 75 for Product Owner were found.

3. Working Models for Agile Software Development teams

When the Agile Manifesto was created, the only option for software development teams was to be located at the same building and the same office space, in a traditional 9-to-5 work schedule. The rise of the collaboration software and the need for talent beyond the geographical boundaries of an organization, altered the working models and the flexibility to work remotely has been offered by many companies. Although many organizations were reluctant to provide non-office working possibilities, the pandemic of COVID-19 changed their perspective and it appears that flexible working options will be the new normality for software development organizations.

3.1. Co-location

Co-location for the ASD team, means that all team members co-exist at the same office space and work closely with each other and stakeholders during the day.

As it was mentioned earlier, co-location was one of the most important aspects of Agile, since one of the twelve principles of the Agile Manifesto stated that face-to-face communication is the most efficient way to convey information from and to the development team. Indeed, the co-location of the team members was one of the most important factors for agile's growth since it promotes and facilitates the exchange of information and maximizes communication.

Scrum's creator Ken Schwaber stated that "the best communication is face to face, with communications occurring through facial expression, body language, intonation and words. When a white board is thrown in and the teams work out design as a group, the communication bandwidth absolutely sizzles." (Schwaber, 2007).

Co-location has been the golden standard over the last decades, especially for Scrum, but this reference was removed from the latest Scrum Guide (Sutherland & Schwabber, 2020), since the technological evolution of collaboration tools over the last years has improved, providing a large variety of software that can replace some of the aspects of face-to-face communication (Scrum inc., 2021).

3.2. Remote working

As defined by the European Framework Agreement on Telework (2002) telework or remote work is "*a form of organising and/or performing work, using information technology, in the context of an employment contract/relationship, where work, which could also be performed*

at the employer's premises, is carried out away from those premises on a regular basis" (Grzegorczyk et al., 2021).

Remote work became the new normal during the pandemic. It's not a new phenomenon but was never applied on this scale before (Grzegorczyk et al., 2021). Remote working has benefits for both employers and employees, since it provides autonomy, supporting work-life balance, productivity and time spent for transportation. For employers, it offers cost-saving opportunities and talent attraction without being limited from the place of residence of potential employees.

On the negative side of teleworking, remote workers have reported longer working hours and higher workload. According to Eurofound, the European Agency for the improvement of living and working conditions, workers who make use of remote working occasionally, are the ones benefited more, since it results in better working conditions, work-life balance, and well-being in general (Grzegorczyk et al., 2021).

While working remotely is an option usually perceived as a benefit from the employer to the employee, working at a distributed team means that co-workers that can be located in different geographic locations. Working from an office or co-working space is not a prerequisite for a distributed team, but sometimes it is an option. Distributed teams are often called Virtual or Dispersed teams (Wikipedia, 2019).

3.3. Hybrid working

The hybrid working model combines the advantages of both co-located and remote working models. Hybrid, or Flexible is a blended model that supports both working from office and working from home. In this model, employees that are classified as WFH (work from home) can perform most of their work remotely, with occasional visits to the office if required, while those classified as WFO (work from office) will operate from the office, but will have the option to work remotely. It is on the organization to define the rules, based on its needs, workforce structure and cultural aspects. According to Microsoft's Work Trend Index, flexibility and hybrid work will define the post-pandemic workplace (Microsoft, 2021).

This model provides benefits both for the employees and the employers. A research conducted in the US and published by PwC states that remote work has been a success so far, the role of the office will change and there is still a debate on the number of days that will be agreed for working remotely and working from home per week (PwC, 2021).

4. COVID-19

As described by the World Health Organization, COVID-19 is an infectious disease, caused by the SARS-CoV-2 virus. The disease was declared a pandemic, and as of February 2022, was responsible for the death of almost 6 millions of people worldwide. Apart from the serious implications on the global health, the pandemic caused various effects on the global economy and financial markets (Jackson et al., 2021).

In December 2019, the first human cases of COVID-19 were identified in Wuhan, China. On January 2020, the World Health Organization declared the COVID-19 outbreak a Public Health Emergency of International Concern, while on 11 March 2020 the outbreak was declared a Pandemic (Wikipedia, 2021).

At this point, the majority of countries around the world were put under lockdowns, in order to prevent the spread of the virus. The lockdowns included a many societal restrictions such as staying at home, curfews, quarantines and more (Wikipedia, 2021).

In Greece, the first recorded case was at 26th of February 2020, while the first death was recorded at 12th of March 2020. The first set of measures against COVID-19 started at 28th of February 2020 while the first national strict lockdown was declared at 23th of March 2020. Over the next months, measures were applied, depending on the time of the year (lighter on summer, harder on autumn and winter) while on 18th May 2021 the hardest part of the lockdown ended (Wikipedia, 2021).

During this period, many companies, public sector, schools, and universities switched to remote, where it was possible, and teleconference and collaboration software was used to replace human interaction.

5. Research Methodology

In order to identify the impact of the enforced remote working to ASD team during the lockdowns, an online survey was created in order to collect the necessary data. The survey was built upon a questionnaire, consisted of four sections with closed ended questions with rating scales, so as to collect quantitative data, and one section with open ended questions used to collect qualitative data.

Initially, a pilot run with was conducted that was used to finalize the questionnaire, followed by a large-scale survey. The survey was distributed to software development professionals that work with ASD methodologies.

5.1. Research Question

The main purpose of the research, was to assess the impact of remote working, imposed out of necessity due to the COVID-19 pandemic, on teams working using ASD methodologies in companies based in Greece.

5.2. Questionnaire Design

A draft questionnaire was created and was later reviewed by three professionals with vast experience in Agile Methodologies. Then, a pilot run was executed by these professionals and based on their comments and feedback, the questionnaire was finalized.

The final format of the questionnaire included the following sections:

1. Demographics and professional information
2. Experience with remote work
3. Organization's experience with ASD and the impact of COVID-19 constraints
4. Software and tools used by the organization
5. Comments and suggestions

Section 1 focuses on the respondents' personal and professional information while Section 2 the respondents' and their organizations' experience with remote work and their plans and preferences for the future. Section 4 was created to gather information for the communication tools and software used by the ASD teams, since digital communication and collaboration tools are vital to create an online workspace to support remote working. Section 5 consists of two open-ended questions, where the respondents could share their comments on their experience during the pandemic and make their proposals accordingly.

Section 3 is the most important part of the survey. It consists of four sub-sections:

1. What is the experience of the respondents and their organizations with agile methodologies (framework, years of practicing agile)?
2. How were the main Agile Ceremonies impacted by the restrictions applied?
3. How was the application of the Agile Principles impacted by the restrictions applied?
4. How was teamwork quality and performance impacted by the restrictions applied?

For the sub-sections 3 and 4, 5-point Likert scale closed ended questions were used to assess the respondents' view on the topics, while sub-section 2 had another option, "No Answer" since some of the ceremonies may not apply to all Agile Frameworks.

Regarding sub-section 3, which is the most essential part of the research, a set of 13 questions was created. Each question represents one principle, except from principle 1, where the same two questions for principles 3 and 7 are used and principles 5 and 6 where two questions were created for each, due to their more direct relevance to the subject under study. All questions were created based on the literature sources referenced on the table below. Laanti et al. (2013) analysis of agile principles was used to validate the questions, making sure that they comply with the corresponding points of emphasis.

Principle	Question	Reference
Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.	Our customers were satisfied with the software delivered by my team	Croix, 2018 Abrahamsson et al 2003
	My team delivered software in a specific delivery period (2 or 4 weeks)	Sutherland, 2015 Croix, 2018
Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.	My team successfully reacted to customer needs and changing requirements during the development process	Klünder et al., 2018
Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.	My team delivered software within a certain delivery iteration (2 or 4 weeks)	Sutherland, 2015 Croix, 2018
Business people and developers must work together daily throughout the project.	There was frequent alignment and everyday communication between my team and business stakeholders	Croix, 2018

Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.	My team maintained a high level of common focus, mutual respect and trust	Hoda et al., 2010 Croix, 2018
	My team had the support required to get the work done	
The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.	There was frequent and direct communication within the team	Lindsjørn et al., 2016 Croix, 2018 Doherty-Sneddon et al., 1997
	Remote video-conversations delivered the same benefits as face-to-face conversations	Sutherland & Schwaber 2017
Working software is the primary measure of progress.	Our customers were satisfied with the software my team delivered	Croix, 2018 Abrahamsson et al., 2003
Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.	My team had set a rhythm of work that helped us maintain work-life balance	Grant & Russel, 2020
Continuous attention to technical excellence and good design enhances agility.	My team delivered software with future-proof design and high-quality code	Alami & Paasivaara, 2021
Simplicity–the art of maximizing the amount of work not done–is essential.	My team worked only on the most important and necessary tasks	Dockery & Knudsen, 2018
The best architectures, requirements, and designs emerge from self-organizing teams.	My team achieved high performance by managing workload and distribution of work	Hoda et al., 2010 Croix, 2018
At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.	My team constantly identified areas of improvement and took actions to improve	Andriyani et al., 2017

Table 4: Agile Principles Questions Mapping

To investigate the teamwork quality during the lockdown, we used the approach described in Lindsjørn et al., (2016) research on teamwork quality in agile development teams, which was based on Hoegl & Gemuenden (2001) research on traditional software development teams. We didn't use the total of their research material, but only some questions that could match

several aspects of everyday work in the team, in the context of the enforced remote working. Therefore, we used two questions for mutual support, one for communication, one for balance of member contribution and two questions to explore the impact team performance and team member's success, in terms of work satisfaction and learning.

