Quaderni
IRCrES
Temi e problemi di sostenibilità sociale, economica, ambientale

AGILE WORKING IN PUBLIC RESEARCH ORGANIZATIONS DURING THE COVID-19 PANDEMIC

Organizational factors and individual attitudes in knowledge production

edited by EMANUELA REALE

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IRCrES - Istituto di Ricerca sulla Crescita Economica Sostenibile
ISSN (online): 2499-6661 ISSN (print): 2499-6955

Quaderni IRCrES
Temi e problemi di sostenibilità sociale, economica, ambientale

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Quaderni IRCrES 14

ISBN (online): 978-88-98193-26-4
ISBN (print): 978-88-98193-27-1

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Introduction

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ABSTRACT
CNR-IRCrES has investigated on the effects of the agile working on researchers and technologists, in the specific context of the Italian Public Research Organizations (PROs), during the COVID-19 pandemic. The project is one of the research initiatives launched by the CNR to deal with the emergency of COVID-19. Between February and March 2021, a year after the widespread emergency adoption of agile working during the COVID-19 pandemic, a survey was launched, which was based on a structured online questionnaire targeted to the research personnel working in two Italian PROs. Our investigation focuses on several dimensions either directly related to the research work – namely: scientific creativity and productivity, researchers' well-being, the use of ICT tools – or involving general aspects, such as the effects on the environment by the reduction of the carbon footprint.

KEYWORDS: agile working, COVID-19 pandemic, Public Research Organisations.

ISBN (online): 978-88-98193-26-4
ISBN (print): 978-88-98193-27-1

HOW TO CITE THIS CHAPTER
Reale, E. (2022). Introduction. In Reale, E. (ed). *Agile working in Public Research Organizations during the COVID-19 pandemic. Organizational factors and individual attitudes in knowledge production* (pp. 3-8). Quaderni IRCrES 14. Moncalieri, TO: CNR-IRCrES. http://dx.doi.org/10.23760/2499-6661.2022.14

Agile working (henceforth the term 'smart working' is used as a synonym) is a dynamic and adaptable method of flexible working[1]. Flexibility encompasses more than one level of work activity, which is therefore carried out in times, places, and with tools that are determined and organized independently by the worker (D'Amato, 2014). Flexibility refers also to the development of the ability to adapt to sudden changes and return to the initial structure, to cope with changing situations. Smart working pushes towards the transition from hierarchical organizational models based on the physical presence to work systems that favour the achievement of results, work autonomy and the spread of relationships of trust (Butera, 2020), with strong innovation in performance achievements (Bergamante et al., 2021; Giuzio & Rizzica, 2021; Reale et al., 2020; Della Ratta-Rinaldi et al., 2020; INPS 2021; Cinque et al., 2020; Canal, Gualtieri & Zucaro, 2022).

The effects of the smart working can be observed in a variety of ways, including:

a. the rules governing the two distinct types of work (work outside the office and work in the office),
b. the methods by which the performance is carried out and the achievement is measured,
c. the worker's individual well-being and satisfaction in reconciling work and family life,
d. the worker's extensive use of new technologies, which increases the need for training,
e. the new ways in which the leadership is exerted within public or private organizations, which must go beyond the traditional hierarchical relationship, in order to favour forms of collaborative and proactive forms of work by the worker (Gastaldi et al., 2014; Van der Voet et al., 2016).

The literature emphasizes the inherent logic of this type of work, which has to be directed towards greater professionalization of the employee (Oliva, 2019), a greater involvement in the achievement of the result and in the choice of means to do that, shifting from the control over the execution of the performance to the evaluation of the ability, to develop new ideas and solutions for the improvement of the work efficiency and of its effectiveness. Agile working pushes towards rethinking the working spaces, the working hours, and the tools in the name of greater freedom and empowerment for the workers (European Commission, 2005). In fact, the temporal and geographical flexibility represents non-monetary benefits to workers, in term of intellectual challenge, recognition, opportunities to make pro-social contributions, and work-life balance, all aspects that can positively influence the outcomes and motivate the efforts (Choudhury et al., 2021). Thus, the term flexibility takes on a new meaning, one that appears particularly promising when applied to intellectual and creative services, where the worker's autonomy can promote more innovative results (Chiaro et al., 2015; Dagnino, 2016).

It is worth to recall that the innovation brought by agile working is not always considered as a positive development. On the employers' side, the awareness of the necessary change in the organization of the work and in the exercise of their leadership makes them cautious about the implementation of agile working. The fear of losing their control over the workers, which has traditionally been exercised ex-ante through prescriptions linked to the use of the required tools and behaviours , and only loosely linked to the achievement of a result, goes hand in hand with the awareness of a lack of tools and training aimed to manage the change towards an ex-post control of the work, that focuses on the results achieved by the worker on the basis of a negotiated

[1] In the present book we use the terms 'agile working', 'smart working', 'remote working', and 'work from home' as synonyms. The authors are aware that the literature coined several definitions for the agile working aimed at distinguishing between different forms, characteristics, and requirements. However, the mentioned classifications/distinctions are not relevant for the purposes of this study. Therefore, we will use the mentioned expressions as equivalent, all indicating the special features of smart working implemented during the COVID-19 pandemic, which entailed conducting research and technological work outside the office – and initially exclusively from home – in compliance with the extraordinary mandatory rules related to health emergency.

schedule in which the worker maintains a wide space of autonomy for the achievement of the identified objective.

From the trade union side, it is feared that the supposed "professionalization" of the worker will have a very high price in terms of union protection, leaving the worker at the mercy of the employer for what concerns the evaluation of the service rendered, with possible effects on the remuneration or even on the permanence in the workplace. In fact, the substance of agile working lies in the profound change in the structure of the contractual relationship, which replaces the measurement of the amount of work rendered based on the time dedicated, with the observation of the performance rendered in relation to the immediate result achieved; the worker is responsible for the achievement (or non-achievement) of this result, even in the possibility that the non-achievement depends on causes not attributable to him/her. Furthermore, the absence of a clear distinction between the time dedicated to work and the one dedicated to the family presents the risk of activating a sort of continuous cycle of work with consequent psychological implications (Klehe & Anderson, 2007); also, the continuous use of web connections for work needs could have potentially harmful consequences for the health, with the need to configure a "right to disconnect" (Ray, 2016).

Having in mind the mentioned problems, the CNR-IRCrES investigates on the effects of the agile working on researchers and technologists, in the specific context of the Italian Public Research Organizations (PROs), during the COVID-19 pandemic. The project is one of the research initiatives launched by the CNR to deal with the emergency of COVID-19.

Between February and March 2021, a year after the widespread emergency adoption of agile working during the COVID-19 pandemic, a survey was launched, which was based on a structured online questionnaire targeted to the research personnel working in two Italian PROs[2]. Prior to the pandemic, agile working was either in the experimental phase or had never been experienced in PROs (Reale et al., 2020), but during the most intense phase of the COVID-19 pandemic, suddenly it became the ordinary and exclusive mode (with the concept of delocalization of work partially eluded because everyone works at home, with no possibility of choosing an alternative workplace, at a first stage, and no voluntary agreement between the employees and the employer to work in a 'smart' mode).

Despite the special features of smart working during the pandemic event, investigating the attitudes and the opinions of the PRO researchers and technologists can shed light on the effects it has produced for a special type of professionals, whose activity is characterized by the highest level of creativity; it is commonly organized by projects and objectives to be achieved, with a highly flexible mode of working. To researchers and technologists are already guaranteed rather high levels of autonomy, which allow them to decide for themselves when and how they can work; however, they face some constraints in their choice of workplace, which in most cases does not include working at home. The mentioned features let us expect that we will find positive effects of the smart working despite the exceptional circumstances and the time of its implementation.

However, there are several open questions about the consequences of smart working, including the possible psychological effects of an extensive use of ICTs, the possible phenomena of gender discrimination that would affect the women and their productivity, since the reconciliation between working time and family care is often not easy and is likely to produce discrimination in practice. Furthermore, the problems deriving from the loss of socialization between the colleagues deprive the individuals of the benefits deriving from interpersonal relationships and collaboration, but leave intact (or even increase) the phenomena of internal competition . Finally, the positive and negative effects of agile working on the scientific productivity still need to be monitored more accurately (Reale, 2020). The evidence gathered on this extreme case could suggest changes to the national legislation, which would allow greater room for manoeuvres in the different organizational contexts and would allow to adapt the performance of agile working to the actual configuration of the work and to the various existing performance objectives. Our investigation

[2] The questionnaire created for the survey is reported in its entirety at the end of the volume.

focuses on several dimensions either directly related to the research work – namely: scientific creativity and productivity, researchers' well-being, the use of ICT tools – or involving general aspects, such as the effects on the environment by the reduction of the carbon footprint.

Chapter 2, entitled The methodology of the survey on the effects of agile working in Italian Public Research Organizations, describes the methodological approach implemented for the survey, emphasizing the analytical dimensions under investigation and the fundamental characteristics of the study project.

In Chapter 3, Individual autonomy and research creativity in time of COVID-19, our team investigates the value of the autonomy in the organization of the individual work, with respect to the production of new scientific knowledge in non-university academic organizations, by following two main questions: does the agile working during the COVID-19 pandemic affect the ability of the researchers to explore both already existing and new research questions/trajectories, and technologists' attitudes towards finding innovative ways of supporting research activities? Was agile working during the pandemic a threat or an opportunity for knowledge creation? The results show the positive assessment of the scholars on the experience of smart working, even under the special conditions of the pandemic event. However, Chapter 3 also presents some limitations of smart working concerning the scientific work, which needs personal contacts and networks to increase production and productivity.

Chapter 4, entitled Scientific productivity and smart working. Evidence from researchers' perception, deepens the issue of the productivity during the pandemic event of COVID-19 to control whether the agile working during this special period favoured or impeded the capability of researchers to explore both already existing and new research questions/trajectories, and to control technologists' attitudes toward finding innovative ways of supporting research activities. The overarching question of the chapter is whether agile working threatened the knowledge creation, or it was an opportunity. Beyond the fact that the perceived productivity was stable or had increased during the period, the perception of the interviewed PRO researchers and technologists show a positive attitude towards the future use of smart working, even outside the pandemic emergency of COVID-19. Women feel to be more productive under the smart working scheme, but they feel less efficient and intend to use it for fewer days than men in the future.

Chapter 5, Agile working and well-being during the Covid-19 pandemic, is focused on the well-being deriving from the adoption of smart-working, questioning how researchers and technologists' perceptions on well-being differ by gender, age groups, family composition, commuting and working habits, contractual and sectoral aspects, and the benefits and the limits perceived by the respondents with smart working during the pandemic. The chapter investigates whether agile working favours the conciliation between work and free/family time, and if there are specific characteristics that influence the respondents' well-being, with a specific attention to the gender issues. From the combination of the textual analysis and the econometric model, five areas of advantages emerged : life quality, new working tools and methods, free time and working time conciliation, efficiency, and savings. Women generally recognize as an advantage the increased possibility of looking after children and relatives; however, limitations are visible too, since the presence of minors in the family is also a source of stress, leading to the fragmentation of the work during the day and the expansion of the daily hours worked.

In Chapter 6, The use of ICT services and tools by PRO research personnel in agile working during the COVID-19 pandemic, our team describes the mode and intensity of use of the ICT services and tools by non-academic research personnel, during the agile working performed in the course of the emergency. The focus is primarily on the individual level of adoption of ICT resources in response to out-of-office working conditions. The new working condition has forced researchers and technologists to intensify the use of some previously experimented ICTs, and has also measured for the first time the use of new ones. The transformations in the work due to the use of new tools was generally well accepted, with researchers and technologist engaged to fill eventual organizational technological gaps to perform activities in an effective and productive way.

Finally, Chapter 7, Environmental implications of agile working: an assessment of commuting emissions, deals with the positive impact that smart working can have on the environment,

looking at the work mobility emissions, and with how the new labour organization can maximize this positive impact. Despite the fact that the evolution towards a larger use of ecologic means of transport is positive (but not so strong), a positive outcome for the environment can be foreseen with the introduction of the smart working, reducing the CO2 emissions due to fewer trips to the workplace and, at the same time, due to the changes in habits of commuting means.

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Chapter 2
The methodology of the survey on the effects of agile working in Italian Public Research Organizations

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ABSTRACT
This chapter describes the methodology of the CNR-IRCrES survey, conducted to investigate the effects of agile working emergency implementation on the research personnel from two Italian Public Research Organizations – the National Research Council (CNR) and the National Institute for Astrophysics (INAF). This survey, based on the CAWI methodology, sought to explore specific aspects of scientific work such as autonomy, creativity and productivity, as well as contextual aspects such as personal well-being, the use of ICT tools and the environmental implications of agile working. The first part of the chapter describes how the survey was designed and the various dimensions that were investigated by the questionnaire. The second part summarizes the implementation phase while also introducing the participants' profile through a descriptive analysis of the sample of respondents.

KEYWORDS: agile working, smart working, Public Research Organisations, methodology; survey.

ISBN (online): 978-88-98193-26-4
ISBN (print): 978-88-98193-27-1

HOW TO CITE THIS CHAPTER
Fabrizio, S., Spinello, A.O., & Lamonica, V. (2022). The methodology of the survey on the effects of agile working in Italian Public Research Organizations. In Reale, E. (ed). *Agile working in Public Research Organizations during the COVID-19 pandemic. Organizational factors and individual attitudes in knowledge production* (pp. 9-19). Quaderni IRCrES 14. Moncalieri, TO: CNR-IRCrES. http://dx.doi.org/10.23760/2499-6661.2022.14

1. INTRODUCTION

In April 2020, while the COVID-19 pandemic was underway and the resulting government measures were affecting people's movements and work arrangements, CNR-IRCrES announced a research project entitled *Agile working in research institutions: organisational factors and individual behaviours in the production of knowledge*. The study aimed to investigate – through an online survey – the effects of agile working during the COVID-19 emergency on the research personnel of two Italian Public Research Organizations (PROs) – the National Research Council (CNR) and the National Institute for Astrophysics (INAF). Rather than determining whether agile working is suitable for research activities, the ultimate goal of the survey was to investigate what happened to the personnel engaged in the production of new knowledge, taking into account peculiar dimensions related to scientific work and well-being.

The survey was launched between February and March 2021, one year after the very first extended implementation of agile working for public and private workers. This time has allowed for the consolidation of behaviours, attitudes, and dispositions toward the new working mode.

This chapter outlines the methodological approach implemented for the survey, stressing the analytical dimensions under investigation and the fundamental characteristics of the study design. The first part illustrates the design of the study and the different dimensions explored, relating to the agile working carried out in the PROs, and outlines the structure of the questionnaire. The second part briefly summarizes the structure of the survey (target population, contact with respondents, pre-test phase) and its online implementation. The last part introduces a brief descriptive analysis of the sample.

2. METHODOLOGICAL APPROACH

The survey's methodology was based on the distribution of a structured questionnaire to the entire research personnel – researchers and technologists (including institute directors) – from two selected PROs under the supervision of the Ministry of University and of Research (MUR): CNR and INAF. The data collection procedure was developed using the CAWI[1] approach and the Lime Survey statistical survey software, which was integrated into the CNR survey platform[2].

The availability of the institutional e-mail addresses from the two PROs websites suggested for the feasibility of a web-based survey, considering both strengths and critical elements related to this kind of technique (Alessi & Martin, 2010; Evans & Mathur, 2018). The key advantage of the CAWI method is the space of manoeuvre with which both the research team and the respondents can handle the study. On the one hand, respondents are given a long time to adhere to the compilation invitation, with the option of answering via different devices; on the other hand, the online questionnaire can reach the target anywhere and at any time. The provision of a questionnaire mainly composed of closed-ended questions has been chosen for its effectiveness, as the research items should be well operationalized allowing for an easy and immediate understanding.

2.1. Non-probability sampling

All the researchers and technologists of the two PROs – CNR (considering all its 88 research institutes organised into seven macro-thematic departments) and INAF were contacted and

[1] Computer Assisted Web Interviewing.

[2] At the end of the book the reader can find the text of the entire questionnaire as it has been automatically generated by the online platform.

invited to participate in the survey[3]. The sample design of the survey is therefore non-probabilistic, which means that a sampling method was not applied to select respondents based on inclusion criteria (i.e., structural characteristics of the target population).

The choice of the two PROs is due, first and foremost, to the importance of the two organizations and the possibility to reach respondents from all scientific fields, and secondly, to the possibility to have respondents from an organization which never experimented agile working and another which already experimented agile working. Indeed, CNR had never experienced agile working prior to the COVID-19 emergency, so it activated an *ad hoc* regulation for the emergency implementation; on the other hand, INAF had approved an agile working regulation in 2019, so it re-proposed the same rules during the emergency while ignoring the temporal limitations imposed by the previous rules (Reale et al., 2020).

The CNR is the major PRO in Italy, and its mission is to conduct scientific research in the major disciplines of knowledge and apply the findings to the country's growth, supporting innovation, internationalization of the research system and industrial system competitiveness. The activities are carried out by a large human resource base of approximately 8,500 individuals spread across the country, with around 5,500 units engaging in research activities (87% researchers and 13% technologists)[4]. The 88 CNR research institutes are divided into different technical and scientific sectors and are geographically distributed across Italy.

INAF is the main Italian PRO for astronomy and astrophysics; its research activity spans the entire spectrum of Universe sciences, from solar system studies to cosmology, and includes observational, experimental and theoretical aspects. It has over 1,200 employees, working in 16 research units in addition to the Headquarters, whose around 750 are research personnel, 73% researchers-27% technologists[5]. INAF seats are divided into observatories and research sites and can be found all over Italy.

Personnel from the two PROs were manually listed from the websites of their respective units or institutes. The final list included 5,677 CNR units and 783 INAF units. Due to the "manual" collection of respondents' contact information from websites, list errors were taken into account – these could include incompleteness (or under-coverage) or non-existent/unrelated units (over-coverage), which could lead to the eventual participation in the survey of units not belonging to the target population. The bias was remedied by the respondent's self-declaration of role in the PRO to the first question of the survey (Section A of the questionnaire): if the respondent declares that he or she was not a researcher, a technologist, or a director, the advancement of the questionnaire would have been stopped.

2.2. Questionnaire design

The questionnaire, which is available in its entirety in the Annex of this book, has been structured into eight main sections, five of which (the final part of C and D-E-F-G) were designed for the analysis of the five main research dimensions (see par. 3); two of them – the initial part of Section C and Section H, were respectively aimed at collecting structural data of the respondent and information on future guidance on applying agile working after the end of the pandemic. One section (B) was totally dedicated to the respondents' understanding of the definition of agile working used for the survey:

> Mode of execution of the subordinate employment relationship, governed by the Law No. 81/2017, established by agreement between the parties, also with forms of organization by phases, cycles and

[3] Research fellows, research associates and technical-administrative personnel from the two selected PROs are excluded from the target of the survey.

[4] Source: CNR PTA 2020-2022 – Aggiornamento del Piano di Fabbisogno del Personale – Anni 2020-2022. The number of researchers includes the number of unit directors.

[5] Source: INAF – Piano triennale delle attività 2019-2021. Data on researchers include the number of the role of "astronomer (old system of role classification)" and unit directors.

objectives and without precise constraints of time or place of work, with the possible use of technological tools for the performance of the work activity.

Surprisingly enough, the definition was unfamiliar to a share of the respondents: 81.1% of CNR respondents identified the correct definition of agile working, while the remaining 18.9% confused it with that of teleworking or preferred not to answer. INAF respondents answered 94.1% correctly, while 5.9% did not identify the correct definition. For moving on with the questionnaire, the respondents were asked to refer to the definition, reported once again, adding that the subject of the questionnaire is the agile working intended as the working mode made necessary by the health emergency linked to the spread of the COVID-19 epidemic.

The questionnaire included 55 questions in total and the estimated time to complete the interview is approximately 10-12 minutes. The duration of the interview has been studied considering that the time taken for each question decreases as the number of questions increases, causing the possible presence of inaccurate answers[6].

Most of the questions are closed-ended, and the respondent is asked to choose an answer from a structured list of options. Being aware that the inclusion of every possible option could have led to excessively long response lists, the strategy chosen was to limit the number of responses that included an "other" option accompanied by a "specify". The choice to avoid open questions on specific research items was made due to the risk of incompleteness and the potential loss of motivation of the respondent as the answers could have been difficult or long to transcribe. However, some open-ended answers were added to allow respondents to comment on specific issues and encourage them to share their opinions and attitudes. In order to detect attitudes towards an object or phenomenon, scaling techniques have been adopted. The Likert scale was chosen in a 4-option variant, omitting the neutral response option to "force" the position of respondents in one way or another.

3. Analytical dimensions

The COVID-19 pandemic outbreak has imposed a massive introduction of the agile working, mostly done from home. Even highly qualified workers, used to work independently and flexibly, had to adapt to the new ways of working, with the benefits and limits connected with an almost uneven condition. Through the questionnaire designed and implemented by CNR-IRCrES and administrated to PRO researchers and technologists, five dimensions have been operationalized in batteries of items and measurement scales:

a. autonomy and creativity in scientific work;
b. scientific productivity;
c. workers' wellbeing;
d. use of ICT tools and services;
e. environmental implications of agile working.

The research team has operationalized the dimensions mainly through specific Sections of the questionnaire, but also used a transversal approach to investigate specific sub-dimensions using items from different sections. The operationalization of the topics was included starting from the end of Section C, after the development of some classification questions related to the respondent's characteristics, such as gender, age group, demographic range of the hometown, characteristics of the house, information on presence of children in the household, professional classification by role, CUN research area and the type of research activity that is carried out (experimental, non-experimental, etc).

[6] SurveyMonkey, a professional service for online surveys, reports that if an online survey exceeds 7-8 minutes, dropout rates can go up to 20% (https://www.surveymonkey.com/curiosity/survey_completion_times/).

The last questions from Section C of the questionnaire allowed to investigate the different dimensions related to the autonomy in scientific work. In particular, the autonomy in deciding the mode and timing of doing research before the pandemic was examined through the questionnaire item C17. Emphasis was put into the importance of the organization of activities by deadlines and objectives, the possibility to consult materials or resources in an office setting, having the greatest possible operational autonomy and having opportunities for constant discussion with colleagues or supervisors (C18). This Section also covered preferences in terms of places where specific tasks were carried out before the pandemic (i.e.: paper drafting, peer review activities, data analysis, literature review, project management) through the question C19. Though the last questions from Section C were specifically designed to investigate autonomy, Other questions in the survey were created in order to reinforce the analysis. In particular, the questions highlighting the limits and benefits in the organisation of individual work of researchers and technologists during agile working (D11-12) were useful to complete a preliminary framework related to the work conditions in which the concept of autonomy is embedded. The analysis of autonomy intersects with that of *creativity* with items from section D introducing two main dimensions:

i. the variation of some research activities from the pre-pandemic period to the pandemic;
ii. the analysis of the dimensions that have caused changes in terms of scientific production, that is the difficulty of carrying out some work activities; the instructions received from the research organization's management; the logistics of domestic spaces; the reorganization of working times and activities.

Furthermore, opinions related to autonomy and creativity and work organization were the core of the battery presented by question D1, by which the respondent was invited to express his agreement on a battery of phrases on agile working. Section C and some contents taken from Section D gave the research team the possibility to answer to the two research questions explored in Chapter 3, dedicated to Individual autonomy and research creativity in time of COVID-19:

> did the agile working during the COVID-19 pandemic affect the capability of the researchers to explore both already existing and new research questions/trajectories, and technologists' attitudes towards finding innovative ways of supporting the research activities? Was agile working during the pandemic a threat or an opportunity for knowledge creation?

Section D of the questionnaire was mainly aimed at investigating limits and advantages in term of workers' wellbeing during agile working. After a short series of questions regarding the agile working experience before the pandemic, the questionnaire focuses on investigating the mode of working during the pandemic period, through multiple choice questions (D11-12): *Based on your experience, please indicate the most relevant limits/benefits of the agile working during the COVID-19 health emergency.* This section is strictly related to section F which allows to analyse two other dimensions of wellbeing: the work-family balance and the risk of workaholism to the detriment of the right to disconnect from job requests. In particular, question F3 *During the COVID-19 emergency, how does agile working affect your work-family balance?* provides four answer items:

a. agile working does not affect time balance,
b. agile working determines a redefinition of time in favour of family/leisure with respect to work,
c. agile working determines a redefinition of time in favour of work with respect to family/leisure,
d. agile working favours the conciliation between family/leisure time and work time.