Teamwork Quality	
Sub-category	**Question**
Mutual support	Team members did their best in helping and supporting each other.
	Team member suggestions and contributions were respected
Communication	Team members were happy with the information flow coming from other team members
Balance of member contribution	Team members contributed to the achievement of the team's goals in accordance with their specific potential
Team performance and team members' success	
Sub-category	**Question**
Work satisfaction	I am satisfied with my contribution to the collaborative teamwork
Learning	I feel that teamwork in the remote agile working model has promoted me professionally

Table 5: Teamwork Quality and Performance mapping

5.3. Sampling

The sample used for this research was from the population of software development professionals working for companies located in Greece. The sampling strategy followed the non-probability method, using convenience and voluntary response sampling.

- Convenience: The survey was distributed through personal contacts with colleagues, former or current, or professional contacts that the researcher knew they are working in organizations that apply Agile methodologies. Most of the responses were collected through this channel, ensuring the respondent's experience on the subject. 46 responses were collected this way.

- Voluntary response sampling: through the professional social network LinkedIn. Via a personal post by the researcher, addressed to his network of contacts. 18 responses were collected with this approach.

The survey was conducted between September and November 2021, was anonymous and a total of 64 responses were collected. The tool used to create and distribute the questionnaire was an installation of Lime Survey on the Hellenic Mediterranean University (https://www.limesurvey.org).

6. Results

The analysis of the results of the 64 responses collected through the survey are presented below. For the creation of the graphs that accompany each result category, the free edition of visme software was used (visme.co).

6.1. Demographics and Professional Information

6.1.1. Sample Demographics

- *Gender*

Of the total respondents, 70% were men, 28% were women, and there was one response that did not wish to disclose their gender.

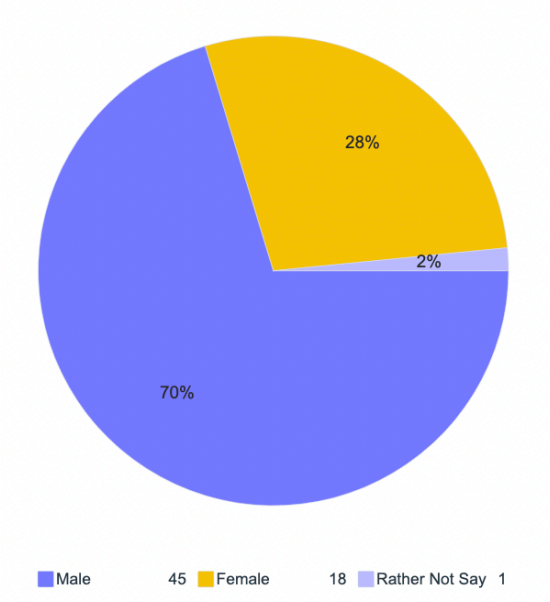

Figure 5: Gender

- *Age*

Regarding the age of respondents, the responses are quite balanced in three age groups (under 30, between 31 and 35, between 36 and 40). Seven of the respondents belong to the 41 to 45 group and only two of them were older than 45 years.

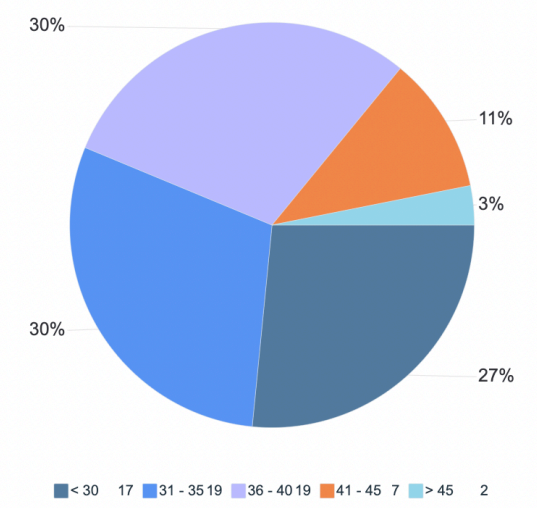

Figure 6: Age

6.1.2. Professional Information

- *Role*

Most of the respondents, with 38% are Software Engineers/Developers followed by Software Engineers in Test/QA Engineers with 23%. Next are Agile Delivery Leads/Scrum Masters with 14%, while in managerial positions (Head of function/Manager, Chapter Lead) an 8%. Project Managers and Product Owners with the same percentage (5%), while in smaller percentages we find DevOps, Process and Support Engineers.

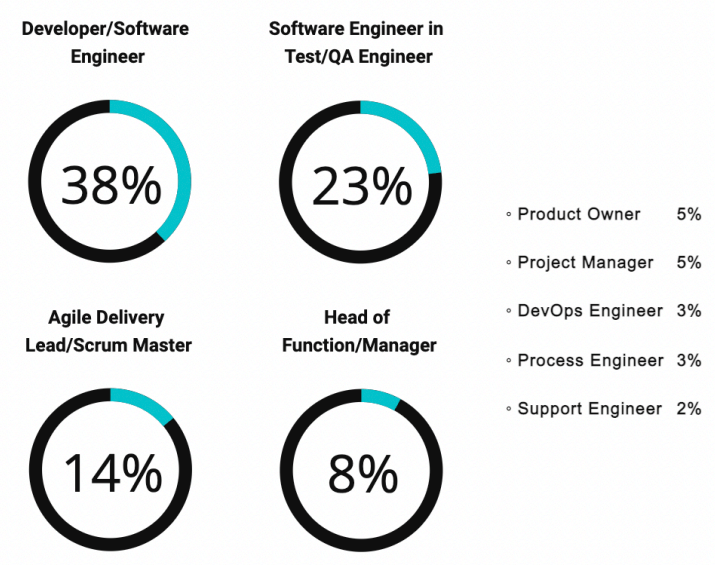

Figure 7: Role

- *Years of experience*

A large percentage of respondents (42%) have more than 10 years of professional experience, while less than 3 years was reported by 8% of the participants. A percentage of 28% have been working between 3 and 7 years, while 22% have been working between 7 and 10 years.

The largest percentage of the respondents (59%) have been working for their current employer for less than 3 years, while the next largest group (27%) have been working for their current employer for between 3 and 7 years. Six of the respondents (9%) had been working for their current employer for between 7 and 10 years, while 5% for more than 10 years.

Regarding experience in the role, 33% have been working for less than three years, while 36% have been working between 3 and 7 years. 17% have worked in the role for between 7 and 10 years, while 14% have been in the role for more than 10 years.

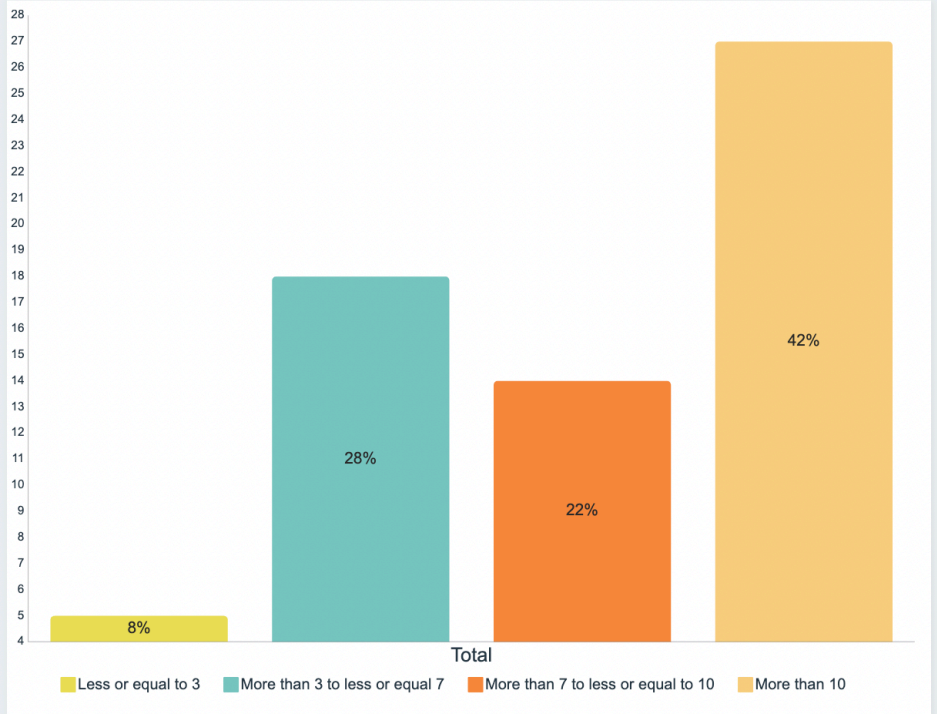

Figure 8: Years of experience in total

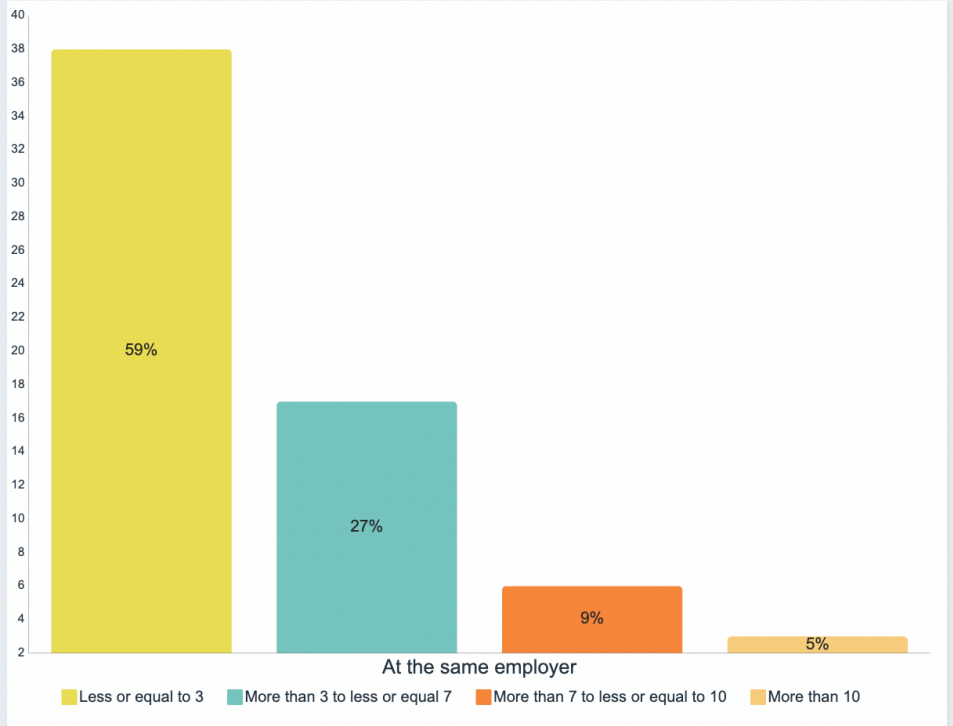

Figure 9: At the same employer

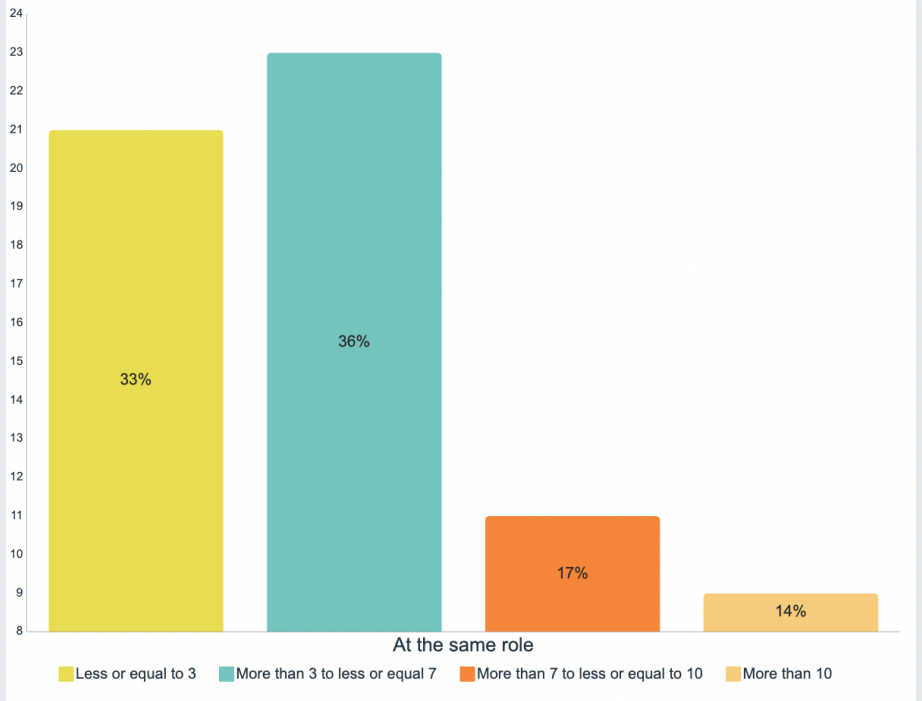

Figure 10: At the same role

6.1.3. Organizational Information

For the organizational information section, three questions were used, for the size, the domain, and the name of the company. For the first question, If the respondent works in a multinational company, then the question concerns the size of the Greek department of the organization. For this question, the relevant clarification was also given. The last question was optional, answered by 31 of the 64 respondents and the results will not be disclosed.

- *Organization size*

Most of the responses (75%) stated that they work in large companies, with size of more than 251 employees in the Greek market. 9% in companies with between 101 and 250 employees, 8% between 51-100 employees and 4.7% between 11-50 employees. Only 3% of the respondents answered that they work in companies with less than 10 employees.

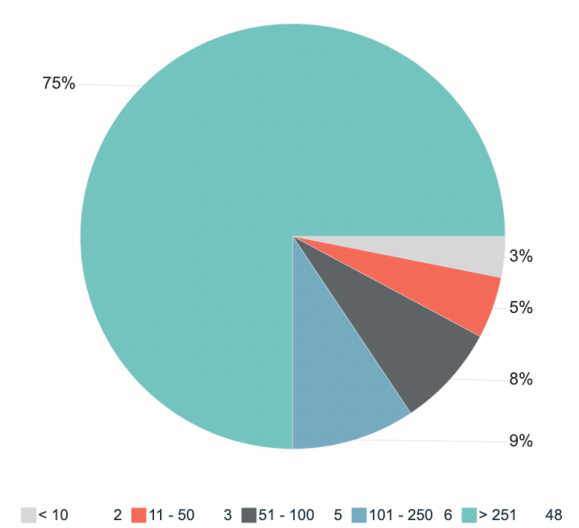

Figure 11: Size of the company

- *Organization's domain*

The next question was about the industry domain of the organization. The largest percentage (28%) was for companies operating in gaming and entertainment (software companies producing software for betting and gaming). The next highest percentage (25%) was for companies whose main activity is financial services and 16% for telecommunications. The following domains were also included in the answers, but in smaller percentages

- Software Consultants
- E-commerce
- Internet of Things
- Cloud Computing

- Semiconductor software
- Travel
- Music
- Public transportation

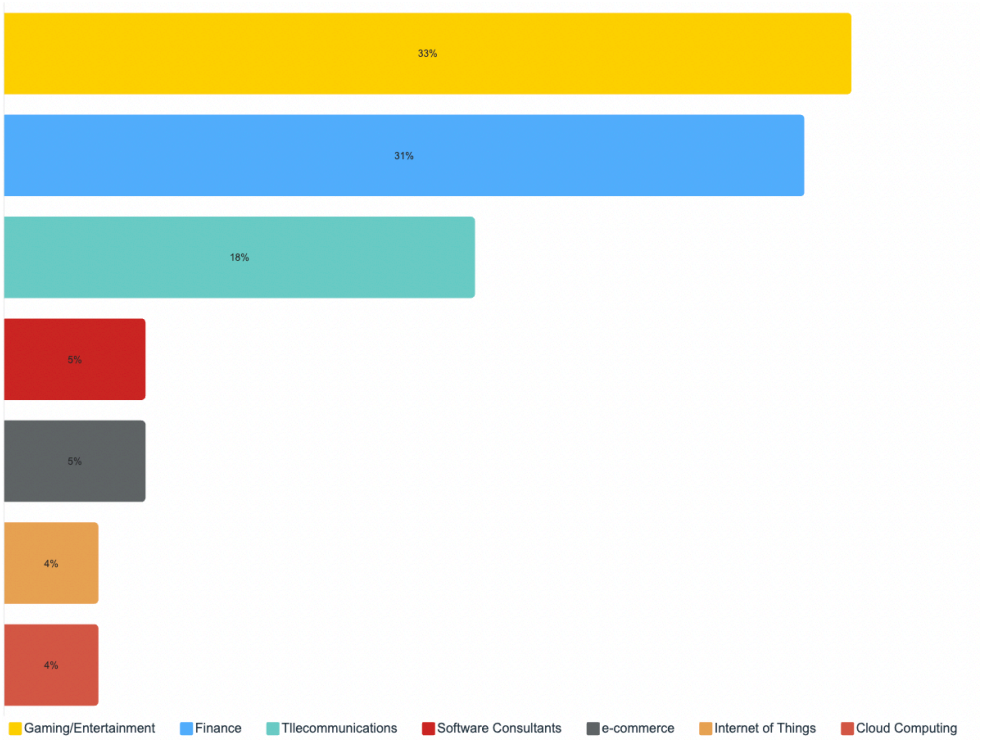

Figure 12: Organization's Domain

6.2. Remote working experience

The next category relates to both the employee's and the organization's experience with remote working.

6.2.1. Working Model

The first question in the category asked about the working model applied by the organization before COVID-19. 50% of the respondents answered that they worked exclusively from the office. 30% worked from the office, with the option of working from home some days a week. 9% indicated that they worked from the office as members of distributed team, while 3% worked remotely as member of distributed team. Finally, 8% responded that they worked only remotely.

The next question was about the working model the organization applied during the first lockdown period, between March 2020 and May 2021. 59% responded that they worked only

remotely, with 17% stating that they worked remotely as members of a distributed team. 14% continued to work exclusively from the office, while 8% worked from the office, with the option to work from home some days a week. Finally, there was one response for working from the office as a distributed team member.