Thanks to section D and F, it was possible to answer to the research questions explored in Chapter 5 on Agile working and well-being during the COVID-19 pandemic: "does agile working

favour the reconciliation between work and free/family time? Are there specific characteristics that influence the respondents' well-being?"

In addition to this, section D was also essential to deepen the possible impact of agile working on researchers and technologists' productivity (topic covered in Chapter 4). The research questions were: "Has researchers' and technologists' productivity increased? Can we identify specific characteristics that affected the productivity? Which scientific activities are most difficult to carry out in agile working?". In order to answer these questions, the questionnaire allows to deepen the characteristics that can affect the following activities: writing of papers or scientific monographs; study of the scientific literature; participation in conferences (including web conferences); in presence or virtual meetings related to research projects; scientific dissemination through seminars, lectures or webinars; peer review for scientific journals.

Section E of the survey intended to investigate change in terms of awareness, and the knowledge and use of some ICT tools (commercial cloud, storage with private access, cloud storage made available by the organization, VPN/Proxy server, programs for audio/video conferencing, chat programs, IT support service/help desk, shared online planning for research teams, use of specific software on the institutions' server, remote access to databases) with the activation of agile working. Furthermore, questions E4 and E5 allowed to investigate the possible problems encountered in the use of ICT and the possibility, given by the institution to which they belong, to access training on the subject in question. Through this Section, it has been possible to answer to three research questions treated in Chapter 6:

i. How did the research personnel approach the use of ICTs during agile working in emergency, taking into account their personal preferences and individual and organizational preparation?
ii. What was the research personnel experience with ICT tools and services during agile working, and which tools or services showed the potential to transform the individual work organization?
iii. What were the major obstacles they faced when utilizing ICTs during agile working?

Finally, Section G intended to explore the environmental implication of agile working through a series of closed-ended questions aimed at investigating the commuting time and kilometres of each respondent (G1 and G2). The means of transport mainly used to reach the workplace (G3) and any possible post-pandemic changes in terms of means of commuting to work were treated, as well as change in consumption (paper, electricity, heating, and air conditioning) with respect to the pre-pandemic period (G6). This Section has been used in Chapter 7 to analyse the effects of the intensive use of agile working on environmental benefits, deriving from a decreasing demand for labour mobility. Different preferences and experiences of trips to the workplace before and during the pandemic in terms of advantages/disadvantages are explored in order to figure out to what extent agile working in PROs can have a positive environmental impact. The aforementioned chapter will mainly answer to two questions:

i. to what extent can agile working in PROs have a positive environmental impact on work mobility emissions?
ii. how can the new labor organization maximize this positive impact?

4. SURVEY IMPLEMENTATION

4.1. Pre-test phase

A pre-test phase on a limited subsample of 10 researchers from CNR was developed in January 2021 to verify any issues related to the questionnaire items, and highlight difficulties and technical problems with the online procedure. The clarity of any instructions and the sequence of questions, while respecting the logic of the branching, were given special consideration. The development

of the pre-test also checked the possibility of common errors in the development of an electronic survey (see Andrews et al., 2003).

4.2. Contact method and privacy policy

The invitation to participate in the survey came from an institutional e-mail address that reported the domain of the National Research Council: survey.lavoroagile@ircres.cnr.it. In addition, the text of the e-mail included a brief description of the purpose of the research, specifying the identity and affiliations of the researchers involved. The CNR-IRCrES research group has foreseen three recalls for those who do not respond to the first calls.

Researchers and technicians were asked to follow a link to fill out the questionnaire and refer to a document that illustrates the survey's Privacy Policy. The creation of a privacy policy document is aimed at communicating to the interviewees the guarantees on the security of the information shared through the questionnaire and to ensure that the research group complies with the principles of confidentiality that are set out. The privacy policy clarified that respondents' data would have been processed

i. only for research purposes, in accordance with the principles of lawfulness, correctness, transparency, relevance and non-excess, and to ensure adequate security of personal data;
ii. in a way that the respondent units are rendered unidentifiable, through procedures of contact data separation and pseudonymization with the use of random codes.

4.3. Survey waves and response rate

Two waves were launched – the first at the end of February 2021, targeted to INAF, and the second, targeted to CNR, in mid-March 2021. The interviewees were allowed a large period – 14 days – to adhere to the proposal of participation in the survey.

At the end of the two rounds of administration of the questionnaire, 2,921 responses were obtained with a total response rate of 45.7%. About one researcher/technologist out of two of INAF completed the questionnaire and about 45% of the CNR, with a response rate of the researchers higher than the technologists in the latter case. Table 2.1 presents in detail the response rate of the survey with breakdown by organization and professional role.

Table 2.1. Response rate of the survey with breakdown by organizations and professional role

	Units, A.V.	Respondent units, A.V.	Response rate on total units, %
1st wave - INAF researchers (including directors) (14 days, February 2020)	559	282	50.4
1st wave - INAF technologists (14 days, February 2020)	207	106	51.2
2nd wave - CNR researchers (including directors) (14 days, March 2020)	4,864	2,276	46.8
2nd wave - CNR technologists (14 days, March 2020)	756	257	34.0
TOTAL	**6,386**	**2,921**	**45.7%**

The high response rate could be attributed to several factors:

i. the contacted units identified their current work situation in the survey topic;
ii. the participation proposal came from the same organization (in the case of CNR) or from a similar and reliable organization (in the case of INAF);
iii. a possible word-of-mouth among colleagues who received the questionnaire;
iv. there was an actual different perception of the theme during the historical period of compilation. An unexpectedly large participation of respondents was obtained from the (few) open-ended questions in the questionnaire, testifying to the great interest aroused by the survey and the desire to express themselves on a relevant topic.

The survey allowed respondents to reflect on agile working in general (questionnaire item D2), as well as on the possibility of implementing this method when the pandemic emergency is over (H3). Both questions were not mandatory, but for the first, 564 people responded, accounting for one-third of the total number of respondents; for the second, 2,080 people responded, accounting for nearly all the respondents.

The non-probabilistic nature of the sampling does not allow the use of statistical inference techniques to attribute the characteristics detected on the respondents to the population from which they come; however, the high response rate reasonably allows to consider the results valid to represent the target of the study, especially regarding INAF staff and CNR researchers.

Table 2.2 presents the demographic profile of the survey respondents, due to the analysis of the questionnaire items that were intended to detect their basic characteristics. The characterization of the respondents will be useful for interpreting the data on the different dimensions covered by the questionnaire, highlighting eventual differences in the effects of agile working.

The survey collected complete questionnaires from 1,475 men (50.5%) and 1,409 women (48.2%), while 37 units (1.3%) did not want to disclose their gender. Therefore, a good balance between the representatives of the two genders was achieved. The most represented age group is that of 45-54 years old (37.7%), followed closely by 30-44 years old (32.4%) and 55-65 years old (28.3%). Geographical origin is prevalently linked to Central Italy (37.7%); the North is represented by 33.8% (almost on a par with the North-West and North-East); the South and the Islands are represented by 32.5% of the sample. Most respondents work in large cities – with populations over 250,000 (41.5%) –, while the cities with population between 60,000-250,000 are represented by just under a quarter (23.1%). Nearly 40% of respondents live with minor children at home, 12% with children over 18 years old, 5% with both minor children and children over 18 years old, 28.7% live with no children but a partner or relatives, and 14.3% live alone.

The dominant type of contract is permanent full-time (95.4%); other types are poorly represented. Among both researchers and technologists, those belonging to the third professional level are decidedly the most represented (65.3% of researchers and 82.9% of technologists). The most represented CUN area is Physics (25%), and this prevalence is explained by the presence of INAF. This is followed by Biology (14.1%), Earth Sciences (13.3%) and Chemistry (12.0%). There is also a good presence of respondents from Industrial and Information Engineering (10.0%). The presence of respondents from the Social Science and Humanities sectors is more limited, in line with the composition of CNR research resources. Most respondents conduct experimental research (73.9%).

Table 2.2. Profile of the participants in the Survey (n=2921)[7]

Variables	N (%)
Gender	
Female	1,409 (48.2%)
Male	1,475 (50.5%)
No Response	37 (1.3%)
Age in years	
30-44	945 (32.4%)
45-54	1,102 (37.7%)
55-65	828 (28.3%)
More than 65	46 (1.6%)
Geographic area (Italy)	
North-West	491 (16.8%)
North-East	478 (16.4%)
Centre	1,003 (34.3%)
South	623 (21.3%)
Islands	326 (11.2%)
Demographic level of the city of the place of work (population)	
Less than 5,000	156 (5.3%)
5,000-9,999	186 (6.4%)
10,000-19,999	253 (8.7%)
20,000-59,999	439 (15.0%)
60,000-250,000	676 (23.1%)
More than 250,000	1,211 (41.5%)
Presence of children in the household	
Living alone	417 (14.3%)
Living with no children but not alone (with partner or relatives)	838 (28.7%)
Living with children under 18 years old	1,166 (39.9%)
Living with children over 18 years old	357 (12.2%)
Living with children under 18 and over 18 years old	143 (4.9%)
Type of contract	
Permanent full-time	2,788 (95.4%)
Permanent part-time	35 (1.2%)
Non-permanent full-time	88 (3.0%)
Non-permanent part-time	10 (0.3%)
Organization	
CNR	2,533 (86.7%)
INAF	388 (13.3%)
Role in the PRO	
Director	34 (1.2%)
Researcher - of which	2,524 (86.4%)
- Research director	*233 (9.2%)*
- Senior researcher	*384 (15.2%)*
- Researcher (III lev.)	*1,907 (75.6%)*
Technologist – of which	363 (12.4%)
- Technological research director	*17 (4.6%)*
- Senior technologist	*45 (12.4%)*
- Technologist (III lev.)	*301 (82.9%)*
CUN Research Area	
01 Mathematics and Informatics	175 (6.0%)
02 Physics	729 (25.0%)
03 Chemistry	351 (12.0%)
04 Earth Sciences	388 (13.3%)

[7] Only a few units reported that they were under the age of 30 and were grouped with the 30-44 cohort to maintain anonymity.

Variables	N (%)
05 Biology	411 (14.1%)
06 Medicine	121 (4.1%)
07 Agricultural and Veterinary Sciences	174 (6.0%)
08 Civil Engineering and Architecture	48 (1.6%)
09 Industrial and Information Engineering	291 (10.0%)
10 Antiquities, Philology, Literary Studies, History of Art	70 (2.4%)
11 History, Philosophy, Pedagogy and Psychology	56 (1.9%)
12 Law Studies	32 (1.1%)
13 Economics and Statistics	42 (1.4%)
14 Political and Social Sciences	33 (1.1%)
Type of research activities (not mutually exclusive)	
Experimental research	2,159 (73.9%)
Non-experimental research	1,099 (37.6%)
Technical support for projects	414 (14.2%)
Technical support in laboratory	118 (4.0%)

The implementation of agile working during the COVID-19 pandemic emergency in PROs is studied as a phenomenon that has effects on work organization patterns, on knowledge production dynamics, on contextual dimensions such as personal well-being, and on environmental dynamics. An online questionnaire was created to detect the most important factors that can influence and determine a change in working methods, with a focus on processes of adaptation and/or reaction by knowledge workers. The study's originality lies in its analytical attention both to the "subjects" on whom the effects are observed – performers of a highly creative work characterized by intrinsic work autonomy – and the "objects" that come into play in the agile working experienced during the COVID-19 pandemic (regulatory context, ICT tools, work settings, limitations). The in-depth operationalization of the main analytical dimensions through the creation of articulated questionnaire sections, structured with special attention to the balancing of themes and questions, has the potential to return a richness of outputs that allows for a deeper understanding of the relationship between agile working, pandemic, and research practices, as well as the definition of the phenomenon's perimeter. It is worth noting that the study enables to address topics that have received little attention in the literature, such as research personnel productivity in relation to work-life balance and the principle of researcher autonomy, by situating them both in the unique context of a sudden and forced change of work settings and routines, as well as with an eye to the future.

The design of the study is based on a non-probability sample, which limits the possibility of generalizations of the results. Nevertheless, the high response rate obtained by the survey gives the results sufficient robustness to be interpreted as expression of the reference population. Considering the type of survey, based on the CAWI methodology, a high percentage of respondents took part and provided a large number of open comments that qualitatively deepened the evidence that emerged from the close-ended answers. The strategy developed for implementing the survey, which considered the topic's current relevance as well as the selection of specific dimensions to be operationalized, could be used as a methodological framework for the study of agile working in the context of intellectual or creative works.

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Chapter 3
Individual autonomy and research creativity in time of COVID-19

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ABSTRACT
This chapter wants to shed light on the value of the autonomy in the organization of the individual work, with respect to the production of new scientific knowledge in non-university research institutions. The empirical base is the experience of smart working implemented in the Public Research Organizations (PROs) during the COVID-19 pandemic emergency, and the individual adaptation/reaction of the research personnel in two Italian PROs: the National Research Council (CNR) and the National Institute for Astrophysics (INAF). During the health-emergency period, scholars were required to work for most of the time at home, and several restrictions on free movement of people were imposed. The aim of this paper is to understand how this special condition influenced the activities of researchers and technologists and the production of original research work, thus impacting positively or negatively their creativity –namely, their attitudes of going beyond the exploitation of existing capabilities and routines.

KEYWORDS: smart working, research, creativity, research performance, autonomy.

ISBN (online): 978-88-98193-26-4
ISBN (print): 978-88-98193-27-1

HOW TO CITE THIS CHAPTER
Reale, E., Spinello, A.O., Fabrizio, S., & De Marchis, E. (2022). Individual autonomy and research creativity in time of COVID-19. In Reale, E. (ed). *Agile working in Public Research Organizations during the COVID-19 pandemic. Organizational factors and individual attitudes in knowledge production* (pp. 21-42). Quaderni IRCrES 14. Moncalieri, TO: CNR-IRCrES. http://dx.doi.org/10.23760/2499-6661.2022.14

1. INTRODUCTION AND RESEARCH QUESTIONS

This chapter wants to shed light on the value of the autonomy in the organization of the individual work, with respect to the production of new scientific knowledge in non-university research institutions. The focus is on the experience of agile working implemented in the Public Research Organizations (PROs), and on the individual adaptation/reaction to these assets, which inform the autonomy of the scholar's behavior during the social containment measures deriving from the COVID-19 pandemic.

The observation refers to the effects of the special agile working that took place during the COVID-19 pandemic emergency in two Italian PROs, the National Research Council (CNR) and the National Institute for Astrophysics (INAF). During the health-emergency period, starting from March 2020, scholars were required to work most of the time at home, and several restrictions on free movement of people were imposed. The aim of this paper is to understand how this particular and extraordinary condition influenced the activities of researchers and technologists and the production of original research work, thus impacting positively or negatively their creativity – namely, their attitudes toward carrying out the scientific work even going beyond the exploitation of existing capabilities and routines.

Two main research questions drive the investigation: did the agile working during the COVID-19 pandemic affect the capability of the researchers to explore both already existing and new research questions/trajectories, and technologists' attitudes towards finding innovative ways of supporting the research activities? Was agile working during the pandemic a threat or an opportunity for knowledge creation?

The hypothesis we formulate starts from the consideration of the intrinsic characteristics of the scientific work carried out by the researchers (both scholars and creators of knowledge, following the Merton's types – Merton, 1973). The researchers' work is characterized by a strong dynamism, which arises from the curiosity to face new research questions or to find new solutions to ancient questions, through new investigation paths, new methods, new controls, and new theories. The research work, therefore, has a high degree of creativity and a natural tendency towards innovation; it represents the ground of choice for an organization that precisely enhances the characteristics of dynamism, flexibility, and adaptability to unforeseen events. Thus, we expect to find in the research institutions a work environment in which researchers and technologists have quickly adapted to the new working conditions, even if they have been extreme, quickly recovering the conditions of productivity and efficiency. This expectation is also in line with the part of the literature on smart working, which highlighted its advantages in the case of high creative industries (Chiaro et al., 2015; Leonardi & Bailey, 2008; Choudhury et al., 2021).

This chapter is divided into three sections: Section 2 discusses the researcher's work in terms of flexibility and innovation; Section 3 defines the dimensions analyzed in the chapter and the applied methods of analysis; Section 4 presents the analysis on preferences and on the work autonomy before the COVID-19 emergency, on the opinions about the smart working and on the attitudes towards the knowledge production and the research agenda during the COVID-19 emergency. At the very end, some concluding remarks are outlined, following the initial research questions and the operative hypothesis.

2. THE RESEARCHERS' WORK

Innovation is a key feature of the research profession (Shalley, 1995). The capacity to produce innovation in the scientific work is strongly related to the environment in which the researcher operates, its internal structures and processes; and the elements of the context can either trigger or constrain the innovation (Heinze et al., 2009).

Innovation in the research work can therefore be understood along three dimensions: innovation drivers (structures, processes, and contextual factors that help/hinder innovation), networking (the frequency of the communication outside the organization), and leadership (the qualities and capabilities of senior individuals within the organization) (Lewis et al., 2017). This chapter deepens the former and the second dimension with respect to the introduction of the agile working during the COVID-19 pandemic, to understand its relevance and its effects on the research work.

The analysis starts by considering some key features of the research work. Researchers are a special type of professionals that enjoy the freedom to manage their time and modes of knowledge production in a high flexible manner, changing and transforming them as needed, to adapt to new and unexpected events. According to Bourdieu, the scientist is «a man whose cognitive structures are homologous to the structure of the field and, thus, constantly adapted to the expectations inscribed in the field» (Bourdieu, 1984, p. 57). It is worth to recall that the research profession has as the most important and effective incentives the reputation and the prestige, which also produce direct positive effects on the organizations (Nicholas et al., 2015; Woolston, 2015; Origgi, 2016; Gonzalez-Sauri & Rossello, 2019). Thus, there are several elements to consider in the researcher's profession, which are likely to contribute to his scientific production: on the one hand, the relationship with the environment that has effects on the activities, including professional aspirations and motivations, and, on the other hand, the definition of the researcher and of his distinctive and specific characteristics, referring both to the professional and the personal level.

The outcomes deriving from the research work can, therefore, be a direct indicator of the work done (e.g., publications produced, projects managed, etc.), as well as an indirect indicator of the overall organizational context in which the research is produced. The level of satisfaction of the scholars refers not only to the results they achieve in terms of advancement of knowledge, but also to the level of organizational coordination and the possibility of making autonomous choices (Cannavò, 1989; Ziman, 1984).

The analyses in this chapter are intended to shed light on the inconveniences and the benefits in the organization of the individual work of non-academic research personnel who performed the smart working during the COVID-19 pandemic emergency period, with a particular attention on the importance of the autonomy for the research work, and the effect of this extraordinary condition on the scientific performance.

3. Dimensions of interest and methods

The empirical base comes from a questionnaire administered by CNR-IRCrES, targeted to detect perceptions and attitudes of researchers and technologists from CNR and INAF toward smart working implemented during the COVID-19 pandemic (Fabrizio et al., 2021; Fabrizio et al., § Chapter 2). The attitudes are related to actions or behaviors; therefore, they are the set of beliefs, ideas, values, and motivations that lead someone to action (Pickens, 2005). Perceptions are one's own feelings or opinions about something, which are based on sensory information and on the stimuli coming from the environment; they can shape the attitudes that in turn can be the foundations of the perceptions. Attitudes are associated with intentions and decisions. Attitudes and perceptions can be designed as a linear model towards decisions, or as components of more complex relationships, where there is not a transition from one component to another, but the mutual influence of different elements combining and re-combining to get different points of equilibrium over time (Fischer, 2017)

The data first depict some characteristics related to the spaces of autonomy inherent to the work in the Italian PROs during the ordinary time prior to the emergency; then they provide a picture of attitudes and perceptions on various dimensions related to (almost) uneven working patterns implemented in the emergency situation, including the repercussions that the smart working has had on intellectual performance. Finally, some evidence let us understand the

researchers' future vision, with reference to the possible application of agile working after the end of the emergency. Particularly, the questionnaire (see the Annex of this book) focuses on the possibility to choose the organizational modes that were most convenient before the COVID-19 emergency for performing the research activities (items C17, C19); on the perceptions about various dimensions of agile working i.e. associated with autonomy, efficiency and collaboration (D1, D9c); on the most relevant limits and advantages of the experienced agile working (D10, D11, D12); on the changes in the research performance between the pre-COVID period and the agile working period, with a special attention on the drafting of new papers and on the referee activity (D13a, D13f, D14); on the preferences about the implementation of agile working even after the COVID-19 emergency has finished (H1, H2, H3).

The analyses consider all the respondents from CNR and INAF who took part in the survey (2,921 respondents, of which 388 units from INAF and 2,533 units from CNR, see Chapter 2).

The breakdowns were based on the research domain[1] (mainly), the gender[2], the age cohorts, the type of research performed (experimental vs. non-experimental), the working position – researcher or technologist –, and on the presence of minor children at home. All the variables mentioned reflect critical items of both research profession and working under "special smart working conditions" (see Chapter 2). For categorical variables, the percentages were calculated using the denominator of the number of valid responses. In the analyses of the questions about perceptions and attitudes, the positive assessments are the sum of the two points on the positive side of a four-point Likert scale, whereas the negative assessments are the sum of the two points on the negative side.

Multiple Correspondence Analysis (MCA, see Di Franco, 2011) was used to investigate the pattern of the relationships between categorical variables describing the profiles of researchers/technologists expressing benefits and limitations related to the agile working performed during the emergency period. MCA allowed for pattern extrapolation across a group of variables described by single components; these components are referred to as latent unobserved variables that reflect the maximum variance of a set of other variables.

Free texts and comments to the open-ended questions were deepened using the traditional content analysis, reporting comments within coherent thematic classifications based on the experience of smart working in the emergency phase (D2 referred to D1), and on the benefits that might come from smart working in the future, when the pandemic emergency will be over (H3 referred to H1 and H2). The interpretation of the texts was developed under the hermeneutic approach, which has the aim of finding meaning in the written word. Since language provides both understanding (direct meanings) and knowledge (hidden meanings), the hermeneutic approach in the textual analysis emphasizes the sociocultural and historic influences on qualitative interpretation (Ricœur, 1976; Byrne, 2011).

[1] The disciplinary areas of the respondents were grouped into five research domains: Mathematics, Physics and Nature sciences (acronym MFNS, including 1 Mathematics and Informatics; 2 Physics; 3 Chemistry; 4 Earth Sciences); Life Sciences (LS, including 5 Biology; 6 Medicine; 7 Agricultural and Veterinary Sciences; Engineering sciences (ENG, including 8 Civil Engineering and Architecture; 9 Industrial and Information Engineering; Humanities (HUM, including 10 Antiquities, Philology, Literary Studies, Art History; 11 History, Philosophy, Pedagogy and Psychology); Social Sciences (SS, including 12 Law Studies; 13 Economics and Statistics; 14 Political and Social Sciences). It should be remembered that almost all the INAF respondents belong to the CUN 2 area (Physics), therefore to the MPNS research domain, while the CNR respondents are distributed over multiple research domains. In addition, different numbers of respondents refer to the identified research domains (1,643 from MPNS, 706 from LS, 339 from ENG, 126 from HUM and 107 from SS).

[2] 37 respondents did not indicate the gender and therefore were excluded from the analyses with a breakdown by gender.

4. ANALYSES

4.1. Work autonomy and work at office before the COVID-19 emergency

The COVID-19 pandemic imposed a flexible work organizational model, which included the spatial and temporal relocation of the tasks to be performed. Nevertheless, flexibility in work location and in the time of work are not novelty items for the research workers, but inherent aspects associated with the room of maneuver which characterizes the ordinary work of researchers and technologists (European Commission, 2011). Indeed, the Italian PROs are regulated by a specific contractual agreement that guarantees "the autonomous determination of the working time", and allows for different applications in various institutional contexts; this principle is accompanied, on the one hand, by the possibility of carrying out the work outside the office (e.g., in suitable places such as universities and libraries) using the institution of "self-certified off-site work", and on the other hand, by the researcher's autonomy in determining how to work in order to achieve the scientific and technological results specified in the annual program of activities.

In this regard, it is particularly interesting to investigate how far the research personnel from various research domains had exploited – prior to the onset of the COVID-19 pandemic – the possibilities associated with the self-determination of the autonomy space in terms of *where*, *when*, and *how* to carry out the work activity – which are the three elements of change that would have been influenced by the way they worked during the agile working period.