Participants were then asked about the organization's working model after May 2021, when the anti-COVID-19 measures were loosened up. 33% responded continued to work exclusively remotely. 25% continued to work remotely as members of a distributed team. 30% worked only from office and 13% returned from the office, with the option of working from home some days a week.

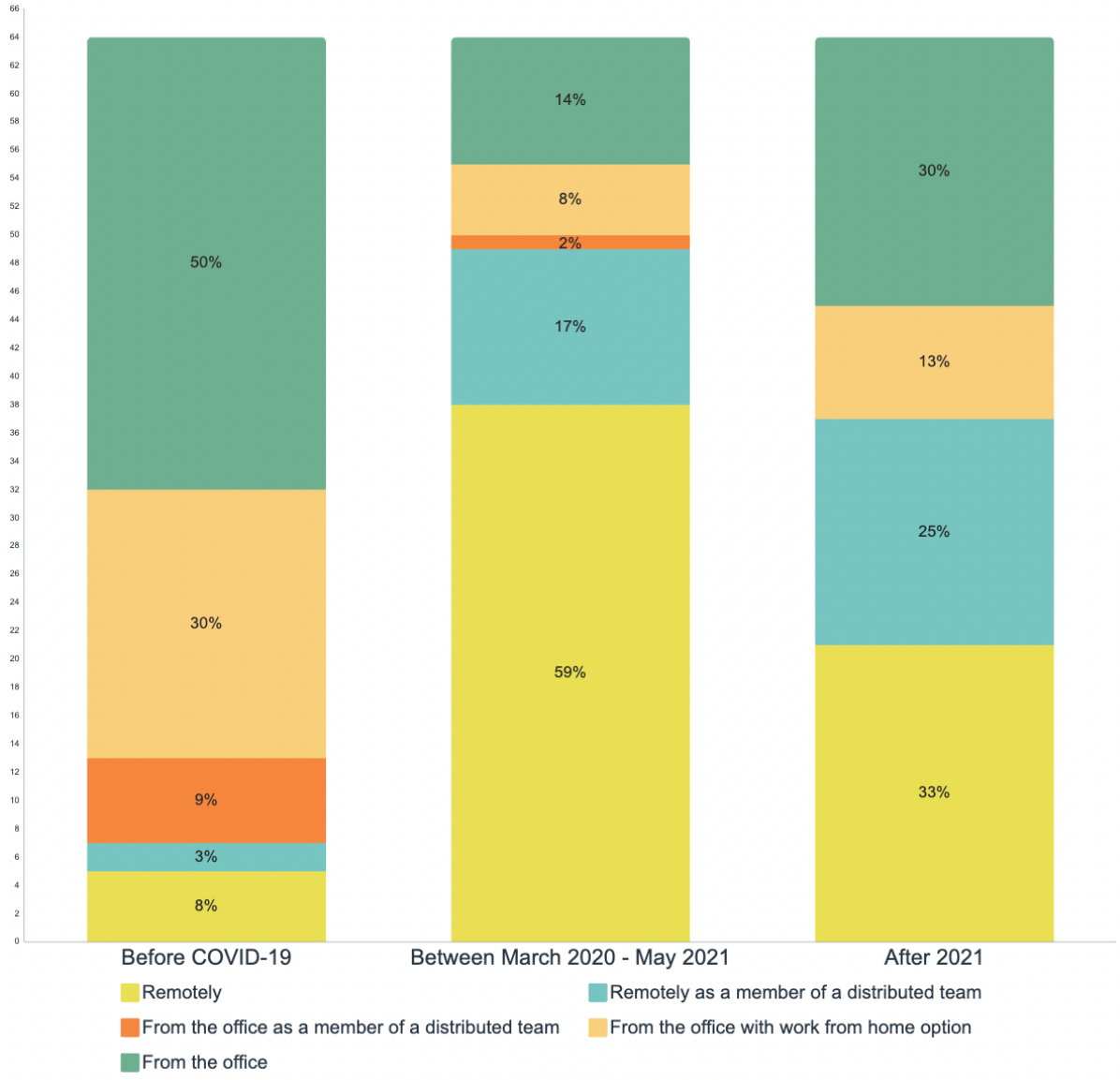

Figure 13: Working model

6.2.2. Plan of return to the post-COVID-19 era

Finally, participants were asked about their organization's plan in the post COVID-19 era and their respective preference.

In Figure 14, we can see that the return to a hybrid work model from both the office and home dominates in both responses with almost the same percentage (61% and 60% respectively).

Returning to the office on a permanent basis is the next option with 31% in the case of company, which in the case of employees is at 11%, in contrast to working remotely on a permanent basis which is at 30% in employees' preferences and only 5% in organization's plans.

Finally, only 3% of respondents said that the company has not yet decided on a plan to return to the post COVID-19 era.

Figure 14: After COVID-19 plan

6.3. Organization's experience with ASD and the impact of COVID-19 constraints

6.3.1. Agile Framework

This category investigates the relationship of the organization and the respondent with the agile methodologies used by the company in question. As we can see in the chart below, 50% of the respondents answered that the most popular framework is Scrum followed by Kanban with 20%. Hybrid models, combining more than one framework answered that 11% of respondents use it, while Scaling Agile models were used by 5%. Finally, a percentage of 6% answered that they do not know the framework the organization uses. 8% responded with the option "other", but without specifying further.

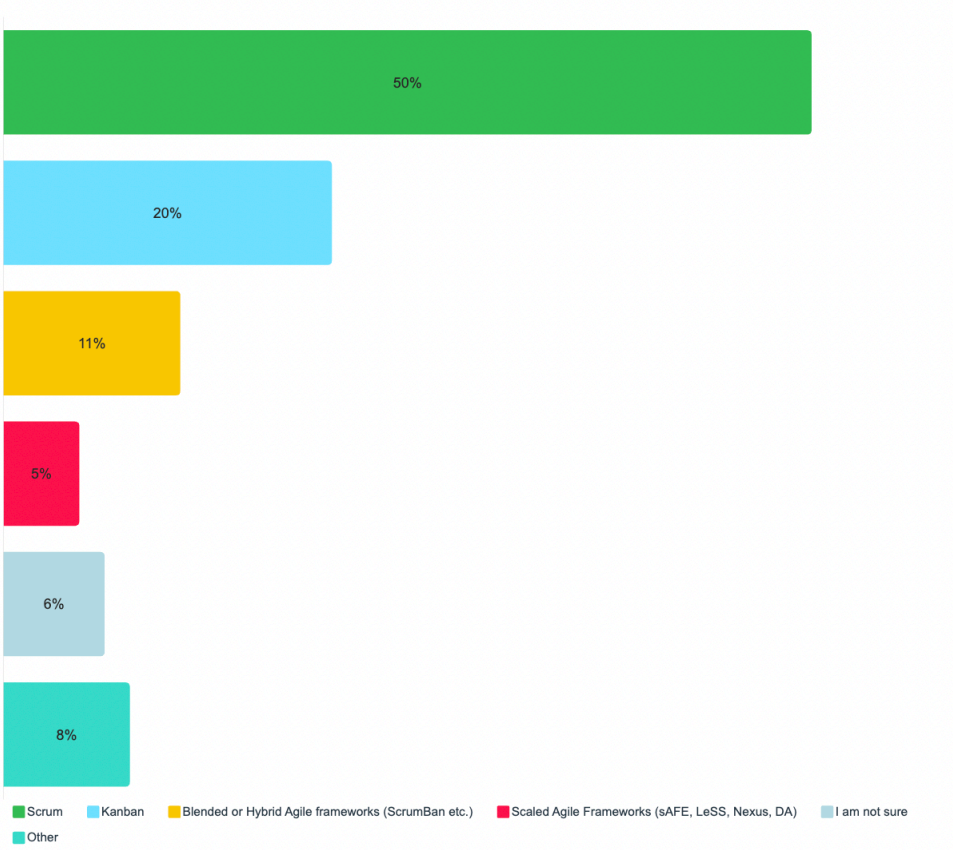

Figure 15: Agile framework

6.3.2. Years practicing agile

The next question asked about the years in which the organization has been implementing ASD practices. The largest percentage (31%) responded that they did not know, while the largest percentage of respondents who knew (27%) responded that the organization has been implementing such practices between 5 and 10 years. The 19% responded between 3 and 5

years, while the 13% responded between 1 and 3 years. More than 10 years answered 6% while 5% answered less than one year.

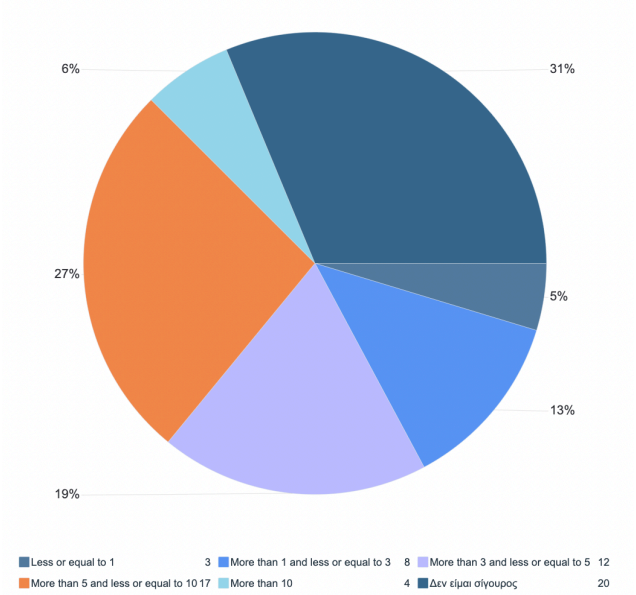

Figure 16: Years practicing agile

6.3.3. Impact on Agile Ceremonies

This section included questions on how much respondents felt that the main events that take place in ASD process were affected during the period when the hard restrictions due to COVID-19 are implemented (between March 2020 and May 2021). A question was also asked about the impact in terms of the time duration of these ceremonies.