On a global level, the possibility to work off-side used to be exploited, at least partially, by one respondent out of two. Little more than half of the respondents stated that they did not believe they had the possibility to choose their preferred workplace during the ordinary working period before the emergency (51.8%), while a third stated that this option existed only in part (32.9%). The remaining 15.3% reported that they used to have complete control over where they work. As the respondents' ages increase, so does their possibility to choose their place of work autonomously totally or in part: while respondents in the 30-44 age cohort reported being able to decide autonomously for 41.2%, the respondents in the 45-54 age cohort reported so in 46.9% of cases, and those in the 55-65 age cohort in 56.6% of cases. The difference between the two different research organizations under examination is significant as regard to the choose of the option on having complete control: while the CNR respondents answered in the affirmative for 16.7%, those of the INAF did so only for 6.2%. The reason for not taking advantage of the opportunity to choose the workplace autonomously could be associated with negative indications from the management of the research institute/organization, but also with the peculiarities of the research domain to which the respondent belongs, for which the possibility of working in the office could be indispensable for obtaining research results.

Figure 3.1 therefore shows the differences between the various research domains. The respondents from HUM exploit most the possibility of choosing the preferred workplace (30% yes, 44% partly), and the SS also show greater possibilities (20% yes, 44% partly).

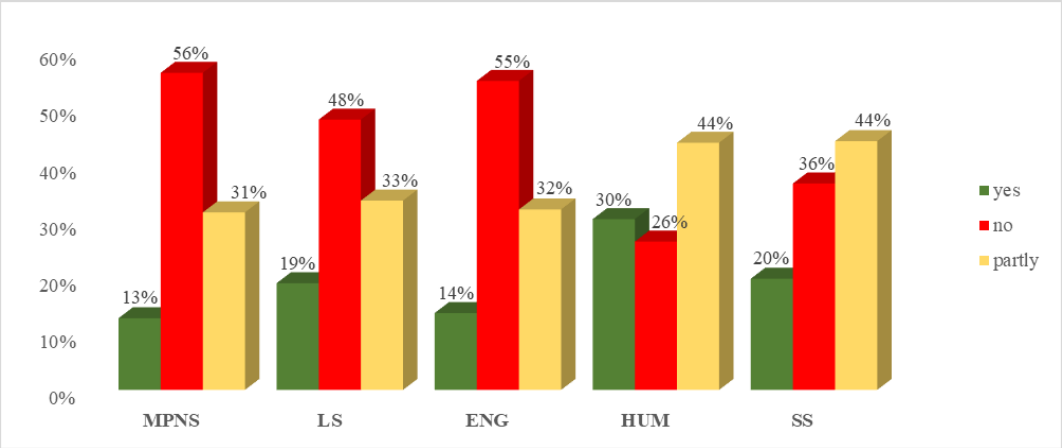

Figure 3.1. Possibility to choose the place of work autonomously before COVID-19 emergency. Breakdown by research domain. Total respondents: 2,921.

On the contrary, autonomously determining working time is a possibility that researchers and technologists have used more in their everyday activities before the emergency, fully or in part. Only 13.4% of all respondents reported they did not have the possibility to independently determine when performing the work, while 43.9% reported that they were used to choose, and 42.7% answered that this possibility already existed in part. The difference between age cohorts is not significant, although older cohorts indicate the affirmative option more frequently than younger cohorts. Furthermore, between CNR and INAF, as well as between researchers and technologists, there are no significant differences.

A greater autonomy on *how* to perform the work was reported by MPNS and LS (65% yes to the question) and by HUM (62%, with a very low percentage of full "no", with 2%). The SS shows higher percentages of respondents who indicated that it was not possible for them to choose the organizational mode of work they preferred (11%), but together with the ENG, they still show high percentages of respondents who answered "yes" or "partially" (89% and 92% respectively).

The respondents were asked about the preferred place of work for performing specific tasks, such as drafting papers or monographs, peer reviews, data analysis, literature consultation, and research project management during the ordinary work, before the COVID-19 emergency (Table 3.1).

The workplace chosen for the performance of the tasks is always the office, but with different importance: for the data processing and analysis (62%) and for the management of research projects (68%) it represents a place of absolute preference; while for the drafting of papers (41%) or monographs and for the peer review for scientific journals (34%) it does not represent an essential option. The first two activities are hardly carried out at home (10% and 4% respectively), while for the latter two the "at home" modality represents more than a quarter of the choices.

Table 3.1. Preference for the workplace for developing specific activities. Total respondents: 2,921

	At office	At home	In other places	Indifferent seat	Not applicable
Drafting of papers or scientific monographs	41%	26%	1%	26%	5%
Peer review for scientific journals	34%	28%	1%	29%	8%
Data processing and analysis	62%	10%	1%	23%	4%
Consultation of documents / literature	51%	14%	3%	29%	3%
Research project management	68%	4%	1%	21%	6%

Younger age group respondents are more likely to draft papers at home than the ones of the older cohorts (e.g., cohort 30-44: 29.3% vs. cohort 55-65: 23.4%); the same applies to the performing of reviewing activities (cohort 30-44: 30.3% vs. cohort 55-65: 24.9%). Living with minor children is not a determining factor in the choice of the work location, except for a slight preference for the office when it comes to drafting papers (49.2% of respondents living with minor children). Particularly interesting is that between 21% and 29% of the interviewees the location is completely indifferent. There were no significant differences regarding the choice of the "indifferent location" option among cohorts.

The data shows that the SS and the HUM are more accustomed to produce research outputs at home as far as the drafting phase is concerned, but also other scientific domains do not disdain this mode and do not see the office ad an essential workplace. Furthermore, there are no significant differences between living alone and living with others. Those living alone have a slightly higher preference for drafting papers or monographs at home (28.5% vs. 26.2%), while those living with others do not have specific preferences for this task (27%).

4.2. The general perceptions on agile working and the performance of the research work

When agile working became necessary for researchers and technologists because of the COVID-19 pandemic, it had to be implemented without significant organizational experience or a complete understanding of its complexities. The research organizations allowed for easy and extensive access to this mode of working: in the case of INAF, derogating from the regulation that accompanied the experimentation phase, whereas the CNR, which did not have a pre-existing disciplinary, established a transitional arrangement (Reale et al., 2020). Only a small fraction of the INAF's research staff had prior experience with agile working at the time of the emergency implementation, whereas all the CNR research personnel were in an unprecedented situation.

Agile working appears to be a positive experience for the research staff[3]. Indeed, analyzing the answers it is clear how the possibility of working from home, exclusively in a first stage of the health emergency and alternating with the presence in the office at a later stage, made it possible to manage work efficiently. Therefore, for many respondents, the opportunity/need to work from home represented an advantage that allowed the achievement of better working results:

[3] The survey gave the respondents the opportunity to reflect on agile working and express – through free spaces for comments – feelings and notes both on their experience and on the possible implementation of this method at the end of the COVID-19 emergency. The open-ended questions recorded a high participation by the respondents: for the first item, in fact, the answers were 564, one third of the total number of respondents; for the second (H3), the interviewees who gave their opinion were 2.080, almost all the respondents. Opinions and comments will be reported to highlight the empirical evidence through the respondents' own words.

> Having the possibility to mix the agile working with the face-to-face work allows for better work results in some scientific research activities. Many experimental activities are obviously linked to face-to-face work, but many others, such as data processing, bibliographic research, experiment discussion, research planning, writing scientific papers, the preparation and organization of seminars and conferences, the simulation of data, and the understanding of the results obtained, can also be done in agile working mode, achieving excellent results (Researcher CNR – Area 3 – Male).

The analysis of the comments gave a positive perception of agile working, with regard to the increase in productivity: this different way of working is profitable and advantageous for work performance:

> During this period of agile working, my work performance has improved considerably: I work much more but, at the same time, I can do many more things. I have expanded my contacts with other research groups, both national and international; I can concentrate much better on writing activities (articles, projects, presentation preparation); I can meet colleagues from other time zones and I have very encouraging concrete results (Researcher CNR – Area 11 – Female).

It is worth, therefore, to deepen the perceptions of research workers who have been suddenly introduced to a new way of working, different from the previous in several aspects, such as autonomy, efficiency, collaborations, and the reconciliation of work time and private life. In this regard, the interviewees were provided a battery of statements to test whether they agree with some general sentences about the new working condition or not (Figure 3.2 and 3.3).

With reference to the statement "It enhances the autonomy of work", the assessment of the respondents was largely positive. The aspects of freedom and autonomy would be even more emphasized by the agile working mode. Globally, 82% of respondents showed themselves to be "in agreement" or "very much in agreement" (where the latter modality affects about a third of the interviewees). The most enthusiastic about it were the researchers and technologists of the SS, who agreed for 88%, as well as those of HUM (87%); 83% of the workers from MPNS and ENG share the same opinion. A minor agreement comes from the respondents of the LS (76%), who for about a quarter expressed doubts about this statement.

When it comes to more specific aspects, such as work efficiency and collaborative work, the percentages tend to decrease slightly. The dimension of efficiency ("It promotes work efficiency") remains very high (HUM 79%, SS 76%, MPNS 70%). As to the collaborative work ("It is an opportunity for better organization of collaborative work"), no research domain reaches two thirds of sample.

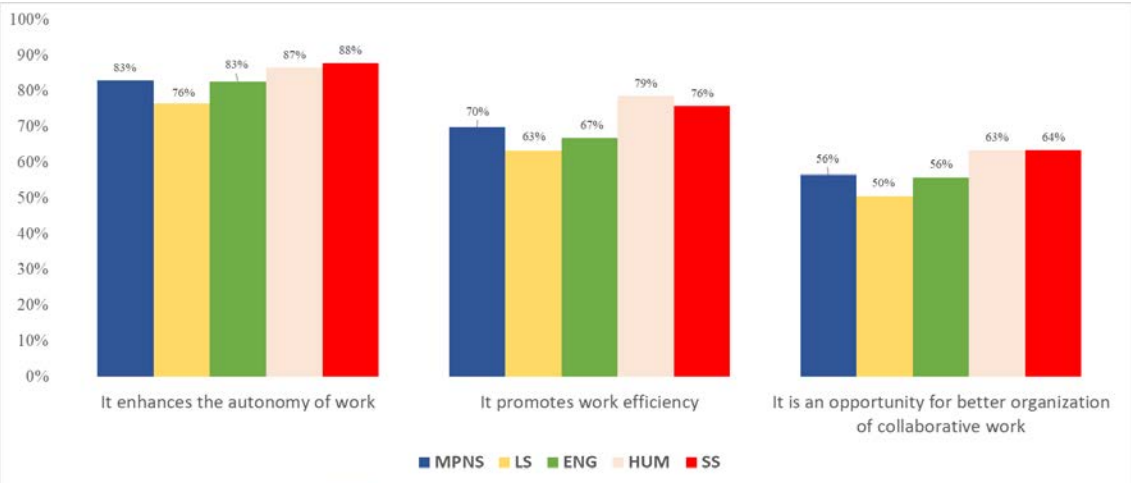

Figure 3.2. Agreement with some characteristics of agile working: autonomy, work efficiency, collaborative work. Breakdown by research domain. Total respondents: 2,921.

It is noteworthy that, regardless of the research domain, the level of enthusiasm for the opportunity of more autonomy, efficiency and collaboration brought by agile working is more intense for younger cohorts (about 83%, 71% and 57% respectively of positive reactions, both for the 30-44 and 45-54 age cohorts), and as age increases, this enthusiasm cools down (77%, 62% and 51% respectively for the 55-65 age cohort). Based on these data, according to a first impression, it is possible to infer – at least for most of the respondents – a general intrinsic predisposition of researchers to adapt without negative effects on efficiency and collaboration, enhancing the characteristics of autonomy connected to scientific work.

Figure 3.3 shows the level of agreement with the other two sentences proposed by the questionnaire. The first concerned the potential benefits of the agile working to reconcile working time and time spent on personal matters. Five out of five respondents said that "It is a way of working that allows to better reconcile work time and private life"[4]. The breakdown by disciplines does not present major differences, although once again the SS (86%) show a higher adhesion and the LS a lower one (76%).

As for the sentence "If not carefully regulated, it can have negative consequences", more than half of the respondents (57.1%) expressed fears about the possible negative consequences following the absence of a careful regulation of agile working. The main concern is expressed by social scientists (65%), while the other research domains have percentages ranging between 55% of MPNS and 61% of ENG. In this case, respondents living with children reported a stronger intensity of agreement with the sentence (45% of units living with minor children vs. 37% of units not living with minor children regarding the total approval). Surprisingly, the younger age cohort (30-44 years old, 61.8%) is the most concerned, compared to older age cohorts (45-54: 55.7%; 55-65: 53.3%).

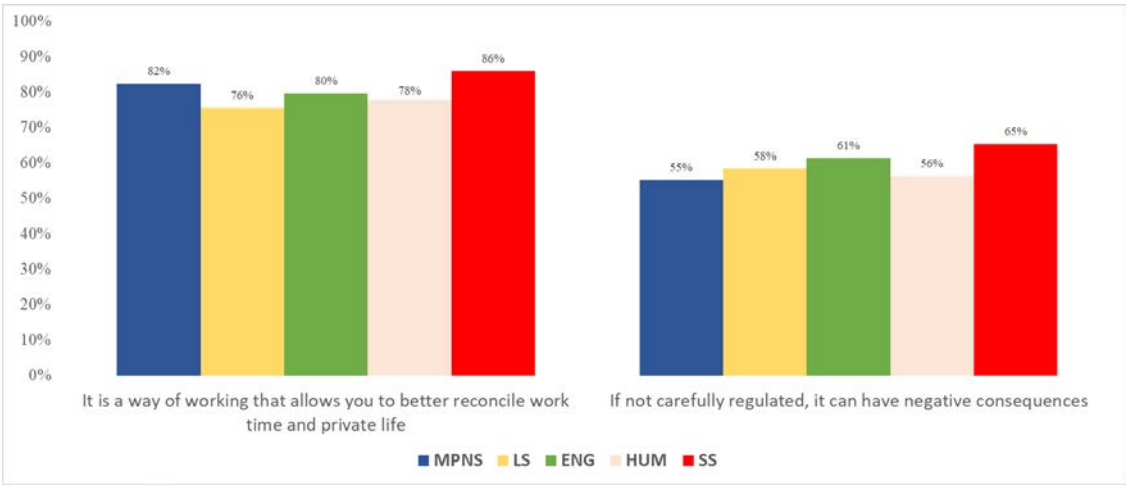

Figure 3.3. Agreement with some characteristics of agile working: reconciliation between work time and private life and eventual negative consequences. Breakdown by research domain. Total respondents: 2,921.

[4] If before pandemic it was almost impossible to be able to combine the different needs without any overlapping of times, now respondents believe that agile working can allow an optimization of times and a better organization of personal activities, whether they are work or family. This is evident from the responses of the respondents: "[agile working] allows for better family organization while also increasing family enjoyment. It reduces the amount of time spent commuting between home and work" (Researcher CNR – Area 1 – Female), or "It would enable me to better organize my family commitments and carry out my work more comfortably, with the proper balance of time spent in the office and at home" (Researcher INAF – Area 2 – Male).

Considering the previous data on the lesser agreement on the affirmation regarding agile working and collaborative work, it is advisable to check whether the results are confirmed by the degree of agreement on another questionnaire item, more focused on the general relational exchange: "Based on your experience of agile working during the COVID-19 emergency, does agile working compromise the relational exchange useful to the research work?" (Table 3.2).[5]

While a good percentage (59.5%) of the respondents disagree with the statement, thus denying negative consequences on relational exchanges, 40.5% manifest either an agreement or a strong agreement. The latter trend is most visible in the 55-65 age cohort (46.3%). The perceptions are therefore the same as the question on collaborative research. Fears about relational exchange are uniformly expressed through the research domains, slightly stronger for HUM than for the other domains. Scholars belonging to the SS consider agile working more favorably as a means that does not compromise the relational exchange, while researchers belonging to other domains follow in the same vein but more timidly.

Table 3.2. Opinions related to the sentence "Agile working compromises relational exchange useful to the research work". Breakdown by research domain. Total respondents: 2,921. Percentages

	Strongly disagree	**Disagree**	**Agree**	**Strongly agree**
MPNS	19.4	39.7	28.8	12.1
LS	22.2	37.0	28.3	12.5
ENG	19.5	40.4	26.8	13.3
HUM	20.6	40.5	23.8	15.1
SS	26.2	37.4	25.2	11.2
All domains	20.4	39.1	28.1	12.4

The element that emerges most from the scholars who decided to leave a free comment is the need for direct contact with colleagues which makes work more stimulating and effective. The absence of direct contact with colleagues represents a negative element of their experience, making work an alienating activity, especially for women.

> The direct scientific confrontation with co-workers in the workplace is irreplaceable and ensures maximum working efficiency. Synergies are formed in the presence of colleagues, which are difficult to achieve in agile working mode (Researcher CNR – Area 6 – Female).

> Agile working has many benefits, but the [contact with colleagues] must be done face-to-face because, by culture and habit, this is the most efficient way of exchanging ideas and coordinating efforts. The social aspect also helps to strengthen the relationships within the working group, which should not be overlooked. A balance is required (Technologist INAF – Area 2 – Female).

4.3. Disadvantages and advantages experienced during the agile working

The restrictions due to the pandemic compelled the researchers and technologists to achieve their work goals while being unable to dispose of office supplies and being separated from co-workers and superiors. Other circumstances at home (where most of the agile working has been done) may have affected the performances of researchers and technologists in various ways, making agile working somewhat difficult. These circumstances may include a wide range of

[5] The questionnaire item voluntarily presented a negative polarity pushing the interviewees to make an effort to reflect.

factors, such as the malfunction of internet connections, the presence at home of people to care for, the workspace inside the home, or the presence of annoying noises (Cellini et al., 2021; Menshikova et al., 2020). Still, some difficulties may be linked to personal peculiarities or to the psychological stress linked to the pandemic in progress (Tintori et al., 2021).

Respondents are almost equally divided into two groups: 49% affirmed the presence of unfavorable circumstances at home, while 51% reported their absence. No substantial difference was found regarding gender: 49.2% of female respondents and 48.6% of male respondents provided positive answers. Conversely, the presence of minor children at home has a strong role (63% of units living with children reported difficulties vs. 38% of units not living with minor children). The younger the age, the greater the likelihood of having experienced unfavorable circumstances to work from home (reported by 55% of the 30-44 cohort, 51.9% of the 45-54 cohort, but only 39.4% of the 55-65 cohort).

The differences can be noted depending on the disciplinary sectors (Figure 3.4), where the difficulties of not working in a laboratory or in the office can affect the respondents relating above all to ENG (54.3%), but also to MPNS (49.5% and LS 48.2%). HUM (38.9%) and SS (43.9%) reported fewer difficulties because working from home had caused less problems.

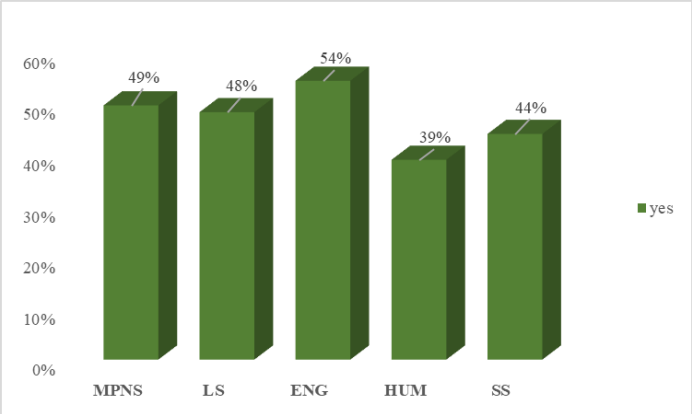

Figure 3.4. Presence of circumstances at home that make agile working difficult during COVID-19 emergency. Breakdown by research domain. Total respondents: 2,921.

The survey questionnaire deepened the most relevant disadvantages that were found by researchers and technologists in carrying out smart working during the emergency. Respondents were asked to choose up to 3 predefined options: in most cases, the interviewees selected three answers (37.9%), 28.2% of interviewees selected one answer, 34% two answers; and 3% of the interviewees did not indicate any disadvantages (Table 3.3).

Table 3.3. Number of disadvantages reported to the sentence "Agile working compromises relational exchange useful to the research work". Breakdown by research domain. Total respondents: 2,921

	N	%	Cumulative %
One disadvantages	823	28.2	28.2
Two disadvantages	992	34	62.1
Three disadvantages	1,106	37.9	100
Total	2,921	100	

The sense of isolation turned out to be the main concern with respect to the implementation of agile working (52%). From the perspective of work organization, more than a third of respondents felt that they were not able to clearly distinguish between the work time and the time dedicated to domestic and family care (37.5%) and the "work overload" (37%) . The increase in utility costs / internet connection was reported by 29% of the interviewees, while the reshaping of work calendars ("Postponement of deadlines and work activities") by 21%. The perception of a limited recognition of productivity represented a limitation for only 18% of respondents. A separate case is the option of excessive autonomy over activities which was reported only by 2% of survey participants, who said that having more autonomy represented a problem for them.

Apart from the most chosen option, there is no clear direction towards specific disadvantages, indicating a relatively accommodative reaction of the population under investigation regarding the extraordinary way of working. Figure 3.5 presents the data on disadvantages associated with agile working, showing that there are no significant differences between male and female respondents in the choice of options, except for the feeling of isolation, the one that had more choices, which affected more the female respondents than the male ones (55 % vs 49%).

In terms of age cohorts, the feeling of isolation was stronger for the 55-65 one (55.3%) than for the 30-44 (50.5%); the same applies to the feeling of work overload. On the contrary, the feeling of work fragmentation was felt more by younger respondents (45.8%). The latter limitation was mostly reported by units with minor children at home (56.5%).

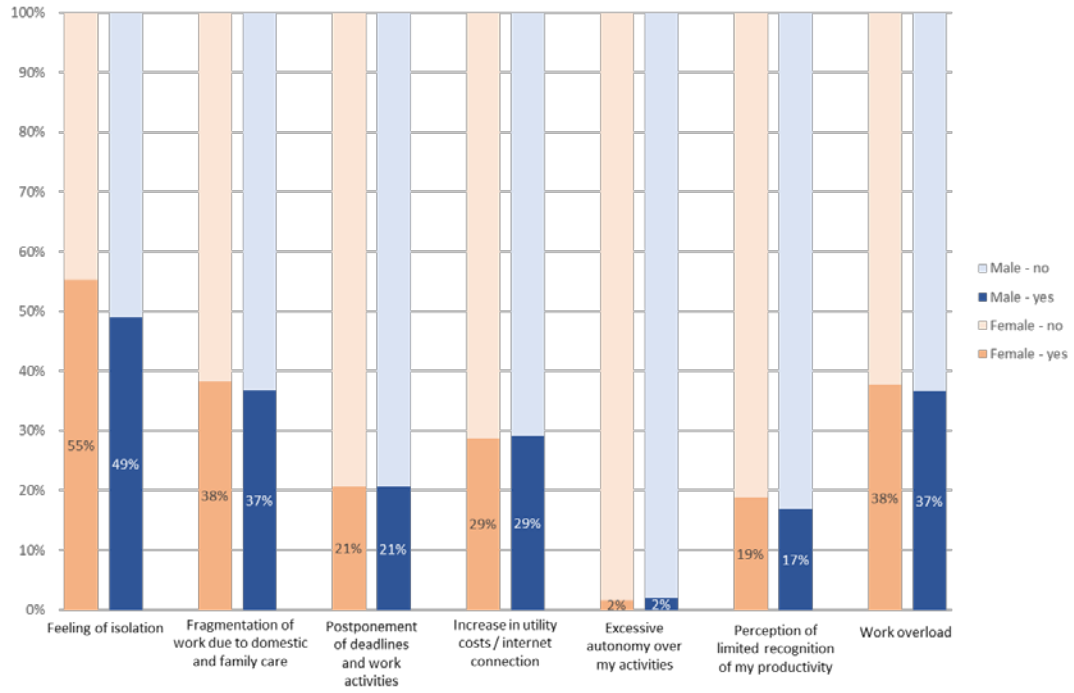

Figure 3.5. Disadvantages related to agile working during COVID-19 emergency. Breakdown by gender. Total respondents: 2,884.

No differences can be observed when comparing the respondents who carry out experimental research and those who carry out non-experimental research, except for two factors. Those who carry out experimental research have suffered most from the possibility of not being able to make a clear separation between working time and time dedicated to family care (39% vs. 35%), a circumstance that probably caused a fragmentation that was not useful neither to the work nor to the time devoted to oneself or to the family. Furthermore, the continuous changes in the work planning, probably due to delays in project deadlines, deliveries, or meetings, have caused greater inconvenience to those carrying out experimental activities (24% vs. 13%).

Following the reporting of the disadvantages of agile working, the interviewees were asked to identify the most important organizational and social advantages. Also in this case respondents had to choose up to 3 predefined options. The difference between the number of answers is more substantial in respect to what seen in the case of the disadvantages: 77.9% of the respondents selected three answers; only 0.7% of the interviewees did not indicate any advantages. Therefore, the advantages of the smart working have received a wider recognition between the respondents than the disadvantages.

Table 3.4. Number of advantages reported to the sentence "Agile working compromises relational exchange useful to the research work". Breakdown by research domain. Total respondents: 2,921.

	N	**%**	**Cumulative %**
One advantage	190	6,5	6.5
Two advantages	456	15.6	22.1
Three advantages	2,275	77.9	100
Total	2,921	100	

Figure 3.6 reports the most relevant benefits perceived by the respondents divided by gender. There are differences between female and male respondents in term of flexibility in time and mode of working (68% vs. 63%), increased productivity (22% vs. 26%) and the improvement of ICT skills, which is slightly more important for women than for men (7% vs 3%).

The perception of productivity is fully in line with other findings, which shows that although a percentage of both men and women experienced increased productivity during the pandemic period, the scale of growth was much higher for men than for women (Squazzoni et al., 2021; United Nations, 2020). This aspect is quite relevant, signaling the presence of trends towards inequalities and gender imbalances that affect also the research work, as happens in other less creative working environments.

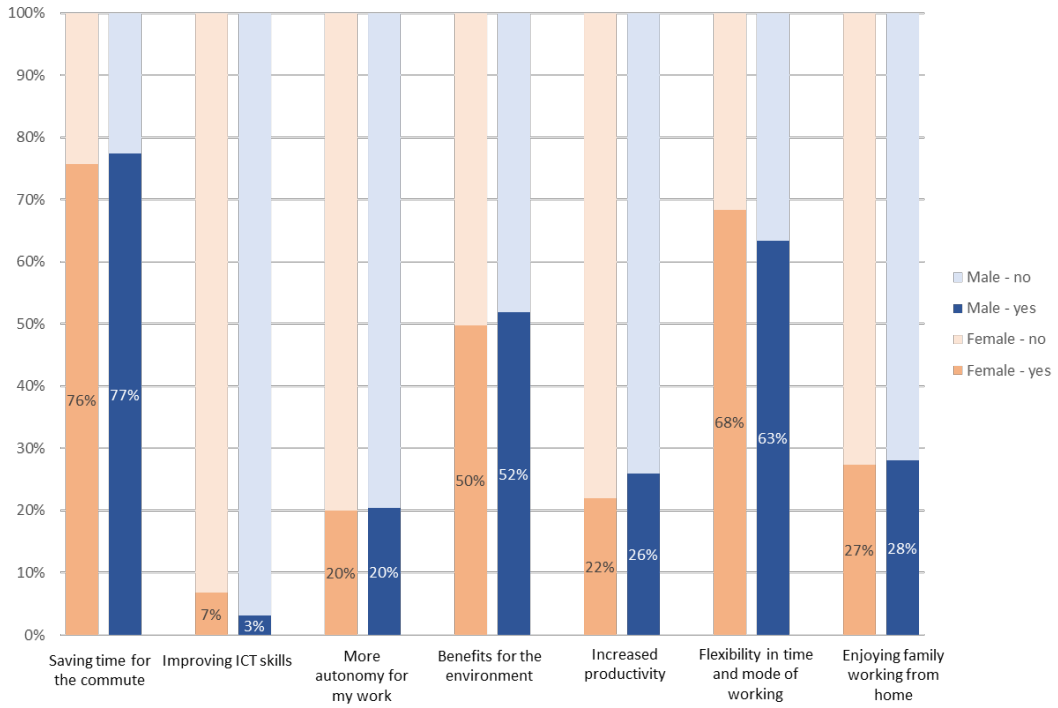

Figure 3.6. Advantages related to agile working during COVID-19 emergency. Breakdown by gender. Total respondents: 2,884.

To further analyze the relationships among the variables under consideration, we applied the Multiple Correspondence Analysis (MCA), which allows a combined analysis on the limits and advantages of the agile working. This analysis is based on the reduction of a set of variables into a reduced number of dimensions (factors) capable of reproducing and synthesizing the information contained in the original variables (see Di Franco, 2011). In this regard, the variables on the disadvantages and advantages related to the agile working[6] and to the structural variables (such as the gender and the disciplinary areas) have been used as active variables (the former) and illustrative variables (the latter).

The factors that summarize the original variables (Figure 3.7) show a distinction among disadvantages and advantages, in the first and second factor respectively. The first factor is characterized by the items related mostly to the disadvantages of the agile working. The positive axis is characterized by "Fragmentation of work due to domestic and family care" (.34), "Feeling of isolation" (score .23), "Postponement of deadlines and work activities" (score .18) and the "Excessive autonomy over my activities", thus referring to elements linked to the management and organization of respondents' work activities. The only exception is represented by the item "Enjoying family working from home", an element to be taken into consideration bearing in mind that the illustrative variables that contribute to the explanation of the first factor are the female gender and the belonging to biological and medical areas. The negative semi-axis, on the other hand, is characterized by elements such as "Improving ICT skills", "More autonomy for my work" and "Increased productivity", which refer to a positive perception of agile working; this

[6] The answers given to the category "other" – related to disadvantages and advantages related to agile working – have been separately analysed for both questions in the questionnaire. In the former case, this modality has been chosen by 507 respondents, whose answers, in most cases (310), could be linked to modalities already indicated in the questionnaire question, while, in other cases, they could be considered missing values. In addition, 197 interviewees indicate the "lack of adequate equipment" among the limits of agile working; for this reason, a new category was added to the ones already proposed. Concerning the advantages, the category "other" has been chosen by 72 people, but, differently from the disadvantages, all the answers, except for the missing values, could be linked to the potential advantages already suggested in the questionnaire.

axis is also characterized by structural characteristics, such as the male gender and the belonging to CUN areas like humanities and social sciences.

It is, therefore, evident that the first factor allows us to reflect on a different perception of agile working based on gender: female respondents refer more to the negative and the organizational aspects of work, while male respondents place the emphasis above positive aspects influenced by working from home.

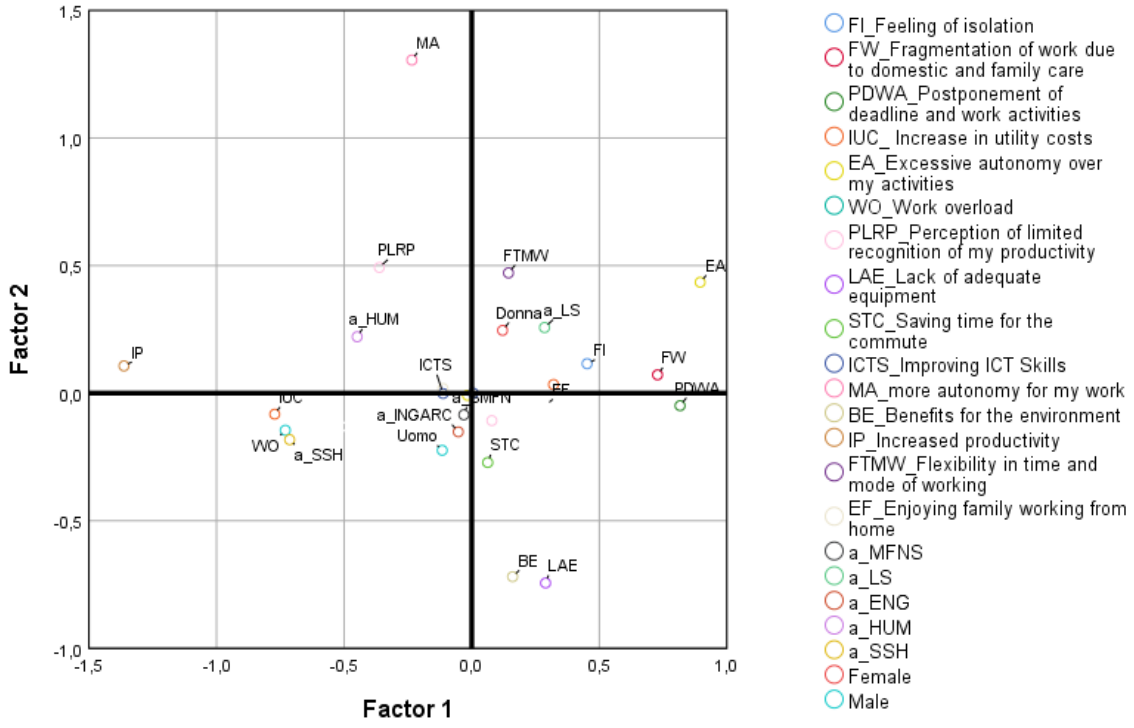

Figure 3.7. Active variables and illustrative variables on the factors extracted from the MCA.

The second factor refers to the advantages, especially on the positive semi-axis: on the one hand, on the positive axis, there are advantages such as “More autonomy for my work” (score .42), “Flexibility in time and mode of working” (score .42); on the other hand, the negative axis is characterized by the presence of some limits of agile working (“Postponement of deadlines and work activities”, “Increase in utility costs”, “Absence of instrumentation”). Figure 3.7 shows that being a woman and belonging to medical and biological areas contribute to the explanation of the positive semi-axes, while being a man and belonging to social science, engineering and architecture contribute to the explanation of the negative semi-axes. Therefore, gender and belonging to specific disciplinary areas are relevant characteristics associated with different perceptions of agile working.

4.4. Attitudes towards scientific performance

A section of the questionnaire compared the changes in the intellectual performance, operationalized through the variations in two peculiar research tasks – the production of papers/monographies and the development of peer reviews – between the pre-COVID period and the health-emergency period.

As mentioned above, the increased productivity has not been considered among the most important benefits of the agile working; nevertheless, through the analysis of data and comments it appears as one of the most promising aspects in the actual experience of the research personnel. Respondents' reports across all research domains point in the same direction: very few scholars experienced a decrease in the production of papers (8.9%), while nearly two-fifths reported an increase (38.4%) and 52.7% reported invariance between pre-COVID period and the agile working period. The breakdown for research domain (Table 3.5) yields a diversified pattern, with an impressive growth as regard to the drafting of papers affecting LS.

While more time spent at home has fostered creativity in terms of drafting research output, the peer review of scientific papers has not shown the same increase. The activity, already practiced by many at home (see Table 3.1), has remained substantially unchanged in quantity between the pre-COVID period and the agile working one. As Table 3.5 reports, once again, the LS reports a strong increase (32.7%).

Table 3.5. Variation of production of paper/monographies and developing of peer reviews in comparison between pre-COVID period and emergency period. Breakdown by research domain. Total respondents: 2,921. Percentages.

	Drafting of papers or scientific monographs		**Peer review for scientific journals**	
	Increased	*Stable*	*Increased*	*Stable*
MPNS	36.9	54.7	20.1	75.5
LS	45.9	46.5	32.7	64.2
ENG	31.3	54.9	24.8	67.6
HUM	38.9	52.4	15.9	77.0
SS	34.6	56.1	16.8	79.4
All domains	38.4	52.7	23.4	72.1

The presence of minor children at home is another important factor in comprehending the trend towards productivity (Table 3.6). In the context of a tendency towards invariance or an increase in drafting papers or monographs, those who do not have minor children at home benefit more from the increase than those who do (40.4% vs. 37.4%). This aspect, however, has no influence on the peer review activity.

Table 3.6. Variation of production of paper/monographies and developing of peer reviews in comparison between pre-COVID-19 period and emergency period. Breakdown by presence of minor children at home. Total respondents: 2,921. Percentages.

	Drafting of papers or scientific monographs		**Peer review for scientific journals**	
	Increased	*Stable*	*Increased*	*Stable*
Minor children at home - Yes	37.4	52.4	23.8	71.4
Minor children at home - No	40.4	52.6	23.3	72.6

Furthermore, age appears to be a relevant factor in relation to the increase in both drafting of papers and reviewing activity (Table 3.7): the younger the age, the higher the claim to increase productivity.

Table 3.7. Variation of production of paper/monographies and developing of peer reviews in comparison between pre-COVID period and emergency period. Breakdown by age cohort. Total respondents: 2,921. Percentages.

	Drafting of papers or scientific monographs		**Peer review for scientific journals**	
	Increased	*Stable*	*Increased*	*Stable*
Cohort 30-44 years	41.3	48.1	26.6	68.2
Cohort 45-54 years	39.1	54.1	24.7	71.2
Cohort 55-65 years	35.0	55.4	18.5	77.2
Cohort +65 years	23.9	63.0	17.4	78.3

Moving to other tasks performed by the research personnel, 43.7% of the research staff belonging to the MPNS and 51.6% of the ENG's one reported a shorter time dedicated to attending conferences (both physical and virtual). These domains also showed a more pronounced decrease in the commitment to scientific dissemination (29.2% from MPNS' respondents and 25.1% from ENG' respondents). A separate case is LS – a sort of outlier considering all the research tasks with reference to "hard sciences" – which has reported marked increases both in participation in conferences (even 49.9% of respondents) and in scientific dissemination (43.5%). In SS and HUM the increase in participation at conferences and web conferences was found to be quite impressive (54.2% for SS and 42.1% for HUM). Also noteworthy is the impulse towards scientific dissemination (reported increase of about 36.5% for both domains).

Among the aspects affecting changes in scientific production (Table 3.8), four out of five respondents reported that management's indications during the agile working period had no or little influence. The messages received from the management were given little weight, favoring autonomous conduct in scientific work. The logistics of the domestic spaces to be dedicated exclusively to the working activities had mostly limited effects, but it still affected almost 30% of the interviewees. The reorganization of working times and activities had a mostly positive impact, reflecting a good predisposition to adaptation, involving 2 out of 5 respondents (41.6%). Finally, the difficulty of carrying out some work activities due to not being able to use office resources and laboratory settings affected just over half of the interviewees (51.6%), and this may have had the positive effect of a greater concentration on the production of papers from unfinished or recently completed works.

Concerning the last point ("The difficulty of carrying out some work activities"), it is precisely the research staff engaged in experimental research who reports a higher level of difficulty than those engaged in non-experimental activities: a lot, 25.7% vs. 9.1%; enough ,34.2% vs. 25.8%.

Table 3.8. Aspects affecting the changes in scientific production during the emergency period. Total respondents: 2,921. Percentages.

	Not at all/A little	Enough/A lot
Specific indications received from the management	80.0	20.0
The logistics of domestic spaces to be dedicated exclusively to working activities	70.8	29.2
The reorganization of working times and activities	58.4	41.6
The difficulty of carrying out some work activities	48.4	51.6

5. Attitudes toward performing agile working when the emergency is over

The widespread activation of agile working during the emergency situations has challenged the traditional organization of individual work, with unavoidable implications for the future. Indeed, it is very likely that the ordinary working mode will shift towards more flexible models capable of balancing sustainability, productivity, and well-being, based on the lessons learned during the emergency. As a result, researchers and technologists can draw a first balance based on the agile working experience, weighing advantages and disadvantages and considering the adoption of a probable alternation between work at office and out-of-office.

When asked "Would you like to work in agile mode when the emergency is over?", 83% of the interviewees expressed themselves in favor, but with marked fluctuations regarding the cohorts, with less positive considerations among the cohort from 55 years old and over (Figure 3.8).

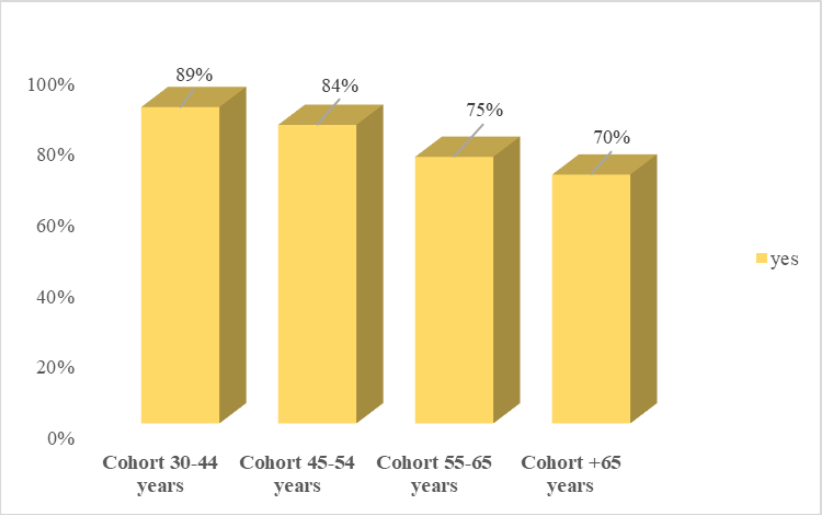

Figure 3.8. "Would you like to work in agile mode when the emergency is over?" Breakdown by age cohort. Total respondents: 2,921.

On the implementation of agile working after the pandemic COVID-19 emergency, many comments were very much in favour of maintaining the possibility to choose this working format, because it proved to improve the individual autonomy:

> I hope that after the pandemic phase, agile working will continue to be a freely selectable option alongside the more traditional vision of the 'office' working. The hope is that the worker will make the decision autonomously and in accordance with the established rules (Researcher CNR – Area 9 – Male).

> Agile working can be a resource that improves the autonomy of the researcher and increases the efficiency at work, also allowing the reconciliation of working times with private life, provided that the researcher can choose when and if to adopt it (Researcher CNR – Area 3 – Female).

Those who showed interest in performing agile working in ordinary time (out of emergency) were asked how many days per week they would like to spend in this working mode. Overall, the respondents preferred two days per week (average 2.5 days, median and mode 2 days). This figure was influenced by the number of respondents from various domains. In fact, SS and HUM prefer three days per week, while respondents from "hard sciences" prefer two (Table 3.9). Furthermore, this preference reinforces a greater compatibility with research activities developed in HUM and SS than in other fields, where however respondents would be willing to spend 40% of their working time in agile mode in any case.

Table 3.9. "How many days a week would you like to perform agile working?" Breakdown by research domain. Total respondents: 2,422.

	Mean	**Median**	**Mode**
MPNS	2.5	2	2
LS	2.3	2	2
ENG	2.6	2	2
HUM	3.2	3	3
SS	3.1	3	3
All domains	2.5	2	2

A final question, based on the interviewees' experiences, was asked to determine how much of the tasks can be effectively carried out in agile mode (Table 3.10). This item is a kind of control over the previous one. HUM and SS have very high percentages of respondents who believe they can perform almost all tasks in agile mode (around 67%), or more than half in any case (about one fifth and about a quarter respectively). Similar percentages are found in MPNS and ENG: at least half, or almost all, ordinary tasks are options chosen by 73.9% and 73.5%, respectively, while the percentage of respondents who claim to be able to carry out less than half of the tasks is four times more than the one found in the other domains. LS are a separate case, where respondents are practically divided into three groups based on their ability to perform less than half, more than half, or almost all the tasks. These latest data demonstrates a greater hesitation – in a context of favorable opinions – about the efficacy of agile working from this research domain.

Table 3.10. "For how much of work do you consider agile working effective" Breakdown by research domain. Total respondents: 2,921.

	Less than 50% my ordinary tasks	More than 50% my ordinary tasks	Almost all my ordinary tasks	Can't estimate
MPNS	21.4	30.9	43.0	4.7
LS	32.4	33.1	28.2	6.2
ENG	20.1	29.8	43.7	6.5
HUM	4.8	20.6	67.5	7.1
SS	5.6	24.3	67.3	2.8
All domains	22.6	30.6	41.4	5.3

6. CONCLUSIONS

We can now try to summarize our results along the research questions addressed, to understand whether the experience of smart working during the COVID-19 pandemic has positively or negatively influenced the scientific work of researchers and technologists at CNR and INFN. The expectation was to face a fast and strong capability of these professionals to adapt to the new and extraordinary working conditions, even if extreme, quickly recovering the conditions of research productivity and efficiency. Some results can be outlined.

First, the survey allows to prove that working from home was an ordinary feature of the scientific profession in public research organizations well before the advent of the pandemic COVID-19. Said differently, it is not something new that emerges for the first time due to the pandemic event, but a normal way that scholars have used in their everyday working activities. Moreover, it is true that a significant number of scholars develop core activities of their professional research life, such as drafting papers exclusively at home or without considering where they are (home or office or elsewhere). The completely new thing is, for the case under study, that the pandemic event allows to overcome some bureaucratic constraints deriving from the rules of the contractual agreement, which in principle do not admit to work at home, thus circumscribing the autonomy of researchers and technologist to decide where they can perform their activities. This special event allows scholars to develop new skill of working remotely, of changing their habits, and of learning new modes for organizing the work, with advantages affecting both the working and the familiar life.

Thus, our hypothesis was not contradicted by the findings. Indeed, the flexibility and the capability of researchers and technologists from all research domains to adapt to the new situation were impressive, and this is particularly true for those belonging to the LS, whose performance during the pandemic event of COVID-19 has improved even more than those of scholars in other fields of science, although in a comparative perspective they have shown a slightly less enthusiastic consideration towards the agile working.

The interesting element is that most of the respondents (especially those belonging to the older age cohort) pointed out the importance of having also physical interactions, denying the possibility that the scientific work could be done only using remote formats. In this respect, two main shortcomings of smart working emerged: a) the smart working during the emergency undermined the quality of the collaborations between scholars, and b) the socialization with other colleagues (professional and human relationships) were also negatively affected. Both the mentioned elements confirm that creativity in research work depends not only on abilities, intrinsic motivations, or engagement in cognitive activities (problem definition, empirical investigation, data gathering, and explanations, Shalley, 1995) but that organizational factors also

play a substantial role (Heinze et al., 2009). Among these factors, individual autonomy in research organization has a key position.

Finally, perceptions and attitudes show differences between fields, with social sciences and humanities scholars feeling more comfortable with smart working than scholars in the other fields. Gender differences, on the contrary, emerge as far as negative aspects of smart working are concerned. Scholars do not live in a vacuum: even in the case of research activities, women suffer much more than men the main disadvantages of agile working during the pandemic event COVID-19, as it was in other labor sectors.

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Chapter 4
Scientific productivity and smart working. Evidence from researchers' perception

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ABSTRACT
In March 2020, in the first months of the emergency caused by the COVID 19 pandemic, the Italian government adopted smart working for companies and public organisations, and it was stated as mandatory by Decree-Law n. 18/2020, with the name of "Agile Working". In the following months, the adoption of smart working in public firms and public organisations was immediate and massive. Millions of public workers experienced a profound change in their professional and life habits. Smart working was a real shock for its characteristics but represented a unique opportunity for understanding the potential effect of a more sustainable labour organisation, to build a more resilient society. The impact of this work transformation in Public Research Organizations (PROs) should have been less shocking than in other sectors because of researchers' and technologists' skills and tasks, but we still know little about the changes that have taken place in terms of productivity. To provide an answer to this question, this chapter presents and describes the results of a survey administrated to researchers and technologists in Italian PROs, aimed at investigating the perception of their productivity with agile working during the pandemic time.

KEYWORDS: smart working, agile working, working from home, Public Research Organisations, productivity.