In this section, respondents were also given the option of "no answer" if any of these ceremonies are not practiced by the organization they work for. It was also clarified that if the respondent holds a management position or works by role with more than one team, to answer based on experience with one of these teams. The following graphs, represent a) the answer of all respondents, including the “no answer” option and b) the answers of the respondents excluding the “no answer” option. The analysis of the results refers to the second graph where a normalization for the excluded questions took place.

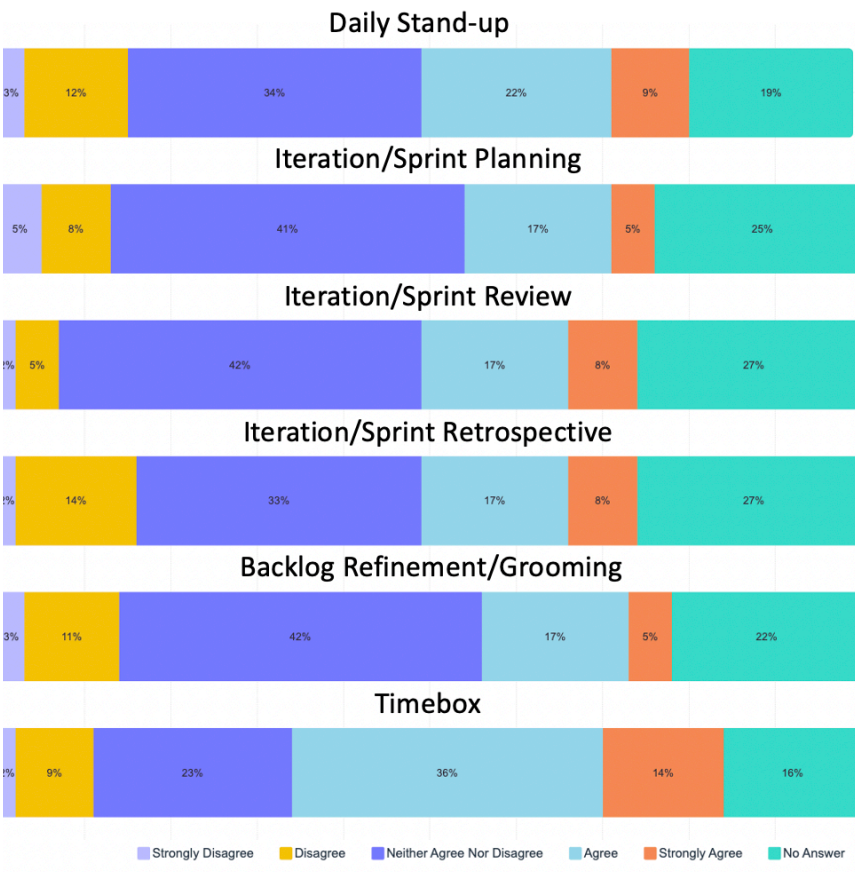

Figure 17: Impact on agile ceremonies (N/A included)

Figure 18: Impact on agile ceremonies (N/A excluded)

- As can be observed in the chart above, regarding the daily standup, a 19% of the respondents that answered this question, had a worse experience compared to the pre-COVID-19 period. 39% has a better experience, while the 42% did not notice any change compared to their previous experience.

- The 29% of the respondents that answered this question, stated that their experience with Iteration/Sprint planning was better than before, with 16% stating the opposite. 54% did not notice any change.

- 57% of the respondents that answered this question, had the same experience as before with Iteration/Sprint review. 34% had a better experience, while 8% had worse.

- The experience of the 28% of the respondents that answered this question with Backlog Refinement/Grooming was better than before, while 54% stated that there was no change on how they perceived this ceremony. 18% had a worse experience than before.

- Regarding the impact of the restrictions on the timebox of the ceremonies, 13% of the respondents that answered this question stated that their experience was worse, while 60% stated that theirs was better. 28% didn't observe any changes in the timebox of the ceremonies.

6.3.4. Impact on Agile Principles

This is the most important section of the research, as it focuses on the impact of the constraints on the principles of agile methodologies, as presented in the Manifesto for Agile Software Development, which, as mentioned in Chapter 1, is the cornerstone of agile methodologies.

In Figure 19, the answers of the respondents are presented in aggregate.

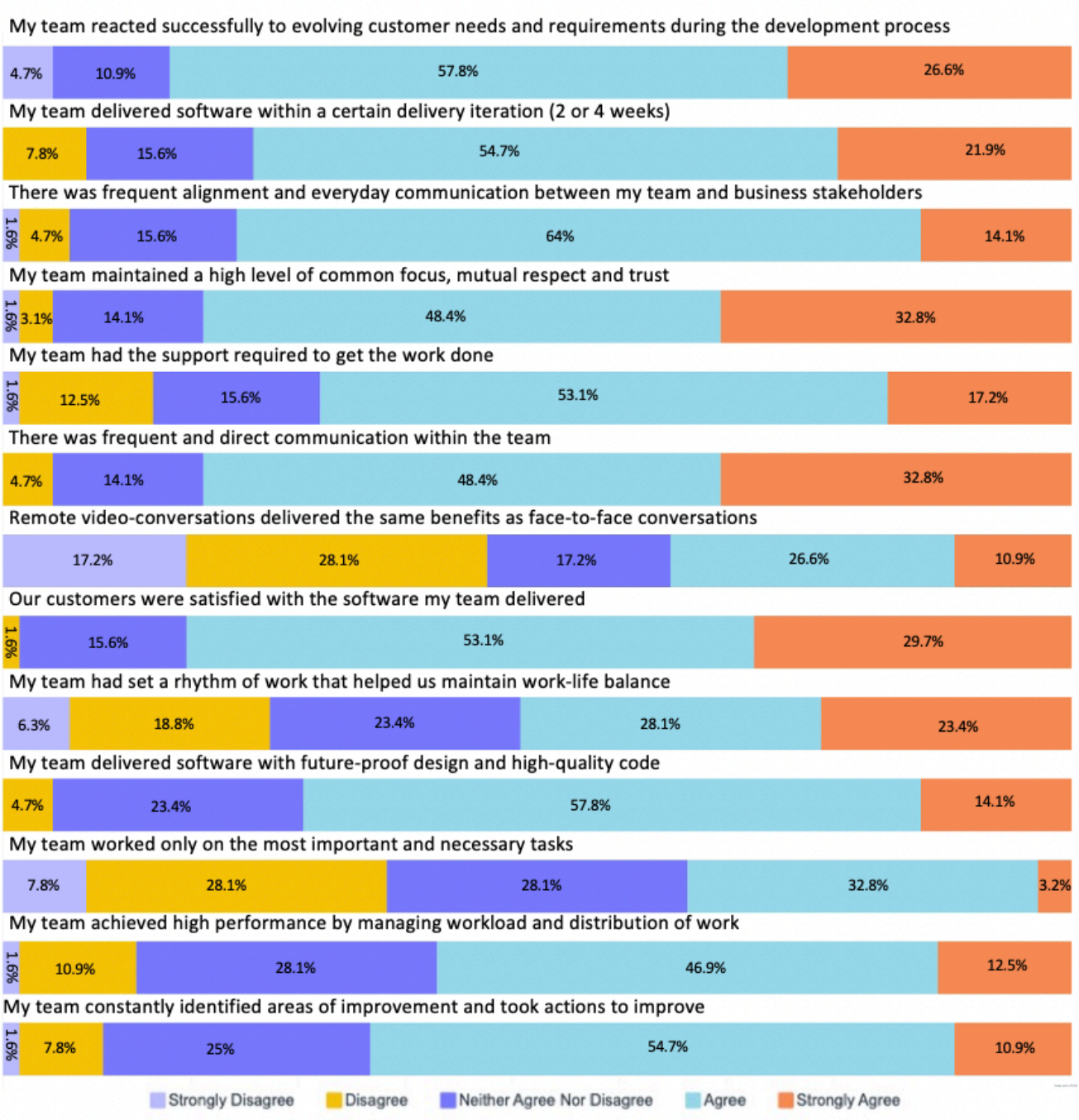

Figure 19: Impact on agile principles

- The vast majority (84.4%) answered positively to this question, with almost 11 % indicating neutral. Less than 5% responded strongly disagreed with this question, while no 'Disagree' response was recorded.

- More than 76% of the responses agreed that their software delivery cycle was between 2 and 4 weeks. Only 7.8% responded that the deliver software in a different frequency, while 15.6% was neutral.

- A 78,2% of the answers agreed that the frequency and communication with stakeholders was not affected, while almost 6% answer it was. 15,6% was neutral to this statement

- Most of the respondents (81,2%) agreed that the levels of common focus, mutual respect and trust were high. Only 4,7% disagreed with this statement, while 14,1% remained neutral.