ISBN (online): 978-88-98193-26-4
ISBN (print): 978-88-98193-27-1

HOW TO CITE THIS CHAPTER
Benati, I., Lamonica, V., & Manello, A. (2022). Scientific productivity and smart working. Evidence from researchers' perception. In Reale, E. (ed). *Agile working in Public Research Organizations during the COVID-19 pandemic. Organizational factors and individual attitudes in knowledge production* (pp. 43-57) Quaderni IRCrES 14. Moncalieri, TO: CNR-IRCrES. http://dx.doi.org/10.23760/2499-6661.2022.14

1. INTRODUCTION

The COVID 19 pandemic, which started in January 2020 and spread across the globe, heavily influenced several aspects of human life. In many countries, a great number of social distancing measures were introduced to prevent the spread of the virus, up to the adoption of lockdown. The restrictive stay at home orders in Italy also influenced the working habits. Decree-Law n. 18, adopted in March 2020, provided mandatory smart working for public organizations, and recommended its use also for private companies. According to Law 81/2017, smart working (namely Agile Working) is a method of execution of the employment relationship established by agreement between the parties, also with forms of organization by phases, cycles and objectives, and without precise constraints of time or place of work, with the possible use of technological tools for the work performance. The work can be performed partly inside a company and partly outside, without a fixed location, within the limits of the maximum duration of daily and weekly working hours, deriving from the law and from the collective bargaining. In general terms, smart working can be included into the wide family of the Working from Home schemes (WFH from now on). During the COVID 19 pandemic, agile working became the usual practice for millions of workers. The change which occurred suddenly and unexpectedly led to an initial phase of difficulty and disorientation for workers and employers, which was followed by a gradual adjustment of working practices. This phenomenon has also occurred in the field of the public research sector, which had to deal with these changes and adapt its working habits to them. Now that the post-pandemic restart is being planned, it is relevant to ask what lessons can be retained from the widest social experiment of all time (Lebow, 2020). In this context, it is interesting to understand how smart working has changed the working practices and how it has affected the productivity. We can do that by trying to answer some questions, such as: Has researchers' and technologists' productivity increased? Can we identify specific characteristics that affected the productivity? Which scientific activities are most difficult to carry out in agile working?

It is plausible to ask whether the productivity in agile working in the research field is comparable to the productivity carried out in presence or not. To give a correct answer we cannot ignore the differences between the different tasks, for example, some tasks are difficult to be carried out at a distance because they involve the physical presence of the operator (laboratory analysis for instance). Instead, what happens for all the other activities that can be carried out in any place at any time? The present study tries to answer all these question by analysing the perception of some Italian Public Research Organisations' (PRO) workers about their productivity under the smart working scheme during the pandemic.

In the socio-economic literature, the topic of smart working has a significant relevance, and it is treated from different points of view. The pandemic, and the consequent development of this way of working, has greatly increased the production of papers about the subject. To compose a theoretical framework on the productivity of the research under the WFH scheme, it is useful to put together different strands of socioeconomic literature. Two issues emerge as predominant. The first issue concerns the characteristics that make a job remotely executable (Dingel & Neiman, 2020; Hensvik et al., 2020; Mongey et al., 2020; Garrote Sanchez et al., 2021). In particular, Dingel & Neiman (2020), in a study on the United States, have classified the different professions according to the possibility of carrying them out remotely, and claim that professions that are better paid are more executable at a distance. Workers in high-skilled occupations such as management, business, financial, and professional occupations, work more hours at home than workers in less-skilled occupations, except for the farmers (Hensvik et al., 2020). Considering different production sectors, except agriculture, the broad industries with the most hours worked at home are information, financial activities, and professional and business services, while industries with the least smart working hours are transportation and utilities, and leisure and hospitality (Hensvik et al., 2020). Occupations and workers' characteristics are both important determinants for smart working ability (Gottlieb, 2020).

The second relevant issue concerns the advantages and disadvantages of smart working (Ipsen et al., 2021; Rubin et al., 2020). Ipsen et al. (2021), using data from 29 European countries on the experiences of knowledge workers, showed that most people had a more positive, rather than negative, experience of working from home during the lockdown period. Three factors represent the main advantages:

i. work-life balance;
ii. improved work efficiency;
iii. greater work control.

The main disadvantages were:

iv. home office constraints;
v. work uncertainties;
vi. inadequate tools.

By comparing the gender, the number of children at home, the age and the type of profession, they provided insights into the differential impact of WFH on people's lives.

All these reflections must obviously be considered in the reasoning on smart working productivity (Bloom, 2014; Angelici & Profeta, 2020; Bao et al, 2020). The topic has been widely studied both in the context of private companies (Bloom, 2015; Morikawa, 2021; Etheridge et al., 2020; Barrero et al., 2021) and of public companies (Battiston, 2021; Kunze et al., 2020; Arkesteijn et al., 2021). However, the emerging evidence on productivity is controversial. Morikava (2021), surveying Japanese workers, found that for the vast majority of employees the productivity in smart working is lower than the productivity at headquarters. Etheridge et al. (2020), whose study is based on a survey of individuals in the United Kingdom, show that, on average, productivity in smart working is not significantly different from that of workplace, but it varies depending on individuals' socio-economic status, industry, and occupation. Barrero et al. (2021), based on a survey of individuals in the United States, indicate that the majority of respondents who have adopted smart working practice, report higher productivity than what they expected before the start of the pandemic.

Empirical studies investigating the productivity of working from home, under COVID-19, from the employer side have been rare. An exception are Bartik et al. (2020), who use data collected from a survey of small-and medium-sized firms in the United States during the period from March to April 2020, that reported a decrease in productivity of about 20% on average. Battiston et al. (2021), using a natural experiment on a public sector organisation in the United Kingdom in charge of answering emergency calls, showed that productivity is higher when teammates are in the same room, and that the effect is stronger for urgent and complex tasks. Kurze et al. (2020), in their survey about German employees, found that, in terms of commitment and productivity, employees' self-assessments suggest that smart working may increase the job satisfaction and lead to similar performance levels as company-based work.

Another line of study concerns the productivity of the research and its determinants. Research productivity, in particular scientific publications, are related to personal, academic, and departmental factors (Zainab, 1999). Among personal factors, gender, age and family background are the most frequently analysed. Many studies identify a gender gap between men and women in scientific productivity (Larivière et al., 2013; Huang et al., 2020; Holman et al., 2018), even if this difference is reducing over time (Frietsch et al., 2009; Abramo et al., 2009; Leahey, 2006); age is also often cited as a factor, although the results of such studies are controversial. While Creswell (1985) affirms that the age has little predictive influence on performance, Bonaccorsi & Daraio (2003) state that the scientific productivity decreases with the average age of researchers.

Family background has also an influence on scientific productivity, but even in this case the literature does not agree. Cole & Zuckerman (1987) indicated that the American natural and social scientists who were married with children have a higher scientific productivity than the unmarried

female researchers. Kyvik (1990), in a Norwegian sample, found that women who have children under 10 years of age published less than their male colleagues (with similar aged children) and other female academics with older children.

Literature on productivity in the research field during COVID 19 pandemic are still little but is growing quickly. Many studies measure scientific productivity by using submission or publication of scientific papers (Cushman, 2020; Seyyed Hosseini & Basirian Jahromi, 2021; Squazzoni et al., 2021) while others focus on more dimensions by making use of perceived productivity (Meehan et al., 2021; Sawert & Keil, 2021). Our study belongs to the second group and analyses the perceived scientific productivity of researchers and technologist in Agile Working during the COVID-19 pandemic emergency.

2. DIMENSIONS OF INTEREST AND METHODS

The goal of our study is to determine the change in productivity that has occurred since the introduction of the agile working, through researchers' perception.

Data were collected through a questionnaire administered to 2,921 respondents, of which 388 units from INAF and 2,533 units from CNR-IRCrES, between February and March 2021 (Fabrizio et al., 2021). The aim of the study is to answer to three research questions: has researchers' and technologists' productivity increased? Can we identify specific characteristics that affect the productivity? Which scientific activities are most difficult to carry out in agile working?

To carry out the study, we analysed several sections of the questionnaire (see the Annex of this book). In particular, we introduced personal variables, such as:

(A1) The professional role in the PROs;
(C1) The gender, that has been analysed as a dummy variable, and that imposes the loss of 37 observations (missing values) in the regression model;
(C2) The age (four groups);
(C5) The approximate size (Sqm) of the house, where the agile working is mainly carried out;
(C6) The number of cohabitants in the same home;
(C7, C8, C9, C10) The specific number of cohabitants, both adults and minor children;
(C15) CUN Scientific disciplinary areas (starting from these 14 areas, we created a dummy variable based on STEM- Science, technology, engineering, and mathematic disciplines- and non-STEM).

Section D concerns the well-being dimension. Below, we will describe some questions followed by the proposed answering mode.

(D13): how much do you consider that the following activities changed from the "pre-COVID-19" period to the "COVID-19 emergency" period?
Writing of papers or scientific monographs;
Study of the scientific literature;
Participation in conferences (including web conferences);
In presence or virtual meetings related to research projects;
Scientific dissemination through seminars, lectures, or webinars;
Peer review for scientific journals.

D13 has been used to build the three indexes presented in our contribution:

i. The Global Productivity Index (GPI) is given by the row-sum of these dummies, assuming the value of six if the perceived productivity increases or remains stable in all aspects, while the value of zero if the respondents indicate a decline in productivity in all aspects.

ii. High Global Productivity Index: dummy for identifying the respondents with high or stable productivity in all listed aspects.
iii. High Perceived Efficiency: the dummy assumes a value of one if the respondent declares to be able to efficiently carry out his own tasks working from home.

In order to collect information on the effectiveness of working from home, we detect the perceived researchers' intention on continuing agile working after pandemic, and we created a dummy named

iv. Agile working in the future.

We have also built an indicator defining the intensity of potential use, in term of agile working days desired:

v. days of agile working in the future.

Finally, we have also asked questions about:

(E1) The internet connection mainly used when working from home;
(G2) The time spent for the usual commute from home to work to home (in minutes).

2.1. Empirical model

Concerning methods, we will describe, through different econometric models, the relationship between the five indicators of productivity of the agile working, considering personal and job characteristics like gender, age, job qualification and distance time variables.

The following equation represents the general estimated model, where the perceived productivity assumes alternatively the previously defined variables from i to v:

$$Perceived\ Productivity_k = \beta Y_k + \mu F_k + \delta Z_k + \varepsilon_k \qquad k = 1, \dots K$$

As described before, the *perceived productivity* variable identifies one of the five different measures of productivity/efficiency or future intention to adopt agile working. In the case of a continuous variable (i and v), we adopt a standard regression model with robust standard errors, while in the case of the dummies (ii, iii, iv), we run probit models, and all the reported coefficients are referred to marginal effects computed at the mean.

Y_k represents a vector collecting the available personal information of the respondent k, to isolate some specific characteristics able to influence the perceived productivity/efficiency or the future adoption of agile working. We include a dummy for the gender (that is active if the respondent is a female), the number of family members, the number of young sons, and a dummy for the presence of old parents in the family.

The vector F_k collects job-specific controls referred to the k worker. We identify if the respondent is a director or a technician (two dedicated dummies), and the main research area, (STEM vs non-STEM, a dummy).

Z_k collects respondent-level information on house-specific variables referred to the dimension of the house (in square meters), the distance from the workplace (in km) and the presence of an ADSL connection (a dummy).

Finally, ε_k represents the idiosyncratic error component.

3. RESULTS AND DISCUSSION

3.1. Descriptive statistics

We decided to condense the relevant information on the perceived personal productivity encountered during the agile working phase, as well as the information on the future availability of working, according to the agile configuration.

We defined three different indicators of productivity and two indicators on the intention of running agile working in the future.

Firstly, we created a composite (*Global Productivity Index)* build using six specific questions on the perceived productivity, according to different aspects of the research work: the elaboration and writing and of scientific papers, review of the literature, participation in workshops and conferences, meetings for research projects, seminars or lessons or webinars, and peer-reviewing. Each of these aspects has been defined as a dummy, equal to one in the case the respondents argue that their productivity remained stable or has grown with the agile working. The resulting Global productivity Index is given by the row-sum of these dummies that assume the value of six if the perceived productivity increases or remains stable in all aspects, and the value of zero if there are cases of reported productivity decreases in all aspects.

Secondly, we defined a dummy for the identification of the respondents who declared a very high or stable productivity performance (*High Global Productivity Index*) in all the aspects listed. Third, we created a dummy based on the perceived efficiency during agile working, defined as the ability of running all job tasks from home. The dummy, named (*High Perceived Efficiency)*, assumes a value of one if the subject argues that all his job tasks can be efficiently done with smart working.

Finally, we asked about intention of continue using agile working in the future. We defined a dummy named (*Agile working in the future)* that assumes a value of one in case of a positive intention of using agile working in the future. Moreover, we define the intensity in its usage by the number of days that the researchers indicate as potentially suitable for performing agile working in the future.

The following tables report some descriptive statistics (averages) for the five indicators created according to some interesting information available in the survey, for what concerns the personal and working characteristics of the respondents.

Table 4.1 shows interesting differences according to the gender: female researchers seem more positive about their experience of agile working, with a higher perception of average productivity (column 2), both in general and in terms of very high productivity (column 3). However, females seem less confident on the idea that all their job tasks could be done online, while they are in line with men on the idea of adopting agile working in the future, but with a lower intensity.

Table 4.1. Perceived productivity, efficiency & future intentions, by gender. Source: Own elaboration on survey data

Gender	Global Productivity Index	High Global Productivity Index (d)	High Perceived Efficiency (d)	Agile working in future (d)	Days of future agile working
Male	4,881	0,399	0,460	0,831	2,673
Female	5,061	0,466	0,368	0,830	2,411
Total	4,969	0,432	0,415	0,830	2,545

Table 4.2 shows some unexpected evidence on the perceived productivity, with the 55-64 years old class characterized by a higher efficiency from the adoption of agile working, with the

older and the younger classes below the average. However, the 55-64 class is also the one with lower confidence on the possibility of doing all job tasks from home (column 3). On the contrary, younger researchers have a greater propensity to continue with the agile working modality in the future, but they claim a lower intensity in comparison to older researchers.

Table 4.2. Perceived productivity, efficiency & future intention, by age class

Age class	Global productivity Index	High Global Productivity Index (d)	High Perceived Efficiency (d)	Agile working in future (d)	Days of future agile working
-44 Y	4,945	0,410	0,416	0,891	2,456
45-54 Y	4,982	0,433	0,429	0,838	2,534
55-64 Y	4,995	0,462	0,392	0,756	2,671
65 +	4,682	0,341	0,477	0,705	2,806
Total	4,969	0,432	0,415	0,830	2,545

Table 4.3, according to some characteristics of the research job, shows the distribution of global productivity, the efficiency, and the future intentions with agile working. In particular, the perceived productivity during the COVID-19 pandemic seems higher for technicians, with an inverse relationship between productivity and research responsibilities. Surprisingly, also in the case of job-task technicians, they seem able to run all their activity online, without the need of a physical presence into offices; on the contrary researchers and directors highlight the necessity of coming back to offices for some activities. The intentions for the future usage of agile working are coherent with those pieces of evidence, with a larger fraction of technicians who argue a frequent and intense usage of agile working.

For what concerns the main area of research, the presence of a large physical laboratory reduces the general propensity of STEM areas to agile working, with regard to productivity, efficiency, and the intensity of working agile in the future.

Table 4.3. Perceived productivity, efficiency & future intention, by job qualification

Job qualification	Global productivity Index	High Global Productivity Index (d)	High Perceived Efficiency (d)	Agile working in future (d)	Days of future agile working
Director	4,794	0,294	0,353	0,559	2,421
Researcher	4,927	0,414	0,392	0,826	2,505
Technician	5,270	0,570	0,579	0,882	2,816
Research Area					
NO STEM	5,090	0,476	0,674	0,837	3,167
STEM	4,958	0,428	0,392	0,829	2,490
Total	4,969	0,432	0,415	0,830	2,545

The last angle of preliminary descriptive analysis is focused on the physical distance between home and workplace. Table 4.4 shows something expected: the perceived level of productivity, both measured as a continuous variable or as a dummy, tends to rise with the physical distance (of course the same evidence is confirmed in case of distance defined according to time) between home and workplace.

Also, for what concerns the capacity of running all the job-tasks from home, this probability tends to increase with the distance, and the same will happen with the future adoption of the agile working.

Table 4.4. Perceived productivity, efficiency & future intention, by distance from the job place

Distance (time)	Global productivity Index	High Global Productivity Index (d)	High Perceived Efficiency (d)	Agile working in future (d)	Days of future agile working
0 - 20 min	4,850	0,384	0,365	0,752	2,304
21- 40 min	4,958	0,441	0,391	0,812	2,576
41- 60 min	5,039	0,454	0,426	0,871	2,568
+ 60 min	5,090	0,472	0,501	0,925	2,772
Total	4,969	0,432	0,415	0,830	2,545

3.1.1. Results for general productivity

After providing descriptive evidence on the five indicators proposed, we investigate with more details on their multivariate relationship with individual level aspects. Table 4.5 reports all the results from the estimation of the model in (1), and the computed coefficients for all control variables.

In general, we find significant gender heterogeneities in our estimates. Female researchers report higher productivity during the pandemic agile working, arguing that working from home helps with balancing work and family needs during the emergency phase, but it cannot be a structural solution given that females are less available to work from home in the future (in terms of days per week) in comparison to males. Surprisingly, females encounter more often difficulties on doing well all their job-tasks from home and, in general, suggest maintaining a more limited number of working-home days in the future, in comparison to male researchers.

The number of family members has a general negative effect on productivity indicators and it is also negative, significant and strong when the indicator measures the high perceived efficiency of doing all job tasks, connected to the availability of working agile in the future and of the intensity of agile working in the future. On the contrary, the presence of minors (sons or daughters) increases the perceived efficiency, as well as the preferences of working agile in the future, both in the extensive and intensive variable.

When considering job-level variables, we find a clear and positive evidence on all indicators for the subgroup of technologist: they report more positive effects of agile working on all aspects considered, in comparison to researchers and directors. In addition to this, researchers and technologists from STEM areas have perceived lower efficiency during agile working, and they would basically like to work lesser days in smart working in the future.

For what concern the remaining aspects, the evidence on the issue of distance is strongly confirmed; the higher is the job-home distance the higher is the expected positive effect on productivity, on efficiency, and on the availability of adopting agile working in the future for researchers. On the contrary, we find no evidence on the relationship between house dimension and productivity, without any kind of effect nor on perceived productivity neither on the future availability of working from home. The ADSL connection seems an important driver for the perception of being able to do all job task, and for the propensity of working smart in the future.

Table 4.5. Perceived productivity, efficiency & future intention, by distance to the job place

	Dependent Variables				
	(1) Global productivity Index (n)	(2) High Global Productivity Index (d)	(3) High Perceived Efficiency (d)	(4) Agile working in future (d)	(5) Days of future agile working (n)
Female (d)	0.183***	0.0663***	-0.106***	0.00105	-0.238***
	(0.0425)	(0.0187)	(0.0187)	(0.0136)	(0.0500)
Family members (n)	-0.00836	-0.00402	-0.0240**	-0.0188***	-0.0595**
	(0.0236)	(0.0101)	(0.0103)	(0.00720)	(0.0288)
Young son (n)	-0.0548	-0.0224	0.0496*	0.0954***	0.195**
	(0.0634)	(0.0278)	(0.0282)	(0.0194)	(0.0782)
Parents (d)	0.00446	0.00817	-0.00136	0.0264	0.0225
	(0.112)	(0.0481)	(0.0498)	(0.0321)	(0.138)
STEM area (d)	-0.0616	-0.0232	-0.282***	0.00111	-0.542***
	(0.0732)	(0.0346)	(0.0327)	(0.0258)	(0.1000)
Directors (d)	-0.0959	-0.110	-0.123	-0.240***	-0.891***
	(0.192)	(0.0832)	(0.0811)	(0.0863)	(0.253)
Technologists (d)	0.336***	0.155***	0.173***	0.0542***	0.367***
	(0.0602)	(0.0279)	(0.0284)	(0.0180)	(0.0745)
House dimension (sq)	-8.84e-05	0.000183	0.000224	-4.42e-05	0.000733
	(0.000579)	(0.000217)	(0.000218)	(0.000162)	(0.000628)
Distance to job (km)	0.00198***	0.000602***	0.00104***	0.00158***	0.00647***
	(0.000432)	(0.000199)	(0.000198)	(0.000208)	(0.000519)
Adsl connection (d)	0.0636	-0.00116	0.0630***	0.0296	0.165***
	(0.0580)	(0.0243)	(0.0240)	(0.0188)	(0.0639)
Constant	4.796***				2.210***
	(0.106)				(0.136)
Observations	2,884	2,884	2,884	2,884	2,884
R-squared	0.024				0.087

Robust SE in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Marginal effects computed at the mean (2) (3) (4).

4. DISCUSSION AND CONCLUSIONS

The measure of the perceived productivity of researchers and technologists offers the possibility of identifying in advance some critical issues. This is particularly useful in a period of strong change, such as that triggered by the COVID-19 pandemic, which has made it possible to massively experiment the use of smart working in the scientific production process.

The results of our study indicate that, in the perception of the researchers and the technologists interviewed, the scientific productivity remained stable or increased with smart working. Data also confirms a positive attitude towards the future use of smart working, even outside the pandemic emergency. Women feel to be more productive under the smart working scheme but feel less efficient and intend to use it for fewer days than man in the future. A potential explanation, already attested in other studies (Czymara et al., 2020; Fodor et al., 2020; Mohring et al., 2020; Cook et al., 2020), can be attributed to the fact that woman typically bears the burden of caring for other family members, in particular for children, but also in terms of home care. When more members of the family are simultaneously present in the house, the workload tends to increase (Craig et al., 2020; Krukowski, et al., 2021; Myers et al., 2020; Staniscuaski et al., 2020; Zoch et al., 2020). Our model confirms that the number of family members have a negative

effect on the perceived scientific productivity, on the possibility to do agile working, and on the number of days they would like to work in agile working.

Our study proves that the perception of productivity is age-related, in fact, researchers between 55 and 64 years are those who declare a higher perceived productivity in smart working, but are the youngest (less than 44 years old) the ones to mostly declare that they would like to use this way of working in the future. This result seems to tell us that, despite the difficulty of smart working, especially if it means working from home in presence of children, smart working allows a better management in terms of flexibility and reconciliation of working and family-free time.

Our study also proves that the perception of an increased productivity is also related to the scientific sector. Researchers and technologists from STEM areas perceived lower efficiency during agile working, and they would like to work fewer days in smart working in the future. This result is likely to be due to the perception of a decrease in efficiency linked to the need to use laboratories and conduct experiments (Camerlink et al., 2021; Korbel & Stegle, 2020).

In conclusion, our survey confirms some of the main theories on scientific productivity and on efficiency during smart working, while highlighting how the pandemic may therefore exacerbate gender inequality, which is already an important concern in Academia (Andersen et al., 2020; Kibbe, 2020; Myers et al., 2020; King & Frederickson, 2021; Martucci, 2021; European Commission, 2019). Obviously, these results constitute a first partial answer to the set of research questions initially proposed. In fact, our study has some obvious limitations. The perception of productivity, although considered reliable in the literature, is however less trusted than a more objective measure of scientific productivity. For this reason, to consolidate the results obtained it would be appropriate to enlarge our study adding the analysis of data compared to high measurable and objective indicators of scientific productivity. In order to do that, it is necessary to wait for the review and for the publication processes of the journals that received scientific contributions during the period in which researchers and technologists were mostly working from home, due to the COVID-19 pandemic.