- While there is a high percentage (more than 73%) that agree that the team had the necessary support to complete its tasks, there is also a 14,1% that disagrees, while 15,6% stated they neither agree nor disagree with this statement

- A high percentage of the respondents (81,2%) stated that the communication was frequent and direct, while a 14,1% stated they were neutral. Only a 4,7% disagreed with this statement

- 45,3% disagreed to this statement, while the 37,5% of the respondents had a similar experience with the face-to-face conversations. 17,2% was neutral.

- The majority of the respondents (82,8%) believe that the software delivered by their teams satisfied their customers. 15,6% stated that they are neutral to this statement, while only 1,6% was negative

- More than half of the respondents (51,5%) of the respondents agreed to this statement, and 25,1% disagreed. The rest 23,4% was neutral

- Almost 72% of the respondents answered that their team’s code was of high quality and futureproof design. A 4,7% disagreed while 23,4% were neutral.

- Almost 36% of the respondents stated that they disagree with this statement, while 32,8% agreed. 28,1% was neutral, while there were no “Strongly Agree” answers

- 59,4% of the respondents agreed that their teams achieved high performance by distributing work and managing the workload among the team members, while 12,5% disagreed. 28,1% was neutral.

- 65,6% of the respondents agreed that their team was improving constantly by identifying areas of improvement and taking actions to improve. 9,4% disagreed with this statement while 25% was neutral

6.3.5. Impact on teamwork quality and performance

Teamwork is one of the most important aspects of agile methodologies. This section explores in more depth the impact of the COVID-19 restrictions on the teamwork quality and performance of ASD teams.

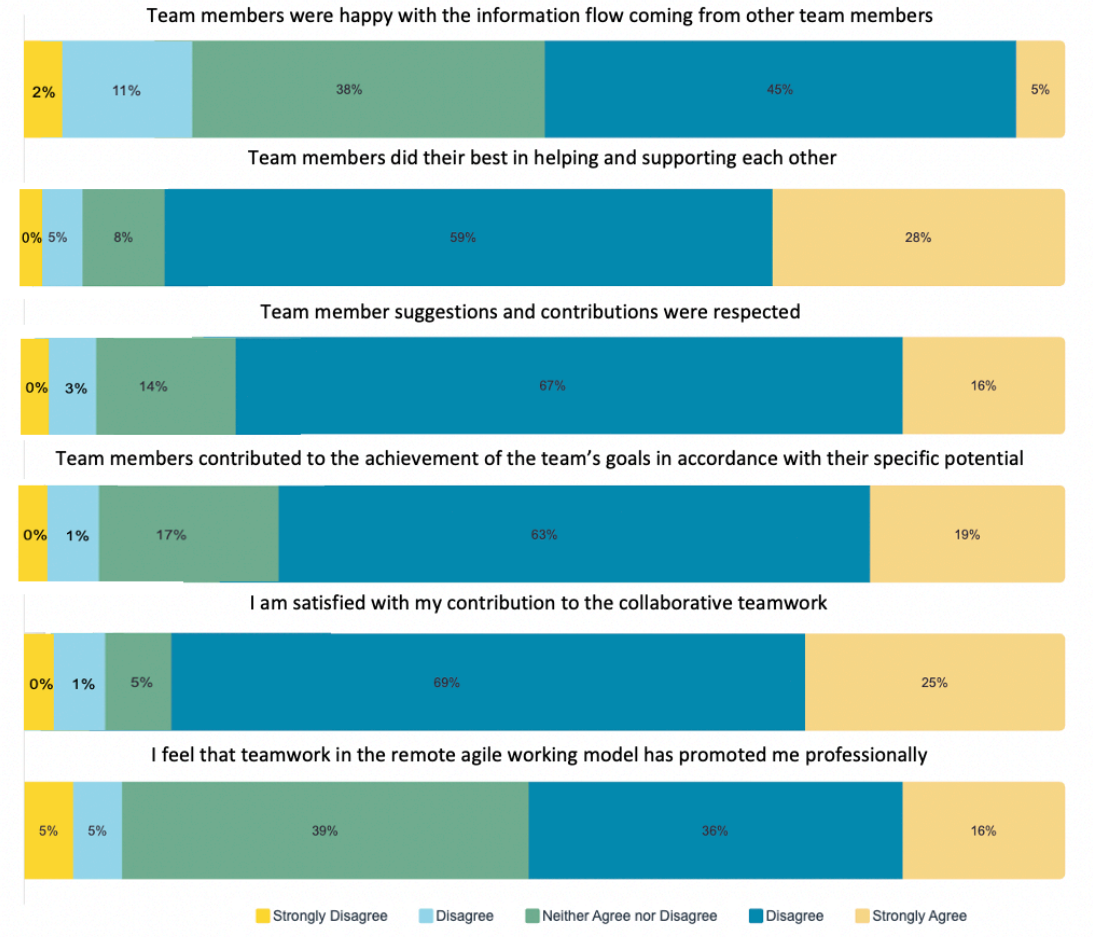

Figure 20: Impact on teamwork quality

- Half of the respondents (50%) stated that they were happy with the exchange of information coming from other team members, while 13% disagreed and 38% were neutral to this statement.

- Most of the respondents, with a percentage of 87% agreed that the team members did their best to help and support each other. Only 5% disagreed with this statement and 8% stated they are neutral.

- According to the 83% of the respondents, the team member suggestions and contribution were respected, while only 3% disagreed and 14% were neutral.

- 82% of the respondents agreed that the team members contributed to achieve the team's goals according to their potential, while 17% stated neutral to this statement and only 1% disagreed.

- The vast majority of the respondents (94%) agreed that they were satisfied with their contribution to the collaborative effort while 1% disagreed and 5% were neutral.

- 52% agreed that their involvement with the team in a remote working model has helped them evolve professionally while 10% disagreed. 39% were neutral to this statement.

6.4. Software and tools used by the organization

For team collaboration and Agile Project Management activities, Atlassian Jira is by far the most popular collaboration tool, used by the 83% of the respondents, with next being Azure DevOps with 25% and Atlassian Trello with 3%.

MS Teams is the most common online communication tool, since 66% use it, followed by Slack with 52%, Google Meet (31%) and Zoom (14%). For documentation creation and sharing, Atlassian Confluence is used by the 52% of the respondents, followed by MS Office (34%) and Google Docs (30%).

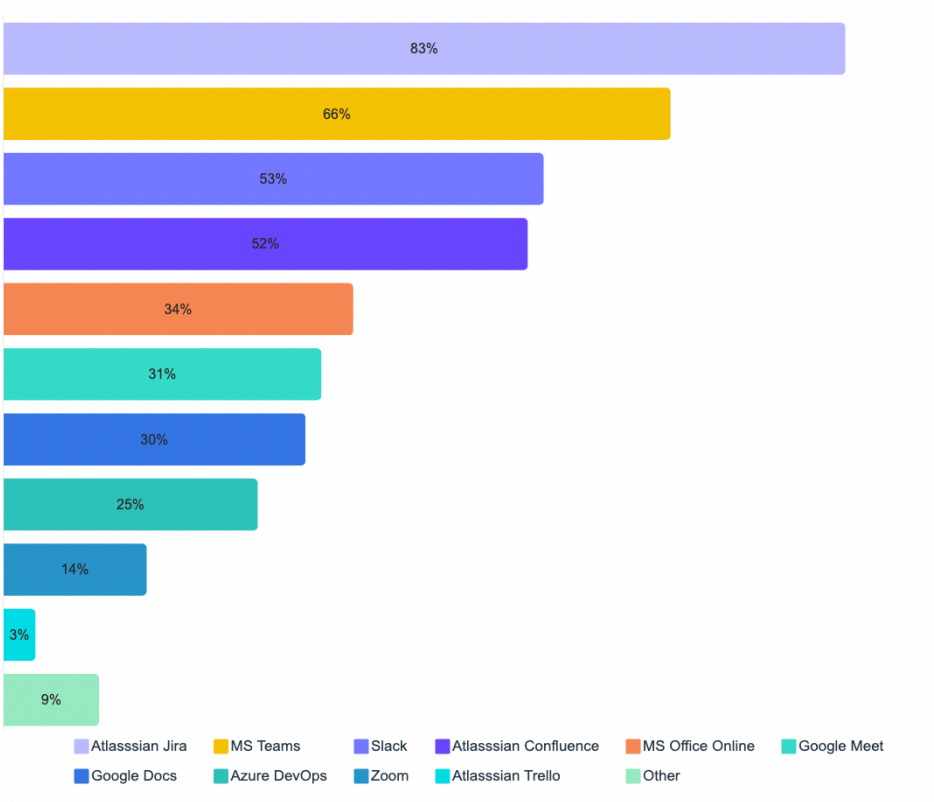

Figure 21: Communication and collaboration software

6.5. Comments and suggestions

A total of 18 responses were collected, capturing the respondents view on the subject under study. Based on their relevance, these responses have been grouped in three categories:

- Remote working
- Wellbeing and work-life balance
- Suggestions

6.5.1. Remote working & COVID-19 restrictions

From the answers collected, six of them demonstrated a positive outcome from the remote working experience during the restrictions of COVID-19.

1. *Most of IT industry proved that they can do their work from anywhere.*
2. *The organization now understands that the same level of commitment, quality and effectiveness can be achieved when working remotely.*

3. *I believe that COVID-19 and the need to work remotely led the organisations to better organise and communicate updates.*
4. *Leadership has communicated to the team's statistics that show that performance has gone up during the restricted period where all employees had to work from home*
5. *Forced us to become more flexible in order to cope with the requirements. Helped us evolve our way of thinking outside the boundaries we had and create new processes to adjust to the new reality.*
6. *Working remotely has been in the culture of my company since day one, so it was not affected by this change.*

Four answers demonstrated a rather negative outcome, focusing more on the benefits of face-to-face communication with colleagues, which no longer exists because of remote working.

1. *Even if cooperation/information sharing among team members is great, remote working isolates teams from each other. There is no chance to get other useful information about e.g. new practices that other teams may be following, or "come across" business news/ information that would witness with physical presence. Remote working kind of narrows down the potential for personal development or team evolution.*
2. *The virtual meetings can entail several technical issues which can impede the flow of the meeting. Also, face-to-face meetings have different impact. Personally, I am more motivated when I am physically surrounded by individuals. The experience did exist when working from home but it was much more distanced. However, the distance was oftentimes helpful in concentrating compared to working from the office, which helped in delivering much faster. Under normal circumstances, I work from an open office and sometimes the information I receive from my environment can be distracting, if not overwhelming. Generally speaking, I believe that the team members and their group dynamics are significant to the overall quality of the produced work, which was not always helped when working from home. As a team member, I appreciate working closely with my colleagues.*
3. *Working remotely provided a great opportunity for increased focus and "getting work done", but on a psychological aspect the return to office was considerably better, as well as for the overall quality of life that it provides (face to face interactions, brainstorming, office activities, socialization). The organization I work in responded*

very efficiently to COVID, having already been a very digital environment, working continuously with Teams etc.

4. *Missed team bonding sessions, personal communication, funny moments, etc.*

6.5.2. Wellbeing and work-life balance

From the answers collected, six of them highlighted the negative effects of remote working during the pandemic on the work-life balance aspects of work.

1. *Working hours has not been well understood during lock-downs. It is important to define strict working hours when working remotely.*
2. *Covid make the teams work more and overtime. The team members lost their work life balance, but on the other side I saw the team members work together more and support each other.*
3. *Overtimes increased significantly during remote working.*
4. *It was an interesting experience, but I strongly believe that working from the office is far more beneficial on the quality of life and work.*
5. *The balance power in many teams has changed as working relationships and bonding activities between teams were not available. Some teams need a more-frequent communication to maintain relationships, to have more morale so as to keep employees connected and engaged. People need much more emotional support from workplace relationships, as it seems that the pandemic has disrupted work-life balance.*
6. *Remote working during lockdown felt like prison while remote working during normality is much more enjoyable and productive.*

6.5.3. Suggestions

1. *Regarding the survey, it would have been interesting to see on how big are the teams that your participants work with and how interdependent are the members of said team. Maybe work from home is more efficient for some teams, based on their characteristics and the way they work.*
2. *Organizations should take into consideration sharing additional payments covering raise in a/c or heat to employees if wish to maintain either remote or hybrid model.*

6.6. Reliability analysis

To assess the internal consistency of the data collected, Cronbach Alpha analysis was used. The software used was SPSS by IBM (version 28.0.1.0 (142) trial version). The analysis was applied for the three basic categories of the study that used Likert scale, with ranges from 1 to 5 (Strongly Disagree to Strongly Agree). The results show that the data collected are reliable, since the overall results and each section's analysis show a Cronbach's Alpha higher than 0.7, which is considered acceptable. The analysis is presented below.

6.6.1. Overall reliability analysis

Reliability Statistics

Cronbach's Alpha	N of Items
.910	27

Figure 22: Cronbach's Alpha - Overall Reliability Statistics

According to the above analysis, our dataset is reliable, since the Alpha value is 0.910 in the total of 27 items included.

6.6.2. Individual reliability analysis - Agile ceremonies

Reliability Statistics

Cronbach's alpha	Cronbach's Alpha Based on Standardized Items	N of items
.953	.954	8

Figure 23: Cronbach's Alpha - Agile Ceremonies

For the first section, regarding the agile methodology ceremonies, our data set can be considered reliable, since the Alpha value is 0.953 on a total of 8 items. None of the questions give us a large increase in the coefficient, so there would be no need to remove any of these questions.

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
The time box of the ceremonies was respected	16.66	99.689	.688	.503	.956
The Daily Stand-up was better than before	17.05	95.950	.835	.731	.947
The Iteration/Sprint Planning was better than before	17.36	94.615	.878	.832	.944
The Iteration/Sprint Review was better than before	17.25	93.397	.874	.906	.944
The Iteration/Sprint Retrospective was better than before	17.34	92.642	.905	.917	.942
The Backlog Refinement/Grooming was better than before	17.27	96.420	.854	.834	.946
The Program Increment/Release Planning Meeting was better than before	17.38	95.698	.839	.818	.946
The Scrum of Scrums Meeting was better than before	17.63	96.270	.744	.568	.953

Figure 24: Cronbach's Alpha - Agile Ceremonies Total Statistics

6.6.3. Reliability Analysis - Principles of Agile Methodologies

For the next section, about the agile principles, the data set is considered reliable. The value of Alpha is 0.857 on a set of 13 items. Similarly, in this category, none of the questions gives us a large increase in the coefficient, so there would be no need to remove any question.

Reliability Statistics

Cronbach's alpha	Cronbach's Alpha Based on Standardized Items	N of items
.857	.872	13

Figure 25: Cronbach's Alpha - Agile Principles

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
My team reacted successfully to evolving customer needs and requirements during the development process	44.05	45.474	.617	.672	.841
My team delivered software within a certain delivery iteration (2 or 4 weeks)	44.16	45.880	.640	.551	.841
There was frequent alignment and everyday communication between my team and business stakeholders	44.22	49.221	.360	.447	.856
My team maintained a high level of common focus, mutual respect and trust	43.98	45.190	.678	.634	.838
My team had the support required to get the work done	44.34	44.229	.683	.597	.837
There was frequent and direct communication within the team	43.97	46.570	.591	.544	.844
Remote video-conversations delivered the same benefits as face-to-face conversations	45.20	44.641	.431	.377	.858
Our customers were satisfied with the software my team delivered	43.95	46.807	.659	.498	.842
My team had set a rhythm of work that helped us maintain work-life balance	44.63	43.698	.532	.427	.848
My team delivered software with future-proof design and high-quality code	44.25	47.429	.576	.475	.845
My team worked only on the most important and necessary tasks	45.11	52.639	.005	.208	.881
My team achieved high performance by managing workload and distribution of work	44.48	44.730	.679	.569	.837
My team constantly identified areas of improvement and took actions to improve	44.41	46.213	.600	.508	.843

Figure 26: Cronbach's Alpha - Agile Principles Total Statistics

6.6.4. Reliability Analysis – Teamwork Quality

For the last section regarding teamwork quality, the data set is considered reliable, but with the lowest value among the three categories. The alpha value is 0.778 on a set of 6 items. However, we notice that the value can be increased significantly if the last question *"I feel that teamwork in the remote agile working model has promoted me professionally"* is removed. In this case, the index increases to 0.815, so this question can be removed.

Reliability Statistics

Cronbach's alpha	Cronbach's Alpha Based on Standardized Items	N of items
.778	.803	6

Figure 27: Cronbach's Alpha – Teamwork Quality

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Team members were happy with the information flow coming from other team members	19.75	7.079	.408	.242	.776
Team members did their best in helping and supporting each other	19.05	6.395	.687	.606	.703
Team member suggestions and contributions were respected	19.20	6.768	.679	.603	.711
Team members contributed to the achievement of the team's goals in accordance with their specific potential	19.17	6.716	.694	.530	.708
I am satisfied with my contribution to the collaborative teamwork	18.98	7.508	.522	.346	.749
I feel that teamwork in the remote agile working model has promoted me professionally	19.63	6.873	.327	.177	.815

Figure 28:Cronbach's Alpha - Teamwork Quality Total Statistics

7. Discussion

This research investigates the impact of the enforced remote working in ASD teams located in Greece, that was applied because of the pandemic of COVID-19. For this purpose, an online survey was conducted, where 64 software development professionals working with agile practices answered a set of closed-ended questions, accompanied with a section of open-ended questions with the option to express their unique view on the subject.

Most of the participants work as members of a development team (Software Engineers/Developers or Software Engineers in Test/Quality Assurance Engineers) and are distributed almost equally among three age groups (under 30, 31 - 35, 36 - 40). The majority has more than ten years of professional experience but work less than three years to their current employer. The respective organizations employ more than 250 people with the most popular domains being Gaming/Entertainment, Financial Services and Telecommunications.

Regarding their organizations' experience with Agile Methodologies, most of the participants stated that they did not know this information, while for the respondents that were aware, the most popular answer was that their companies are practicing Agile for 5 to 10 years. Following the findings of the 15th State of Agile report (digital.ai, 2021), the most popular Agile Framework applied by the organizations in Greece is Scrum.