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6. APPENDIX

Table 4.1. Perceived productivity, efficiency & future intention, by Academic disciplines (CUN areas)

Academic disciplines (Italian definition)	Global productivity Index	High Global Productivity Index (d)	High Percieved Efficiency (d)	Agile working in future (d)	Days of future agile working
Area 1 – Scienze matematiche	4,988	0,439	0,746	0,873	3,119
Area 2 – Scienze fisiche	4,823	0,375	0,462	0,868	2,610
Area 3 – Scienze chimiche	4,928	0,401	0,170	0,787	2,068
Area 4 – Scienze della terra	5,052	0,438	0,472	0,856	2,595
Area 5 – Scienze biologiche	5,165	0,525	0,259	0,788	2,166
Area 6 – Scienze mediche	5,350	0,625	0,350	0,800	2,389
Area 7 – Scienze agrarie e veterinarie	5,023	0,453	0,285	0,756	2,396
Area 8 – Ingegneria civile e architettura	5,104	0,583	0,458	0,750	2,861
Area 9 – Ingegneria industriale	4,669	0,314	0,429	0,854	2,590
Area 10 – Scienze dell'antichità	4,814	0,400	0,686	0,814	3,289
Area 11 – Scienze storiche, filosofia	4,946	0,393	0,661	0,804	3,178
Area 12 – Scienze giuridiche	5,469	0,625	0,688	0,844	3,074
Area 13 – Scienze economiche e statistiche	5,476	0,667	0,667	0,857	3,111
Area 14 – Scienze politiche e sociali	5,061	0,394	0,667	0,909	3,067
Total	4,969	0,432	0,415	0,830	2,545

Table 4.2. Perceived productivity, efficiency & future intention, by connection quality

Connection quality	Global productivity Index	High Global Productivity Index (d)	High Perceived Efficiency (d)	Agile working in future (d)	Days of future agile working
No ADSL	4,936	0,439	0,373	0,818	2,470
ADSL	4,976	0,430	0,425	0,833	2,562
Total	4,969	0,432	0,415	0,830	2,545

Table 3. Perceived productivity in the research-specific components (marginal fixed)

	Dep. Variables: research-specific productivity components					
Dep. variables	(1) papers	(2) literature	(3) conference	(4) projects	(5) lessons	(6) review
Female (d)	0.00848	0.0148	0.0919***	0.0286**	0.0398**	0.000753
	(0.0105)	(0.00975)	(0.0184)	(0.0137)	(0.0163)	(0.00761)
Family members (n.)	-0.00182	-0.00276	0.00542	-0.00181	-0.00516	-0.000926
	(0.00558)	(0.00536)	(0.00994)	(0.00739)	(0.00880)	(0.00414)
Young sons (n.)	-0.0186	-0.0162	-0.0509*	0.0392**	-0.00534	-0.00615
	(0.0155)	(0.0143)	(0.0273)	(0.0199)	(0.0242)	(0.0113)
Parents (d)	0.0163	0.00450	-0.00719	-0.0299	0.0244	-0.00314
	(0.0253)	(0.0241)	(0.0479)	(0.0370)	(0.0409)	(0.0199)
STEM area	0.0087	0.103***	-0.0915***	-0.00670	-0.089***	0.0126
	(0.0204)	(0.0260)	(0.0329)	(0.0251)	(0.0267)	(0.0151)
Director (d)	-0.0500	-0.0192	-0.0471	-0.0142	0.0572	-0.0145
	(0.0583)	(0.0480)	(0.0889)	(0.0625)	(0.0687)	(0.0397)
Technician (d)	0.0374***	0.0277**	0.131***	0.0341*	0.113***	-0.00521
	(0.0131)	(0.0126)	(0.0258)	(0.0192)	(0.0211)	(0.0122)
House dimension (sq)	-0.000323	0.0003**	-0.00016	-0.0002	-0.00015	0.00032
	(0.0001)	(0.0001)	(0.0002)	(0.0001)	(0.0002)	(0.0001)
Distance to job (km)	0.00046***	0.0003**	0.00058***	0.00044***	0.00034*	0.00015
	(0.00013)	(0.0001)	(0.0002)	(0.00016)	(0.000177)	(0.00085)
Adsl connection (d)	0.0138	0.0374**	-0.0153	-0.0123	0.0205	0.0197*
	(0.0144)	(0.0146)	(0.0239)	(0.0175)	(0.0215)	(0.0115)
Observations	2,884	2,884	2,884	2,884	2,884	2,884

Robust SE in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Marginal effects computed at the mean

Chapter 5
Agile working and well-being during the COVID-19 pandemic

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ABSTRACT
This chapter aims to shed light on well-being dimensions and on the implications of the implementation of agile working in the Italian Public Research Organisations (PROs). The empirical investigation is based on an original web-based survey administered during the COVID-19 pandemic to researchers and technologists (R&Ts) of the CNR – the National Research Council of Italy – and INAF – the National Institute of Astrophysics. This study focuses on the main determinants of improvements and/or deteriorations of R&Ts' well-being. Does agile work favour the reconciliation between work and free/family time? Are there specific characteristics that influence the respondents' well-being? We combined quantitative and qualitative analyses to answer to these research questions, and we estimated a multinomial logistic model to identify the main determinants of perceived changes in R&Ts' work-family balance and qualitative methodology to obtain further insights on the perceived benefits and limits of agile working. Since well-being during agile working can be affected by personal, environmental, and organisational factors, the analysis of advantages and criticalities can help developing better strategies to implement agile working in the post-pandemic world.

KEYWORDS: smart working, Public Research Organisations, worker's wellbeing, workaholism, work-family balance.

ISBN (online): 978-88-98193-26-4
ISBN (print): 978-88-98193-27-1

HOW TO CITE THIS CHAPTER
Lamonica, V., & Sella, L. (2022). Agile working and well-being during the COVID-19 pandemic. In Reale, E. (ed). *Agile working in Public Research Organizations during the COVID-19 pandemic. Organizational factors and individual attitudes in knowledge production* (pp. 59-77) Quaderni IRCrES 14. Moncalieri, TO: CNR-IRCrES. http://dx.doi.org/10.23760/2499-6661.2022.14

1. INTRODUCTION AND RESEARCH QUESTIONS

This chapter aims to analyse the implementation of agile working in the Public Research Organisations (PROs) through an in-depth analysis of its well-being dimensions and implications. The empirical investigation is based on data from an original web-based survey, administrated in Italy between February and March 2021 by CNR-IRCrES, to researchers and technologists (R&Ts) of CNR – the National Research Council of Italy – and INAF – the National Institute of Astrophysics, i.e., the two main PROs under the supervision of the Italian Ministry of University and Research. This research does not include R&Ts from Universities, because of the huge differences in work organization (see Fabrizio et al., 2021).

The R&Ts' perceptions concerning well-being in agile working has been analysed in the peculiar COVID-19 lockdown situation, when the great majority of people were compelled to work from home, as well as the students who attended their lessons online. The aim of the study is to take advantage of this unprecedent real-world experimentation of smart working models (Loia & Adinolfi, 2021) to investigate the main determinants of improvements and/or deteriorations in R&Ts' well-being. In fact, well-being during agile working can be affected by personal, environmental, organisational factors and the analysis of advantages and criticalities can help developing better strategies to implement agile working in the post-pandemic world.

Our main research interests concern how R&Ts' perceptions on well-being differ by gender, age groups, family composition, commuting and working habits, contractual and sectoral aspects, the perceived benefits, and the limits of smart working in pandemic: does agile working favour the reconciliation between work and free/family time? Are there specific characteristics that influence respondents' well-being?

Using data from the survey questionnaires (see Chapter 2 for details), this chapter combines quantitative and qualitative analyses to investigate the changes experienced by PROs R&Ts' in well-being, as well as an assessment of the main benefits and limits of agile working. In particular, a multinomial logistical model is estimated to identify the main determinants of the perceived changes in R&Ts' work-family balance when working from home during the lockdown, compared to the pre-pandemic situation. The quantitative approach is complemented by a qualitative methodology applied to obtain further insights on the perceived benefits and limits of agile working during the pandemic. More in details, the econometric model is based on the question (F3) *During the COVID-19 emergency, how does agile working affect your work-family balance?*, while the qualitative analysis concerns text-based answers to two open-ended mode questions (D11 and D12): *Based on your experience, please indicate the most relevant limits of the agile working during the COVID-19 health emergency*; *Based on your experience, please indicate the most relevant benefits of the agile working during the COVID-19 health emergency*.

The rest of the chapter is organized as follows: section 2 overviews the main literature on agile workers' well-being, its main dimensions, and its determinants; section 3 introduces data and methods; section 4 discusses the results of the qualitative and quantitative analyses; and lastly, section 5 concludes the analysis.

2. AGILE WORKING AND WELL- BEING: AN OVERVIEW

The onset of the COVID-19 pandemic has led to a rapid reorganization of work processes in all sectors, including research. Since 2020, many studies have started to analyse the phenomenon in its various facets, investigating the benefits and limits of this new work structure. The large-scale shift to agile working (mostly from home) caused by the pandemic gave to researchers the opportunity to study in a real-world experimentation the impact on workers' wellbeing , and the possibility of reorganizing the work processes towards more flexible schemes.

The lessons learned about agile working during the pandemic time can also provide guidance for an effective implementation of long-term policies for a strategic reorganisation of work

processes in the future post-pandemic era. The complexity of the topic under analysis is due to the implication that agile working (and working from home in our specific case) has on several aspects of workers' lives. In fact, well-being during agile working can be affected by personal, environmental, organisational factors. The multidimensionality of the phenomenon requires a deep literature analysis to detect the several dimensions, both from the sphere of life and from that of work. Although there is a lot of literature on the topic, there are not many studies that have analysed the particular population investigated in this contribution, namely researchers and technologists of the Public Research Organisations. The intent of the contribution is precisely to describe the well-being in relation to this population, which has very specific characteristics compared to other workers (e.g., autonomy, flexibility, but also the need for suitable spaces and equipment to be able to carry out intellectual work).

Working during the pandemic mostly means working from home, in spaces not designed for this purpose, poorly equipped, and often not acoustically isolated from other family members. This way of working also means no direct contact with colleagues, the organization of numerous online meetings and the renunciation of informal exchanges; at worst, it can also mean isolation (Albano et al., 2019; Malzani, 2018). Social relations in the workplace are also an important source of job satisfaction therefore, the reduction of social relationships due to agile working is likely to affect the quality of the working life, too.

The literature that studies well-being in relation to smart working, especially in the last two years, mainly analyses three topics: the family's characteristics, the gender gap, and the ability to define barriers between working time and free/family time. According to George et al. (2021), it seems that the interference of work in personal life is a key factor causing stress. The main problem seems to be connected to the inability to maintain boundaries between work and non-work life activities (Eddleston & Mulki, 2017). This is especially true if working from home with the partner and or with children. Working time can easily become blurred, fragmented and expanded over a longer period of time, as it becomes necessary to take care of the children or manage the household chores (Grant et al., 2019). According to Shamir & Salomon (1985), the stress associated with the inability to distinguish between working and non-working hours is even greater for workers in occupations that require greater concentration, who cannot turn off their work and return to it immediately. In relation to the fluidity of time and spaces dedicated to paid work and private life, Romens (2021) speaks of *spread working*, which spreads everywhere and at any time, overcoming the concept of smart.

Working from home exposes to the risk of being swallowed up by *workaholism*: the colonization of work on other aspects of life. This implies the failure to exercise the right to disconnect, on which many countries have begun to legislate after the COVID-19 pandemic outbreak (Albano et al., 2019). The priority in this context is to limit the negative effects of smart working, protecting employees' non-working time with the possibility of an endless work (Eurofound & ILO, 2017). The intense use of this way of working has brought out the importance of imposing time limits on work activities, to encourage the balance between the work and the private life of the employees.

The analysis of the advantages and the limits of agile working inevitably places us in a gender perspective, especially in Italy, where in the pre-pandemic 2019 only 6% of male and female workers worked from home, and women have had more difficulties than their colleagues to access flexible ways of working, in terms of time and space (ISTAT, 2020). In this context, it is necessary to investigate whether smart work allows to improve the reconciliation between working time and care time (domestic and family), or free time. In Italy, literature on the topic points out that the reconciliation is an issue that concerns, above all, the women, because of the specific characteristics of the family welfare. Care work falls on families and, in particular, on women (Naldini & Saraceno, 2012), due to the weak state support for early childhood services and to the unbalanced distribution of unpaid domestic work.

According to Søresen (2017), the reconciliation issues are closely related to the migratory background, ethnicity, social class, because many women do not have the possibility to stay at

home without a paid work and, thanks to those women, the ones from wealthier social classes can afford to do remote work.

Furthermore, before the pandemic, the literature on the subject highlighted how many smart workers took on domestic and family commitments, precisely because of the increased flexibility guaranteed. For this reason, some authors speak of a strengthening of the roles traditionally attributed to the gender and of the perpetuation of the asymmetry (Hilbrecht et al., 2008).

According to the literature from the pandemic period, several studies proved the strengthening of the division of traditional roles, confirming the man as the breadwinner and the woman as the principal holder of care jobs (Hodder, 2020; McLaren et al., 2020). Especially during the lockdowns, when schools were closed and it was impossible to outsource childcare to grandparents and babysitters, the unequal division of care and household care appeared clearly (Mangiavacchi et al., 2021; Farré et al., 2020; Alon et al., 2020).

An interesting study carried out in Italy in 2020 (Del Boca et al., 2020), on a representative sample of working women, shows that, during the COVID-19 pandemic, 61% of the women vs 51% of the men spend more time in childcare than previously and, controlling for educational attainment, it emerges that parents with higher educational levels (at least with a university degree) are more likely to spend time with their children. Cultural capital seems to have an important role on the recovery of children's educational gaps, especially in recent years of intermittent access to formal courses. Although this study finds an increase in family care duties by both sexes, the analysis of the professions demonstrates the imbalance of family work: especially for working women with young children, conciliation appears to be a mirage, especially when the partner returns to work in presence. The most serious aspect of this imbalance in the management of family care is the risk of an ever-widening gender gap in the economy, but several European studies suggest that co-working from home can help in the rebalancing process in favour of women and it has positive effects on the perceived well-being of workers, in terms of income and life in general (Mas & Pallais, 2020; Angelici & Profeta, 2020; Arntz, et al., 2019; Virick et al., 2010).

Another interesting result emerged from the studies conducted in 2020-2021 is related to the working women's satisfaction. It seems that unemployed women, during the first phase of the pandemic outbreak, are less satisfied about their life in comparison to women working from home (despite all the difficulties described). Once again education plays an important role: more educated women felt less insecure about their future and they presented higher levels of perceived well-being than the less educated ones (Del Boca et al., 2020).

Martucci (2021) compared, in a recently published study, through a qualitative analysis on text-based answers to open-ended question, American professionals and academics who are mothers. It is interesting to refer to this study because it obtained different results from those which we will present in ours, on a rather similar population, but in a different national context. Martucci's hypothesis is based on the idea that the factor that determines the division of care with the partner, and the consequent positive family experience during the lockdown, is the perceived flexibility of the woman's job. The reason seems to be related to the increasing number of working hours and the possibility of interrupting work when it is necessary to carry out care duties. Only 16% of academics mentioned a balance between work and family as a positive aspect of the lockdown: for the majority, it was more likely a conflict with the partner. Flexibility seems to create tension both from the family and from the Academia side, because the possibility to work whenever and wherever can be a negative aspect if colleagues and students can contact you at any time of the day (Rafnsdóttir & Heijstra, 2013). Flexibility, therefore, does not seem to be an advantage of the smart working itself: in fact, it can become a trap and a ploy to delegate care tasks to the partner who works from home and who can interrupt work at any time.

Summing up, the studies presented seem to indicate a path of partial regulation of the spatial-temporal flexibility of the workers, to prevent them from being overwhelmed by the dilution of the working time over several hours during the day, but they leave an open discussion on how to reduce the gender gap with respect to care activities. Some argue that one of the main advantages of working-from-home, from the point of view of the employee's well-being, is the elimination of the stress involved in commuting to work. However, this general statement must be qualified.

It has been suggested that for a considerable number of employees the journey to and from work provides a buffer of time and space between home and workplace that may give them the opportunity to "refresh" and prevent the transfer of stress from one life sphere to the other (Albano et al., 2019; Grant et al., 2019; Salomon & Salomon, 1984).

3. DATA ANALYSIS: DESCRIPTIVE STATISTICS AND METHODS

This section introduces the data and the qualitative and quantitative methodologies applied to investigate R&Ts' well-being during the agile working experience over the COVID-19 pandemic.

The data comes from the survey Agile working in Public Research Organizations: organizational factors and individual behaviours in knowledge creation (*Il lavoro agile negli enti di ricerca: fattori organizzativi e comportamenti individuali nella produzione di conoscenza*) administered between February and March 2021 by CNR-IRCrES (see Fabrizio et al., 2021). The database collects the questionnaires filled by R&Ts from CNR and INAF, the two Public Research Organisation involved in the survey. Out of 2,921 respondents, 388 come from INAF and 2,533 from CNR. The questionnaire was intended to deepen several dimensions of agile working but, in this chapter, we will analyse those related to wellbeing.

In order to answer to our main research questions (does agile working favour the conciliation between work and free/family time in the case of R&Ts? Are there any characteristics that influence the well-being of the respondents?), we consider several aspects, including gender, age group, family composition, commuting and working habits, contractual and sectoral aspects, and the perceived benefits and limits of smart working during the pandemic.

These data come from multiple sections of the questionnaire (see the Annex of this book), in particular:

(C1) gender (37 missing values);
(C2) age group, recoded in three classes (≤44; 45-54; ≥55);
(C4) population class of the municipality of residence;
(C5) approximate size (Sqm) of the house used for agile working;
(C6) number of cohabitants and (C7—11) specific number of adults or minor children, partners, and parents;
(C13) type of contract and (C14) professional position;
(C15) scientific disciplinary area and (C16) type of research activity (experimental, non-experimental, project technical support, laboratory technical support);
(D3) pre-pandemic agile worker;
(D11-12) Based on your experience, please indicate the most relevant limits of the agile working during the COVID-19 health emergency, and based on your experience, please indicate the most relevant benefits of the agile working during the COVID-19 health emergency (multiple choice and open-ended questions, that are analysed by text-based methods in section 4).

In particular, in (D11) we analysed the following items:

a. work overload;
f. feeling of isolation;
g. fragmentation of work due to domestic needs and family care.

Concerning (D12), the items analysed are as follows:

a. saving time on commuting from home to work;
f. increase of productivity.

(E5) type of technical problems when working from home;
(F1) work schedule during the pandemic (see fig. 5);
(F3) During the COVID-19 emergency, how does agile working affect your work-family balance? which provides 4 answer items:

a. agile working does not affect the time balance,
b. agile working determines a redefinition of time in favour of family/leisure with respect to work,
c. agile working determines a redefinition of time in favour of work with respect to family/leisure,
d. agile working favours the conciliation between family/leisure time and work time (this is the outcome variable of the logit model referred to in section 4);

(F4) use of the right to disconnect;
(F5) behavioural problems when working from home;
(G2) usual commuting time round-trip (minutes);
(H1-2) desire for post-pandemic agile working (days per week).

The quantitative analyses described in section 4 included many covariates, but most of them were not significant in the econometric choice model. Subsection 3.1 describes in detail the relevant variables, neglecting the non-significant ones, which have been omitted from the final model due to parsimony. Subsections 3.2 and 3.3 respectively introduce the quantitative and the qualitative methodologies applied in section 4.

3.1. Characterizing the main variables in the analysis

The focus of this chapter is the well-being and the work-family balance experienced by R&Ts when working at home during the pandemic emergency. The main determinants of the workers' perceptions will be analysed by a multinomial choice model in section 4. In particular, we are interested in analysing the implications on workers' well-being. This section explores the main relevant covariates; the rest of the variables are described in Chapter 2.

In Figure 5.1, the upper panel shows how the outcome categories (F3) of our quantitative model are distributed by gender: more than half of the respondents feels that agile working helps to improve their work-family balance (57.6% males, 54.4% females), while 13 respondents over 100 do not perceive changes compared to the pre-COVID period. About one in four females and one in five males feel that working at home favours work rather than family; the opposite is experienced by about one in 10 R&Ts. Overall, gender specificities are rather mild, as the quantitative analysis will confirm.

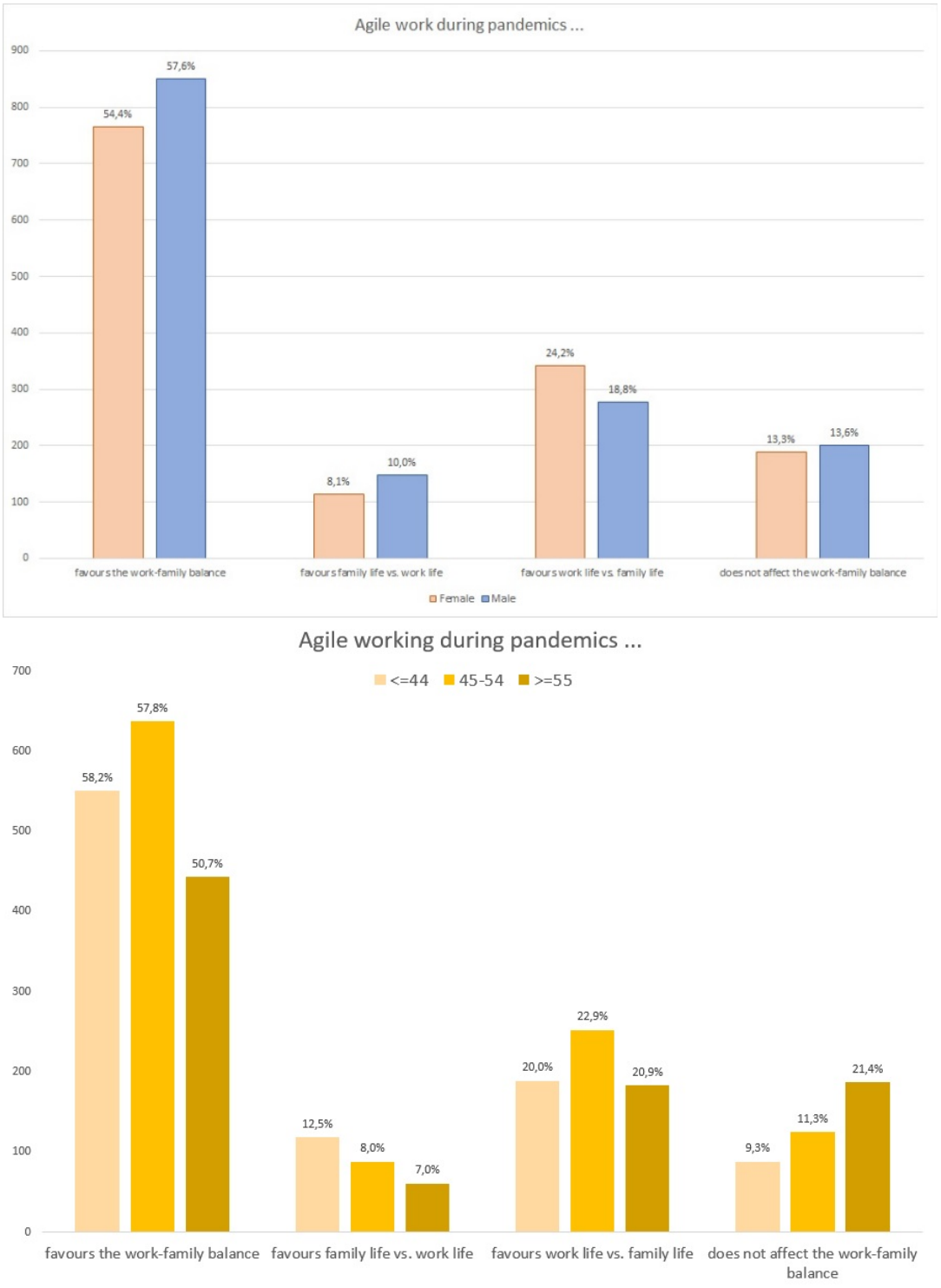

Figure 5.1. Work-family balance: agile workers' perceptions during the pandemic, by gender (upper panel) and by age class (lower panel). Absolute and percentage values. Source: authors' elaboration of survey data.

On the contrary, the age class is relevant (Figure 5.1, lower panel): older workers (aged 55 and more) are less likely to perceive changes in their work-family balance, while about three of five younger workers (aged no more than 54) perceive an improved balance during the pandemic.

Overall, about one in five workers feels that work life is favoured when working from home. This issue will be explored by the econometric model in section 4.

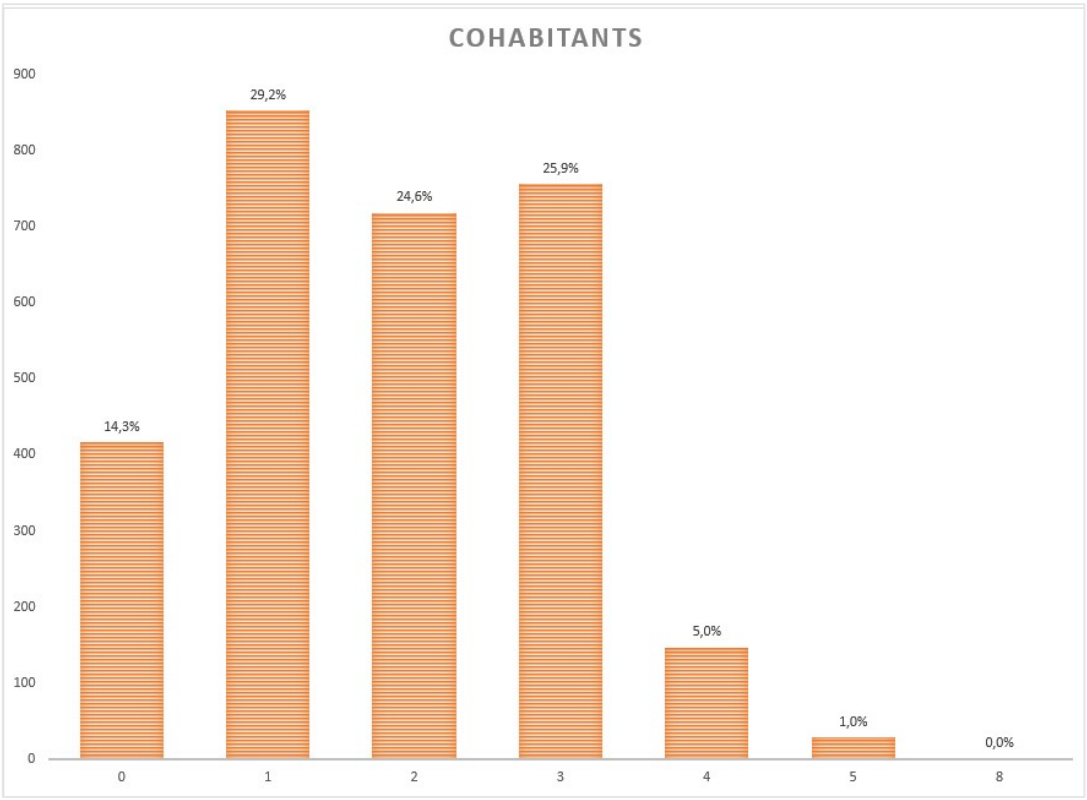

Figure 5.2. Number of cohabitants. Absolute and percentage values. Source: authors' elaboration of survey data.