7.1. Agile Ceremonies

Enforced remote working didn't negatively impacted the scheduling, value, duration, and the overall experience of the software development professionals with the most important agile ceremonies, while they were operating under the restrictions enforced by the pandemic. The respondents' experience was at least the same as before, or sometimes even better. Our results are comparable with a systematic literature review that was conducted by Wohlin and Jalili (2011) and indicates that daily standup meetings, sprint planning, retrospective, and review meetings are among the agile practices that were successfully used by teams that were distributed in more than two geographical locations (Deshpande et al., 2016).

Having the right online tools in place, has been a crucial element in the transition to a remote working model. The adoption of collaboration and communication tools prior to the pandemic helped the teams keep the value of the Agile Ceremonies in a high level, since even co-located teams had already replaced whiteboards and task boards with software like Jira. On the contrary, the engagement of the participants and the level of distractions during the time of

the meetings should be investigated more, since there are cases where the effectiveness of the communication channel has been challenged (Cucolas & Russo, 2021).

7.2. Agile Principles

Delivering value to the customers remained the primary focus of ASD teams while the software delivery cycle stayed short, with iterations from 2 to 4 weeks. The support of potential changing requirements during the development process, to serve evolving customer needs was not impacted, while the communication and alignment of the team with the business stakeholders was frequent. Mutual respect, trust and focus has been identified in high levels, as was the communication among the team members. The teams had the support required to complete their tasks, providing software that satisfied their customers. An important role in the employees' experience was the readiness of the organization to support the transition to remote working and its responsiveness to this change.

Self-organization of the teams was not impacted, therefore they could plan their tasks properly, so that the workload is equally distributed to the team members based on their expertise. Thus, the teams achieved high performance which, as a result generated good architectures, requirements, and designs. Moreover, delivered software remained future-proof and with high quality. The teams identified areas of improvement, and took actions to improve, by carrying out retrospective meetings. Regarding working on the most important and necessary tasks, almost one out of three respondents stated that their experience was worse than before, meaning that their teams spent most of their time working on important tasks, but there was time wasted in less significant ones.

Work-life balance was one of the biggest challenges during the lockdown and remote working model. Although many respondents answered that their team helped them maintain work-life balance, there is a significant number of people that had issues with it. Several comments collected by the respondents confirm that there was an increase in working hours and therefore to a decrease in work-life balance.

In a remote working model, face-to-face communication is replaced with video calls and chats. Most of the respondents stated that, although there was frequent and direct communication between the team members, the benefits from the video calls and chats were not the same as from face-to-face communication. This change of communication channel is one of the biggest challenges of the enforced remote working. According to Cucolas & Russo (2021), it is difficult for individuals to maintain their focus in this context and there are more distractions when

some team members are talking while others are doing something else (chatting with other colleagues, trying to complete work etc).

Agile practitioners were forced to confront for the first time the fact that teams are obliged to work remotely and thus confront this fundamental principle (Mancl & Fraser., 2020). Teams perform much better when all their members are in the same place, since coexistence allows frequent interpersonal contact, helps build trust, simplifies problem solving, encourages direct communication and enhances rapid decision-making (Brosseau et al., 2019).

According to research by the Harvard Business Review, abruptly transitioning teams that were coexisting in the same space to a full telecommuting model may reduce cohesion and increase team inefficiency, and experience has shown that teams working with agile models may behave differently if they start working remotely from scratch (Comella-Dorda et al, 2020). Regarding the future of agile methodologies themselves, the practices are harder to implement since face-to-face interactions, which often help solve problems quickly, are replaced by video calls or messages, which obviously cannot have the same effect (Mancl & Fraser, 2020).

As it is obvious, given that the majority of the responses are at least neutral to very positive for the most part, we can conclude that ASD Teams were not particularly impacted, at least in terms of the application of Agile Principles, so there is not much need for a change in the way they will be applied after the COVID-19 era. Marek et al. (2021), agree that ASD teams were not impacted in terms of delivery rate and software quality, since many elements required to support it, were already in place while Schmidtner et al. (2021) study revealed that there was a quick adaptation of employees and organizations, and thus productivity and agile working was not significantly affected.

Even in the case of face-to-face communication, it turns out that this is indeed the most effective way. However, as the hybrid model is emerging as the way to go in the post COVID-19 world, organizations will need to find ways in which to make day-to-day communication between team members and stakeholders as efficient as possible, so that the advantages of face-to-face communication are maintained in a digital remote environment as well.

7.3. Teamwork Quality and Performance

Regarding teamwork quality and performance, mutual support has been identified in high levels among the respondents. Self-organized teams achieve this with the participation of the team members in daily and retrospective meetings, that the participants have expressed that they had a good experience with, as concluded in Chapter 7.1. Spontaneous communication

is being questioned when it comes to remote working, since the doorway chats and watercooler discussions is difficult to be replaced with video or online chats. Nevertheless, only a small number of the respondents disagreed that the information flow coming from other team members was satisfactory.

The participants highlighted that the contribution was balanced among the team members, according to their specific potential. Daily meetings support balanced contribution since all team members share their contribution towards the team's iteration goal. As a result, most of the respondents felt happy with their contribution to the team effort, and somehow satisfied with their professional promotion, in terms of learning and evolving within this context.

To a narrowed extend, our findings agree with these of Lindsjørn et al. (2016), that Teamwork Quality and team performance are highly related, even in the enforced remote working model. It is also clear from the findings of Chapter 7.2, that the team's success (software quality, customer satisfaction) is tight closely with the teamwork.

7.4. Hybrid working

Partial remote working has been implemented for many years by more and more software development companies worldwide and has been proven to have beneficial effects both for employees, as it serves in several areas of their lives, and for companies, as it reduces their operational costs considerably (Mancl & Fraser, 2020). However, the remote working model, which was imposed out of necessity due to the pandemic, was something that neither businesses nor employees were prepared for and this resulted in many new situations whose impact could not be predicted (McConnell & Stuart. 2020).

The combination of remote and from the office approach will be the next big challenge for the organizations in the near years to come (digital.ai, 2021). This combination, widely known as hybrid model, is the most popular choice amongst employees around the world for the post COVID-19 world. According to a global survey conducted by the collaboration software company Slack, 72% out of more than 9.000 knowledge workers prefer hybrid over other working models (slack, 2020). Baker (2021) also state on their study that 64% of employees were positive about working from home 2-3 days per week. The State of Agile Report for 2020 indicates that 56% of survey participants report that they prefer a hybrid approach, which would involve returning to the office, but not on a daily basis (digital.ai, 2020).

The present research aligns with the above findings, since the adoption of a hybrid model is the main preference of employees working in ASD teams in Greece after the post-COVID-19 era. It is also very interesting that this preference is in almost complete agreement with the corresponding intention of the organizations plans for the meta-pandemic era (61% and 60% respectively). It therefore appears that the hybrid model will prevail, meeting both the needs of companies for a partial return of employees to the office, and the need of employees for a more flexible work model, which better serves their daily needs without affecting their performance. Regarding the other options for returning to work in the post-COVID era, it is interesting that in this survey, the intention of some companies to return to a full-time return to the office, is in clear contrast to employees' choice of an entire remote working model.

However, there are still several aspects of hybrid working that need to be considered, such as work time flexibility, frameworks for fixing and tracking space and time flexibility, provisions for the remote workplace, provisions for work-life balance (Grzegorczyk et al., 2021). Work-life balance, as evidenced by comments collected for the present research, was one of the main aspects affected, since not leaving the workplace, due to the worker being still at home, led to an increase in working hours and therefore to a decrease in work/life balance.

Several comments collected through the current research, highlight the mental health of workers, as another important topic of research during the pandemic. The confinement and removal of workers from their work bases had in many cases a negative impact on the psychology of workers. As stated in a study of EY, Hellas EAP and the Laboratory of Experimental Psychology of the School of Psychology of the National and Kapodistrian University of Athens, the mental health and well-being of workers in the post-COVID era, showed high rates of worker impairment (Kasellaki, 2021).

There are many other problems that may arise in the long run, such as the lack of trust, which is mainly acquired through personal contact, but which cannot yet be proven, since the phenomenon started only a few months ago.

7.5. Tools

As mentioned previously, software tools play a significant role in the evolution of agile and the adoption of remote working mindset. Atlassian Jira is the most popular collaboration tool amongst the ASD teams in Greece, with Microsoft Teams being the most common communication tool with Slack coming next. Atlassian Confluence is the most used knowledge management tool as well, totally aligned with the research findings of the 15th State of Agile report (digital.ai, 2021) and Marek et al. (2021).

8. Conclusion

The aim of this research was to investigate the impact of the forced application of remote working, due to the COVID-19 restrictions, to ASD teams located in Greece. After conducting research with elements of both quantitative and qualitative analysis, it can be concluded that no several impact in the application of agile principles and agile ceremonies was identified. Teams stayed agile and followed the agile mindset and way of working.

Organizations and individuals were already familiar with the remote working context, therefore only small adaptations were required to switch to a full remote working scheme. The use of proper collaboration and communication tools, such as Jira and MS teams helped the teams adapt faster and keep teamwork quality and productivity in high levels. The benefits of video conference and chats over face-to-face communication have been questioned and the work-life balance has been challenged.

Agile is about responding to change and it looks that during this period of lockdowns and overall uncertainty, individuals, teams, and organizations adapted quickly. Hybrid, a relatively new way of working is on the rise, and it looks like it will change the working territory for the years to come.

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