Another relevant issue when working from home is the family composition, particularly in lockdown contingency. Figure 5.2 shows how the number of cohabitants is distributed on the sample: about 14% of R&Ts live alone, with no problems of space sharing during work activities. The rest of the sample (2,504 respondents) has a cohabitant or more: 70.6% of them (1,769 respondents) live with at least one child and/or with a parent. Table 5.1 explores the types of cohabitants for this particular subset of respondents: the great majority lives with minor children (74.0%), a bit more than 1 in 4 with adult children (28.3%), while just 7.2% of them has a parent at home. Finally, 76.8% of R&Ts living with children/parents lives with a partner too. These data are interesting for our analysis, since smart workers' well-being is affected by the sharing of the space and the load of family-care, which generally increases when minor children and not self-sufficient parents are at home, especially if the family-care cannot be shared with a partner.

Table 5.1. Type of cohabitants for respondents living with a child or, at least, a parent . Absolute values and percentage

Type of cohabitant(s)	**Yes**		**No**		**Total**
	#	%	#	%	
Minor son(s)	1309	74,0%	460	26,0%	1769
Adult son(s)	500	28,3%	1269	71,7%	1769
Parent(s)	128	7,2%	1641	92,8%	1769
Partner	1359	76,8%	410	23,2%	1769

Source: Authors' elaboration of survey data.

The multinomial logit model in section 4 embodies a number of regressors concerning the advantages and the limits of agile working during the pandemics (Figure 5.3; they are derived from questions D11, D12, F5; see paragraph 3 for further insights). Overall, about 65% of respondents appreciate its flexibility, while 27% of them acknowledge the opportunity to enjoy the family when working from home. However, more than one in three workers experiences an excessive work-load. Also, in this case, gender differences are very soft.

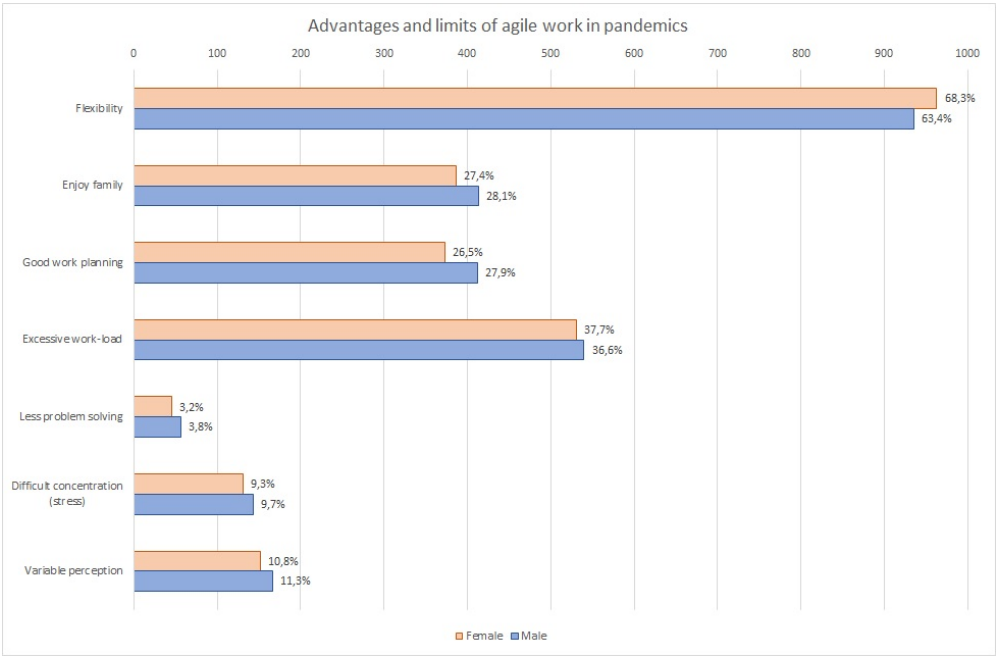

Figure 5.3. Agile working: Main advantages and limits during pandemics, by gender. Absolute values and percentage. Source: authors' elaboration of survey data.

Another relevant issue for investigating workers' perceptions about working from home concerns the time generally spent in commuting (see Chapter 7 for further details). Figure 5.4 shows that less than half of the respondents commute for no more than 30 minutes per day, while about 24% of them has to travel for more than one hour per day.

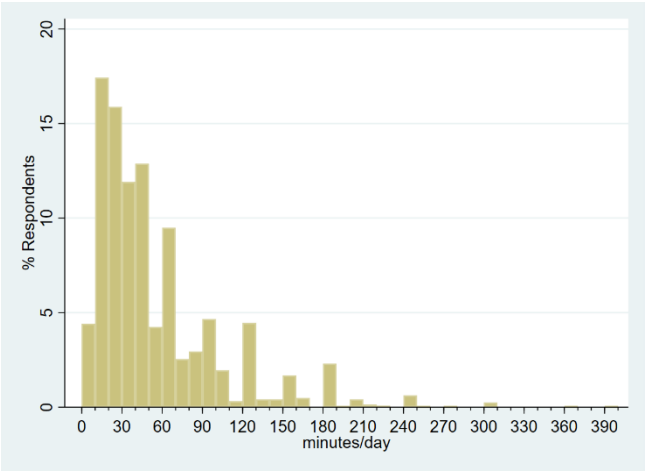

Figure 5.4. Distribution of the frequency of the workers' commuting time in a normal day, round-trip. Source: authors' elaboration of survey data.

Finally, the pie chart in Figure 5.5 shows that the great majority of the workers (59%) associate some unusual times or days to their customary schedule, while 14% of them is forced to split the working time due to the family care burden.

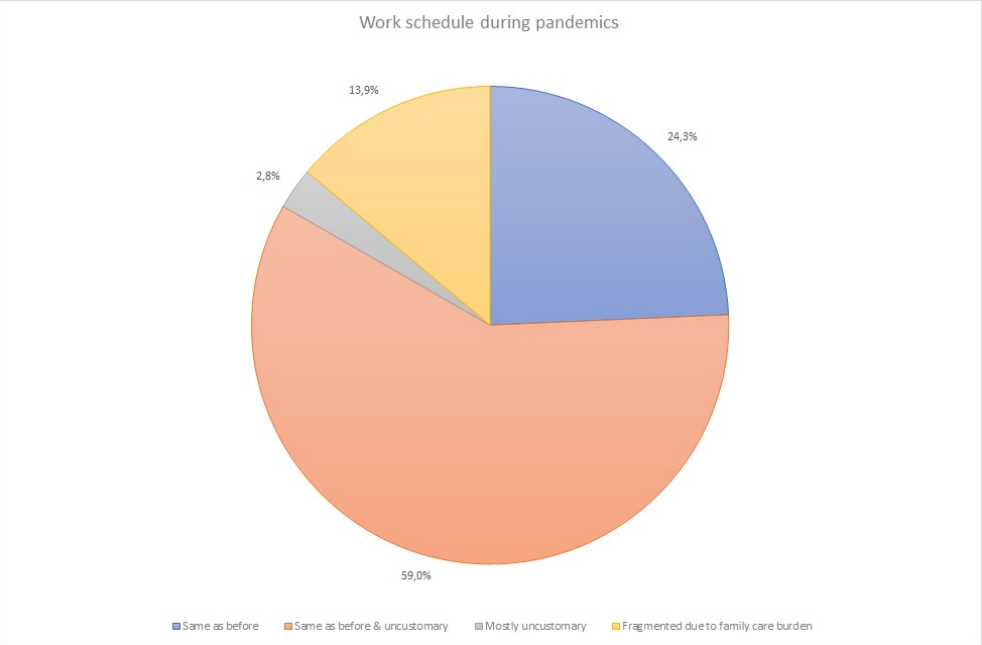

Figure 5.5. Workers' schedule during pandemics. Percentage values. Source: authors' elaboration of survey data.

3.2. Methods used in the quantitative analysis

The quantitative analysis presented in section 4 estimates a multinomial choice model, in order to characterize R&T agile workers' perceptions about their work-family balance during the COVID-19 pandemic.

The multinomial logistic regression models allow to characterize the choice between more than two unordered alternatives, that is a nominal outcome variable with more than two categories, describing how independent covariates affect the probability of choosing one outcome over a convenient reference category. Practically, log-odds ratios are modelled as linear combinations of attributes and individual characteristics. This means that the logarithm of the relative probability of outcome *J* with respect to the reference outcome *K* is expressed as a linear model of a vector of independent variables $\boldsymbol{x}$:

$$ln\left[\frac{\text{Prob}(Y_i=J|\boldsymbol{x}_i)}{\text{Prob}(Y_i=K|\boldsymbol{x}_i)}\right] = \boldsymbol{x}'_i(\boldsymbol{\beta}_j - \boldsymbol{\beta}_k), \qquad (1)$$

Where Y_i is a random variable indicating the category of choice. A convenient normalization is $\boldsymbol{\beta}_k = \mathbf{0}$. For estimation, it is useful that the odds ratio P_j/P_k does not depend on the other alternatives. It is the so-called independence from irrelevant alternatives assumption (see Greene, 2012 for details).

In this framework, the estimated coefficients are interpreted as the variation in the relative log-odds of the outcome *J* with respect to the outcome *K*, due to a unit variation of the corresponding independent variable. In other words, the estimated coefficients are linked to the variation in the relative risk, i.e. the probability of choosing one outcome category with respect to the probability of choosing the reference category. The relative risk can be obtained by an exponentiating equation (1); in this case, the regression coefficients yield relative risk ratios for a unit change of the predictive variable. Practically, in section 4.1 we will introduce a multinomial logistic model

to describe workers' perceived variations in the work-family balance with respect to the pre-pandemic time, controlling for a number of covariates including career profiles, scientific sector, individual characteristics, and family characteristics.

3.3. The methods used in the qualitative analysis

The quantitative analysis was complemented by a qualitative textual exploration, both to confirm the results and to identify dimensions and problems that may have been overlooked.

The qualitative analysis was carried out on the 607 text-based answers to the two open-ended mode questions D11 and D12: "based on your experience, please indicate the most relevant limits of agile working during the COVID-19 health emergency"; "based on your experience, please indicate the most relevant benefits of agile working during the COVID-19 health emergency". The respondents who considered the drop-down list proposed by the questionnaire to not be exhaustive were free to express their answers through a text. Compared to the 607 responses, the limits were listed seven times more (536) than the benefits (71). Among the respondents of the textual part, 455 chose at least one other response mode from the proposed list, while 157 selected the open-ended mode question because they disagreed with all the other proposals.

According to Flick (2014), we analysed qualitative data in order to reduce their complexity, choosing an inductive data-driven approach able to shed light on areas and categories that emerged directly from the texts. We proceeded through theoretical sampling, that is a process by which new data sources are based on codes and categories derived through open coding (Glaser & Strauss, 1967). The four-step procedure is characterized by basic coding (the first general coding that allows emerging new dimensions and categories); fine coding (development of data-driven subcategories); hierarchization and merging of overlapping codes or categories; and analysis after completing the coding (visual tools, maps, frequency tables).

Through the in-depth analysis of the limits and advantages expressed by the respondents, it has been possible to bring out new dimensions that were not identified during the creation of the survey, shedding light on unexpected problems and advantages that will be described in section 4.2.

4. RESULTS

This section is dedicated to uncovering the main determinants of workers' perception about their work-family balance while working from home during the COVID-19 pandemic. The situation was peculiar, but the awareness about these determinants is nonetheless fundamental to develop organizational schemes that favour workers' well-being in future non-pandemic times. By combining quantitative and qualitative methodologies, we are able to identify weak and strong features of agile working, having a direct impact on well-being.

4.1. Work-family balance during pandemics: pros and cons of home working

R&Ts experienced different perceptions of their work-family balance when working from home during the pandemic. We model the perceived variations with respect to the pre-pandemic multinomial logistic regression times, controlling for career profiles, scientific sector, individual characteristics, and family characteristics. The nominal outcomes (from question F3) are:

a. agile working does not affect the time balance (reference outcome);
b. agile working determines a redefinition of time in favours of family/leisure with respect to in relation to work;
c. agile working determines a redefinition of time in favour of work with respect to family/leisure;

d. agile working promotes the conciliation between family/leisure time and work time;

The Hausman-Mc Fadden test confirms that independence of irrelevant alternatives (Long & Freese, 2014).

Table 5.2 shows the main covariates affecting log-odds, i.e., each coefficient represents how a unit change in the covariate affects the probability of perceiving that specific variation with respect to the reference outcome (no change perceived). For a complete understanding, Table 5.3 shows some z-tests assessing the effect of covariates through specific pairs of outcomes, i.e. by changing the category of reference outcome.

Table 5.2. Work-family balance: agile worker's perceptions

Agile working during pandemics favours …		(1)	(2)	(3)
VARIABLES		family life	work life	work-family balance
Female		-0.156	0.233	-0.024
		(0.188)	(0.150)	(0.130)
Age	<=44	0.789***	0.627***	0.628***
		(0.237)	(0.189)	(0.159)
45-54		0.098	0.436**	0.431***
		(0.234)	(0.172)	(0.145)
>55		baseline	baseline	baseline
Children (#)		0.422***	0.325***	0.311***
		(0.094)	(0.077)	(0.067)
Travel to work (mins)		0.002	0.000	0.007***
		(0.002)	(0.002)	(0.002)
Working time				
Fragmented		2.120***	0.840***	0.585*
		(0.331)	(0.323)	(0.305)
Mostly uncustomary		0.480	-0.036	-0.071
		(0.509)	(0.423)	(0.395)
Same + uncustomary		-0.527**	-1.100***	-0.418***
		(0.230)	(0.175)	(0.133)
Excessive work-load		-0.049	1.652***	0.001
		(0.212)	(0.155)	(0.136)
Enjoy family		0.828***	0.577***	1.484***
		(0.242)	(0.214)	(0.190)
Work flexibility		-0.057	0.004	0.601***
		(0.188)	(0.150)	(0.130)
No difficulty		-1.040***	-0.598***	-0.080
		(0.267)	(0.186)	(0.156)
Variable perception of difficulties		0.928***	0.790***	0.064
		(0.286)	(0.256)	(0.245)
Good work planning		-0.361	-0.132	0.633***
		(0.283)	(0.189)	(0.151)
Less problem soving		-0.441	-0.533	-0.884**
		(0.386)	(0.371)	(0.365)
Difficult work planning		0.663**	0.657***	-0.465**
		(0.262)	(0.239)	(0.234)
Less interest for work		0.362	-0.534*	-1.029***

	(0.300)	(0.293)	(0.290)
Difficult concentration (stress)	0.718**	0.951***	-0.006
	(0.307)	(0.282)	(0.287)
Technologist	-0.180	0.261	0.132
	(0.310)	(0.221)	(0.191)
Temporary contract	0.380	-0.085	-0.072
	(0.498)	(0.417)	(0.360)
Sectoral areas	yes	yes	yes
Constant	-0.871*	-0.421	0.204
	(0.511)	(0.408)	(0.355)
Base-outcome	does not affect the work-family balance		
Observations	2,884	2,884	2,884
Pseudo R2	0.214	0.214	0.214

SE in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Multinomial logit model (base outcome: agile working does not affect the work-family balance during pandemics).

Concerning the career profiles, it is worth noticing that there are no differences between the contractual frameworks (i.e., researcher, technologist, director, but also temporary job, part-time employment), while some specificities appear across scientific sectors. In particular, medical scientists and economists are less likely to perceive an improvement in their work-family balance (see Table 5.3, sectoral area). However, there are neither specific effects in STEM (science, technology, engineering, mathematics) vs. non-STEM sectors, nor in experimental vs. non-experimental research (results not shown). At the very least, the distribution of the answers concerning the type of research activity (question C16) among the scientific sectors (C15) casts some doubts about the quality of this piece of information. Since the literature is rather limited on this issue, no comparison can be drawn.

The model shows that the trade-off is substantially affected by individual and familiar characteristics. Surprisingly, the gender effects are rather mild: women are a bit more likely to experience a deterioration of their leisure time rather than a deterioration of work time, or an improvement in their work-family balance. This may be due to the particular population under investigation: R&Ts are the most educated working communities, very far from representing the average working class in Italy, where gender gaps are more likely to emerge (Del Boca et al., 2020).

On the contrary, the age class proves to be relevant: younger people experience a significant difference in their work-family management during the pandemic, which decreases over age classes. This is probably related to family care and organization, which are generally more burdensome in younger families. The model can control for the number of children in the family, but care issues are manifold and difficult to measure. In any case, the family is the key point: each child increases the probability of reallocating time in either way, while the opportunity to enjoy the family when working from home is fundamental to improve the balance. Information on other cohabitants (partner, parents, other types) are not significant, as well as home surface (both total and per person), which could proxy either the space sharing during smart working or the household income. However, this variable could be particularly affected by measurement errors.

Ceteris paribus, another relevant element to improve the balance is saving the commuting time when working from home, while no difference emerges depending on the place of living (small, medium, large municipalities, metropolis).

Table 5.3. Difference in coefficients (outcome A vs. B): z-tests and pvalues

Variable			
Outcome A vs. B	**b**	**z**	**P>|z|**
Female			
working life vs. home life	0,389	2,284	0,022
working life vs. balance	0,257	2,233	0,026
Working time - Fragmented			
home life vs. working life	1,280	5,997	0,000
home life vs. balance	1,535	7,737	0,000
home life vs. no effect	2,120	6,407	0,000
Excessive work-load			
working life vs. home life	1,702	8,986	0,000
working life vs. balance	1,652	14,032	0,000
working life vs. no effect	1,652	10,645	0,000
Enjoy family			
balance vs. home life	0,656	3,746	0,000
balance vs. working life	0,907	6,829	0,000
balance vs. no effect	1,484	7,805	0,000
Sectoral area - Medical science			
balance vs. no effect	-0,840	-2,183	0,029
balance vs. home life	-1,416	-2,221	0,026
Sectoral area - Economics			
balance vs. no effect	-1,158	-2,226	0,026

Finally, personal abilities in managing working routines are necessary: workers who improve their balance experience satisficing work planning and problem-solving, thus appreciating the flexibility implied by agile working. On the contrary, the technical problems experienced when working from home do not produce significant effects. Surprisingly, the ability to use the right to disconnect is not correlated with a specific outcome category (not shown), however the variable could suffer some measurement issue.

However, improving the work-family balance is just one side of the story. During the COVID-19 pandemic, the relative risk of perceiving a deterioration in leisure time is increased by the feeling of an excessive workload, while the relative risk of perceiving a deterioration in work time is dramatically increased by the domestic care burden, which causes a work fragmentation. Both perceptions are significantly associated with planning difficulties, low mental concentration due to stress, scarce resilience due to unstable perceptions.

Certainly, these aspects are sharpened by the pandemic contingency, but they are nonetheless critical if agile working is adopted in normal routines. In order to take full advantage of flexible organizational structures and increase their well-being, workers could benefit from specific training on stress and time management techniques. Overall, these results suggest the main relevance of work-family reconciliation policies to safeguard the workers' well-being.

4.2. Limits and advantages of agile working during the COVID-19 pandemic through a qualitative analysis

The gender analysis of the closed question answers shows few differences between females and males. In general, the main limit of agile working, according to the respondents (55% females and 49% males), is the feeling of isolation. In second place for percentage, we have the fragmentation of the work due to domestic needs and family care, and the work overload (38% females and 37% males). Compared to the advantages of smart working, 78% of the females and

74% of the males declare a perceived increase in productivity, while 76.5% of the respondents declare to save time on commuting from home to work. As anticipated in the methodological paragraph, to deepen insights on the limits and on the advantages of agile working during the pandemic, we analysed the open-ended answers of the D11 and D12 questions through the Maxqda software. This analysis procedure brings out the range of perceptions not grasped through the closed responses. In fact, the procedure of coding and the analysis of the qualitative data allow us to divide the thematic areas of the perceived advantages into five points: life quality, new working tools and methods, free time and working time conciliation, efficiency, savings.

In the life quality dimension, 40% of the respondents declare to have a better management of time, being able to juggle better between work and extra commitments. The respondents appreciated also the possibility to experiment new working tools: for instance, 43% of the respondents declare to have had the opportunity to attend more online conferences than before the pandemic, when they almost exclusively occurred face-to-face. R&Ts also appreciated new tools (IT) and new working places, as well as a greater propensity to develop their work by goals.

Regarding the free time and the working time conciliation, 44% of the answers concern the improved possibility of looking after children and relatives, and they also mentioned, among the advantages, the increased time for housekeeping, the flexible management of working time and the possibility of helping children while they are in distance learning.

Compared to work efficiency, 56% of the segments coded in this dimension identify as an advantage the possibility to have fewer distractions while working from home, with respect to working in the office, and 33% of them claim that they perceived an improvement in terms of productivity. Among the advantages of smart working, they also indicated the promotion of work among teams spread over multiple locations. Finally, the last dimension mentioned in terms of benefits concerns the savings in commuting time (29%), the economic savings due to the lower number of trips, the savings in time lost into the traffic, and the economic savings for the institution (electricity, water, and heating).

While the segments coded for the advantages of smart working were 71, the limits were mentioned seven times more (536). These data describe the heterogeneity of the problems that have emerged and the difficulty of systematizing and plugging them in a closed-ended question. The analysis brought out seven areas of perceived limits: space and tools, workaholism, scientific partnership, family composition, social issues, rigidity of the institution, pandemic-related issues.

The working space and equipment available were the major limitations for the R&T respondents. In fact, 223 strings have been encoded in this area and among these, 43% of them claim as a major limit the difficulty of carrying out experimental activities. Weak internet connection and inadequate working space-equipment (shared family spaces, noisy environment, unsuitable workplace): these difficulties have been perceived more by researchers and technologists coming from STEM disciplines.

To define the second area of limits that emerged, we borrowed the term *workaholism*, introduced by Kreiner et al. (2009) to describe the colonisation of the private life by work. Among researchers and technologists, 26% of the segments coded in this area are related to the difficulty to disconnect. Working from home sometimes means making the barriers between working and free time/space indistinct and disconnecting from work becomes difficult. Respondents declare to remain available even outside the usual working hours, which has a negative impact on family and spare time. In fact, 20% of them declare that during smart working they are not able to distinguish working time from free time. Likewise, respondents detect the fragmentation and expansion of working time caused by household needs and family care. The interruptions impose a time dilation and make the distinctions blurred: these results are consistent with the multinomial logit model presented in the previous subsection.

An unexpected limitation of smart working (11%) is the hyper-connection: overload of telematic meetings, excessive exposure to PCs and other electronic devices such as phones / tablets.

Stress and difficulty of concentration are other limitations identified in the workaholism area: in fact, the interviewee talk about physical and psychological fatigue, less ability to maintain attention and work overload.

The third area is related to scientific partnerships and about 80% of the coded segments refer to the difficulty of maintaining interactions with the colleagues. Researchers and technologists also pointed out the difficulty of starting new research paths because of the difficult communication with colleagues and the different work schedules determined by family needs. Compared to the family composition, the interviewee pointed out that one of the major limits is determined by the presence at home of children to be cared for, especially if they are in distance learning. About this, being always available and present at home determines continuous requests for support, both from children and from partners. Finally, the last element that can impact in a negative way is the increase in personal costs due to smart working, which fall on the family budget.

Social issues also play an important role on the working well-being: the absence of informal meetings with colleagues is an important loss for researchers and technologists, as well as the loss of the sense of community associated with the organisation. The dimension named *rigidity of the institution* lists the limits associated with the unpreparedness of the institutions in the management of smart working during the pandemics. R&Ts complain about the difficulty of communicating with the institution during the smart working and the non-recognition for out-of-work activities. Finally, the last dimension is explicitly connected to the limits of smart working during the COVID-19 pandemic. Work delays, alienation, and inability to move are the three most cited limits.

5. Conclusions

Working from home during the COVID-19 pandemic has been challenging for researchers and technologists working at PROs, in Italy. For the first time, the concept of agile working overlapped with working from home, and seven R&Ts over ten did it with cohabitants in the same house, 74% of whom living with minor sons and daughters. In addition to this, 7.2% of them live with one parent at home.

These data are very interesting for our analysis, since the literature on smart workers' well-being argues that it could be negatively affected by the family-care burden, which generally increases when minor and not self-sufficient parents live together, especially if the family-care cannot be shared with a partner (Grant et al., 2019). More than 50% of the respondents, and unsurprisingly 57.8% of the men, feel that working from home improves the reconciliation between work and family/spare time. It is very interesting to notice that among R&T females, about 25% of them feel that working from home favours work rather than family. This result is probably due to the specific population of interests, having very high educational level and the propensity to work in autonomy, with flexibility. Despite that, even if our analysis does not provide strong evidence regarding the gender unbalance, it emerges that females are a bit more likely to experience a deterioration of their leisure time rather than a deterioration of work time, or an improvement in their work-family balance. According to previous research (Naldini & Saraceno, 2012; Hodder, 2020; McLaren et al., 2020; Mangiavacchi et al., 2021; Farré et al., 2020; Alon et al., 2020), it seems that women working from home take the greatest burden of care (family and home). Care needs are also significantly associated with planning difficulties, low mental concentration due to stress, and scarce resilience due to unstable perceptions. From a policy point of view, our results demonstrate that, if not adequately supported by external care services, women will set aside their free time to deal with family and work needs, and they will be more exposed to stressful events.

Concerning the covariates, our econometric model shows that the age class is relevant: older workers are less likely to perceive modifications in their work-family balance, while about three younger workers over five perceive an improved balance during the pandemic, probably due to the possibility to spend more time with their children and family than before. Furthermore, our

results show that another relevant variable in terms of wellbeing is the time saved for commuting: almost ¼ of the respondents has to travel more than one hour in order to reach the workplace. Some authors argue that one of the best advantages of agile working is the elimination of stress from displacement (Salomon & Salomon, 1984) and the possibility to invest the saved time in leisure activities or family time. This result is also confirmed by the appreciation of the flexibility demonstrated by the respondents: more than ¼ appreciated the opportunity to enjoy the family while working from home.

The qualitative analysis performed on text-based data supports the econometric model, allowing us to identify five areas of advantages: life quality, new working tools and methods, free time and working time conciliation, efficiency, and savings. In particular, when talking about the reconciliation issue, 44% of the respondents identify as an advantage the greater possibility of looking after their children and relatives. Besides that, they appreciated the increased time for housekeeping and the possibility of helping their children while they are in distance learning.

Among the limits, the most important one is the one related to the space and the tools available while working from home. This dimension is very important because it did not emerge from the closed-end question and, above all, it has made it possible to give voice to researchers and technologists working in the STEM field. The results of the qualitative analysis show seven areas of perceived limits: space and tools, workaholism, scientific partnership, family composition, social issues, rigidity of the institution, pandemic-related issues. The difficulty of disconnecting from work and maintaining well-defined limits between working time and free-family time is a limit expressed by the interviewees. To confirm the econometric model, the lack of boundaries appears to be a source of stress for workers. The presence of minors in the family is confirmed as a source of stress for the worker, who is led to fragment his work and to expand it in terms of daily hours worked.

Finally, an interesting element is due to the scientific partnership: about 80% of the coded segments in this area refers to the difficulty of maintaining interactions with the colleagues. The analysis shows that the connections with the colleagues are not easy during agile working, especially in terms of coordination and development of new projects.

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Chapter 6
The use of ICT services and tools by PRO research personnel in agile working during the COVID-19 pandemic

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ABSTRACT
With the outbreak of the COVID-19 pandemic, the Italian public administration had to resort to a massive activation of agile working in a situation characterized by chronic delays in widespread adoption of ICT solutions, as well as a state of inertia in providing adequate training for staff on the use of technological services. While organizations attempted to respond to the emergency by providing new tools and services for remote work, many employees, at least in the first phase, were forced to deal with the skills acquired independently in order to use ICT services available and seek solutions to any technical or operational problems. Even knowledge workers, who are highly qualified and potentially predisposed to autonomous and innovative ways of performing research activities, had to adapt to new work dynamics characterized by an increased use of ICTs. This contribution aims to describe the mode and intensity of use of ICT services and tools by non-academic research personnel during agile working performed in emergency. The interest is primarily focused on the individual early adoption or increased use of ICT resources in response to out-of-office working conditions, regardless of the degree of physical IT equipment eventually provided by organizations. The investigation focuses on the following topics: i) the research personnel's approach to using ICTs for agile working, taking into account individual and organizational preparation; ii) the use experience of ICT tools and services during agile working, enlightening which of them could have played a potentially transformative role in the organization of work; and iii) the main obstacles they encountered in using ICTs in agile working.

KEYWORDS: ICTs, agile working, smart working, remote work, research work.

ISBN (online): 978-88-98193-26-4
ISBN (print): 978-88-98193-27-1

HOW TO CITE THIS CHAPTER
Spinello, A.O., Fabrizio, S., Birello, G., & Perin A. (2022). The use of ICT services and tools by PRO research personnel in agile working during the COVID-19 pandemic. In Reale, E. (ed). *Agile working in Public Research Organizations during the COVID-19 pandemic. Organizational factors and individual attitudes in knowledge production* (pp. 79-100). Quaderni IRCrES 14. Moncalieri, TO: CNR-IRCrES. http://dx.doi.org/10.23760/2499-6661.2022.14

1. INTRODUCTION

With the outbreak of the COVID-19 pandemic, the Italian public administration had to resort to a massive activation of agile working in a situation characterized by chronic delays in widespread adoption of ICT solutions, as well as a state of inertia in providing adequate training for staff on the use of technological services (see ISTAT, 2020). While organizations attempted to respond to the emergency by providing new tools and services for remote work, many employees, at least in the first phase, were forced to deal with the skills acquired independently in order to use ICT services available and seek solutions to any technical or operational problems. Even knowledge workers, who are highly qualified and potentially predisposed to autonomous and innovative ways of performing research activities, had to adapt to new work dynamics characterized by an increased use of ICTs. The ability to adapt to their use and potential is a critical driver of organizational change and can affect both the quality and perceptions of benefits and drawbacks (Albano et al., 2019; Butera, 2020; Loré & Frey, 2020).

The purpose of this contribution is to investigate the research personnel's use of ICT tools and services during agile working in an emergency period. The interest is primarily focused on the individual early adoption or increased use of ICT resources in response to out-of-office working conditions, regardless of the degree of IT physical equipment possibly provided by organizations. Data are provided by the online survey on the effects of agile working in Italian Public Research Organisations (PROs), which was conducted by CNR-IRCrES (see Chapter 2) and targeted to the National Institute of Astrophysics (INAF) and the research institutes belonging to the National Research Council (CNR). The investigation focuses on the following topics: i) the research personnel's approach to using ICTs for agile working, taking into account individual and organizational preparation; ii) the use experience of ICT tools and services, enlightening which of them could have played a potentially transformative role in the organization of work; and iii) the main obstacles they encountered in using ICTs in agile working.

This chapter is structured as follows: Paragraph 2 will briefly examine the digitalization processes in public administrations in light of the need to sustain remote work formats while also responding to the COVID-19 pandemic emergency; Paragraph 3 will focus on the use of ICTs in research practices; Paragraph 4 will introduce the dimensions of interest and the method used; Paragraph 5 will present the analyses based on the research questions, deepening the research personnel experience with ICTs during the performance of agile working in the emergency period. Finally, the conclusions will summarize the findings and discuss the opportunities provided by the “forced” agile working experience for improving ICT advanced solutions for the research sector.

2. THE VALUE OF ICTS IN THE DEVELOPMENT OF NEW WORKING FORMATS

The already pervasive presence of digital technologies in the daily lives of citizens and organizations has become critical when the COVID-19 pandemic made them even more necessary for performing a wide range of activities because of a drastic reduction in physical interactions and movements. The Italian government's decision to implement a shift from traditional office work to agile working (mostly performed at home at a first stage) in “extended mode”, affecting both the public and private economic sectors, forced organizations to increase their efforts to provide ICT services and tools for remote workers. In this regard, the level of organizational preparation between the private and public sector differed significantly. According to the data from the Observatory on Smart Working of the Politecnico di Milano, before the outbreak of the pandemic, 50% of large private companies adopted work from remote one/two days a week, while the percentage drops to 16% for public administrations (Butera, 2020). When dealing especially with the public sector, organizations responded to the need for reorganization by speeding up a previously fragmented and discontinuous path through digitalization (ISTAT, 2020).

High capacity of organizational adaptation is required to implement the agile working regime, and the development of ICT tools and services is a critical driving force behind this process. Though most studies in the literature related to the development of remote work types (see, for example, Rapp et al., 2006; Klehe & Anderson, 2007; Oliva, 2017) were mainly concerned with productivity, well-being and life-work balance issues, a number of contributions particularly highlighted the value of ICTs in the innovation of organizational processes (Albano et al., 2019; Butera 2020) and their role in the redefinition of places, times and working methods towards a progressive flexibility of activities. Furthermore, Loré & Frey (2020) pointed out that the realization of agile working requires the acquisition of digital skills also at the *individual* level beyond the *organizational* one, in line with what other authors theorized in the years preceding the pandemic (see Chiaro et al., 2015). In this regard, on the one hand, the implementation of agile working relies on investments towards the digitalization of many services and work activities and the training of the personnel on the new working formats; on the other hand, it is dependent on the resolution of a number of individual worker issues, such as domestic internet access and the empowerment of basic and advanced ICT skills.

2.1. Relaunching the digitalization process to support agile working

Between 2013 and 2017, all areas of Italy's public sector, with the exception of Healthcare, saw a consistent and widespread decrease in ICT spending, owing to the persistence of the effects of the economic and financial crisis and the resulting adjustment of public finances in accordance with the Stability Pact (see Agenzia per l'Italia Digitale, 2021). A reversal of the trend occurred in the following two years, when the central administrations recorded a constant increase in the spending for ICT goods and services starting from 1.5 billion euros in 2017 and forecast a 23% increase in 2020, amounting to approximately 1.9 billion euros (*ibidem*, p. 19). The forecast data took into account the impact of the COVID-19 pandemic on the government's push for more ICT investment and development in order to support the possibility for implementing agile working.

In compliance with the Action Plans and the European guidelines, Italy sets digital transformation objectives on several levels through multiple initiatives, from the *Transition Plan 4.0* (Ministero dello Sviluppo Economico, Decreto 26 Maggio 2020) in support of businesses to the *Three-Year Plan*[1] *for the digitalization of public administration* (Agenzia per l'Italia Digitale e Dipartimento per la Trasformazione Digitale, 2020), which will include the launch of a national platform for smart working in the public sector through the Smarter Italy program (Ministero dello Sviluppo Economico, Decreto 31 gennaio 2019).

A further step towards the digitization and development of IT systems to support agile working in public bodies, with reference also to PROs, was made through art. 36 of the Simplification Decree (Decreto Legge 16 luglio 2020, n. 76):

> Al fine di favorire la trasformazione digitale della pubblica amministrazione, nonché lo sviluppo, la diffusione e l'impiego delle tecnologie emergenti e di iniziative ad alto valore tecnologico, le imprese, le Università, gli enti di ricerca e le società con caratteristiche di spin off o di start up universitari di cui all'articolo 6, comma 9, della legge 30 dicembre 2010, n. 240, che intendono sperimentare iniziative attinenti all'innovazione tecnologica e alla digitalizzazione, possono presentare alla struttura della Presidenza del Consiglio dei ministri competente per la trasformazione digitale i relativi progetti, con contestuale domanda di temporanea deroga alle norme dello Stato, diverse da quelle di cui al comma 3, che impediscono la sperimentazione[2].

[1] https://pianotriennale-ict.italia.it/en/

[2] Translation by the authors: "In order to foster the digital transformation of the public administration, as well as the development, dissemination and use of emerging technologies and initiatives with a high technological value, companies, universities, research bodies and companies with spin-off or university start-ups characteristics referred to in article 6, paragraph 9, Law n. 240, which intend to experiment with initiatives relating to technological innovation and digitization, may submit the related projects to the structure of the Presidency of the Council of Ministers

The aforementioned initiatives share the goal of relaunching ICT development and speeding up the digitalization process in support of new forms of work; however, this effort cannot be separated from the enhancement of digital skills of the population, which is encouraged at the European level by the actions taken by the European Commission, such as the European Skills Agenda, which was adopted on July 1, 2020 (European Commission, 2020). One of the central points of the Agenda concerns *lifelong learning* and the development of basic skills for sustainable growth through an action plan for digital education; among the objectives for the next five years, the Agenda aims for an increase of 25% of adults with basic digital skills. Furthermore, in 2020, many EU programmes and investments were launched on the three pillars "Connectivity", "Digital Innovation" and "Human Capital" with the aim of increasing the percentage of the population with basic digital skills, introducing specialized training courses in public and private organizations, developing the infrastructures and spreading the broadband connection.

The improvement of the population's digital skills is especially important for Italy, which ranks 25th in Europe in terms of Human Capital with digital skills, according to the latest monitoring by the European Commission on the digital progress of EU27 member countries through the DESI Index (See DESI, 2021[3]). In this regard, the first Italian National Strategy for Digital Skills was launched in 2020, with specific actions aimed at reducing the gap with other European countries by 2025.

2.2. Latest data on ICT initiatives in public organizations

A picture of the latest ICT initiatives implemented by the Italian public institutions emerges from the third Permanent Census of Public Institutions of ISTAT[4], whose preliminary results were released on December 15, 2021, and which focused on the response to the COVID-19 emergency, highlighting the strategies and innovations in terms of internal organization and work.

Larger administrations have more effectively equipped themselves to provide the necessary IT equipment and organize communication and training initiatives aimed at promoting the optimal use of ICT resources. In particular, over 94% of State Administrations and public universities provided employees who did not have personal equipment with hardware devices (e.g. PC) to work remotely in all metropolitan cities, compared to 47.6% of the total of public institutions. The census shows a significant diffusion of technological equipment for secure remote access to data (57.8%) and software for remote collaboration (51.6%). The highest share of entities that have not provided their employees with technological equipment is registered by the non-economic public entities (30.6%, including PROs, marked with the red circle in Fig. 1), which consequently result the least provided for the two types of equipment (42.3% and 45.8%).

responsible for digital transformation, with a simultaneous request for a temporary derogation from the State regulations, other than those referred to in paragraph 3, which prevent the experimentation".

[3] DESI Reports and data are available at https://digital-strategy.ec.europa.eu/en/policies/desi. Another critical issue regarding Italy relates to the development of connectivity networks: in 2021, Italy ranked 20th among the EU27 countries despite the progress made especially during the pandemic (DESI, 2021).

[4] The last census is available at https://www.istat.it/it/files//2021/12/REPORT-ISTITUZIONI-PUBBLICHE-2020.pdf. In the first note released some data are presented, including those relating to the initiatives implemented by the public institutions subject to the census on digitization and enhancement of ICT to support remote work.

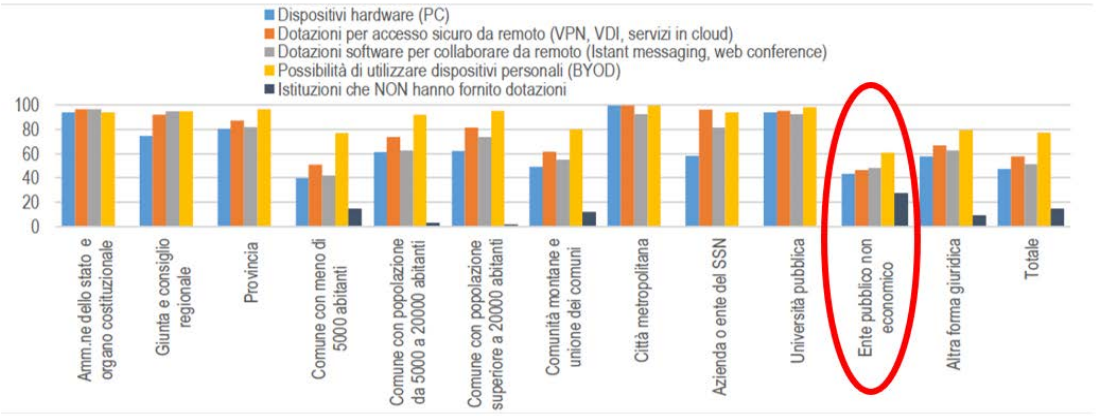

Figure 6.1. Public institutions by legal form and type of technological equipment provided. Percentage values. Year 2020. Source: ISTAT (2021).

Investments in technological equipment have surpassed those in communication and training initiatives, similarly with evidence emerging from the latest DESI monitoring (DESI, 2021). Only one out of four public bodies has implemented training and communication initiatives, albeit with significant variations between the types of bodies. Once again, non-economic public bodies are characterized by below-average investments in such initiatives to enhance the use of the available technological tools (Figure 6.2).

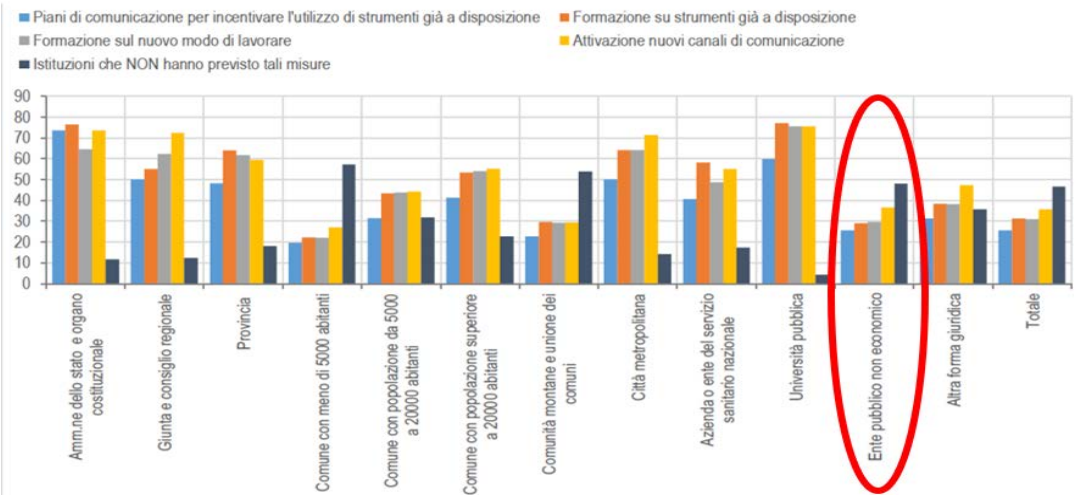

Figure 6.2. Public institutions by legal form and type of communication/training initiative. Percentage values. Year: 2020. Source: ISTAT (2021).

Another aspect, related to the impact of the sudden activation of agile working in public institutions during the COVID-19 emergency period, is the frequency of interactions within working groups, which is ensured remotely by ICT systems. ISTAT data show that this has remained unchanged in 50% of public institutions while it has increased in 30.5% of them, with peaks exceeding 61% in the case of State Administrations and Universities, which have also been more involved in equipping employees with the digital tools and skills necessary to be able to work remotely. Only 12.1% of institutions complain of a decrease in interactions within their working groups.

Statistics reported in the ISTAT census pertain to organizational-level monitoring, as opposed to the subject of this chapter, which is aimed at individuals with the goal of investigating PRO research personnel experiences with ICT during agile working implemented in an emergency. The sources cited are in any case helpful in defining the scenario in which the PROs are placed. The next paragraph will explore specifically the relationship between ICTs and the world of research, with the aim of completing the theoretical framework in preparation to delve deeper into the topic of the use of ICT services and tools by research personnel during agile working implemented in the emergency.

3. Adoption of ICTs in research practices

The use of ICT and web-based resources has had a consistent impact on scientific research activities, triggering new habits from both an institutional and organizational standpoint and proposing new routine models in knowledge production (Borgman, 2007). Over the last decade, a variety of new ICT tools and services have begun to emerge and be used by researchers for their work: chat and video conferencing programs, as well as services such as storing files on cloud platforms, using software on external servers and remotely accessing office resources have all become increasingly popular. Researchers are constantly engaged in a process of social learning that characterizes their use of Web 2.0 and ICT tools for their activities, and organizations have often equipped themselves with IT support services as evidence of the fact that the use of IT tools has become indispensable for research activities.

The adoption of new practices presupposes negotiations and discovery processes: on the one hand, potential ICT users "fight" to discover, explore and exploit new technological capabilities to adapt to their purposes and contexts; on the other hand, developers try to understand emerging users and uses, generating a potentially endless process of experimentation (Williams et al., 2005). With reference to the introduction of technological innovations in the work context, there is no clear consensus in the literature on the identification of determinants of ICT adoption. Venkatesh et al. (2003) tried to standardize the vast production of theoretical frameworks for the understanding and modelling of these processes, noting that each construct was strongly linked to the concept of *performance expectancy*, a composite indicator whose constituent elements are perceived usefulness, extrinsic motivation, relative advantage, job-fit and outcome expectations. In the model created by the authors, known as the Unified Theory of Acceptance and Use of Technology (UTAUT), performance expectancy is moderated by age and gender (the effect is stronger for young people and men) and defined as the degree to which an individual believes that using the system will help him or her achieve a gain in job performance.

With reference to knowledge workers, the use and diffusion of ICT tools for research does not appear to be similar across all disciplinary fields. It turns out that "hard science" researchers make more extensive use of new digital opportunities, whereas their adoption in the social sciences is less widespread and more heterogeneous, though a set of techniques, tools and dynamics has recently found its way into the digital humanities (see Dutton, 2010). While the findings of the Researchers of tomorrow report (JISC & British Library, 2012) emphasise that the new generation of researchers are not using digital technologies to their full potential, the data of Arcila-Calderón et al. (2015) conversely show how scientific outreach via ICT is becoming increasingly important for young researchers. In terms of specific ITC services, Pearce (2010) found that age can be a determinant in the adoption of tools geared towards scientific dissemination, while gender has a positive correlation with the rate of adoption and knowledge of other advanced tools geared towards data analysis and preservation.

Procter et al. (2010) and Ponte & Simon (2011) showed that an increasing number of scholars relied, or favourably expressed their intention to rely in the future, on new online communication practices to promote or disseminate a paper or article, but also to coordinate collaborative work or share digital research artefacts. Nonetheless, the two studies agreed on a degree of "conservatism" in the adoption of *new* digital tools or services. Many researchers still claim to rely on traditional mechanisms of information exchange that had been shown to work in the past,

thus following the trend of using tried and tested tools rather than making a risky investment in unexplored novelties. What emerged was that the proliferation of resources and the constant fragmentation of the offer of tools and platforms paradoxically encountered unexpected resistance from potential users, both because of the difficulty of keeping track of developments in new opportunities and the lack of information or preparation to assess the benefits for some types of activities. Nevertheless, where the benefits of adoption have been perceived as sufficiently high and the investment costs favourably low to motivate community adoption, new resources still manage to reach masses of users, generating network externalities leading to their pervasive adoption by particular communities. The authors identified the role played by local research groups and knowledge intermediaries, within departments or networks, as key determinants to stimulate the adoption of Web 2.0 services and tools through formal or informal means. In the same vein, Arcila-Calderón et al. (2015) applied the UTAUT model in research contexts, although with some variation, essentially confirming that performance expectancy – understood in this case as a set of expectations regarding the future of scientific productivity and the generation of new discoveries – was an important predictor of ICT use in the scientific environment.

Since February 2020, the relationship between ICTs and the world of research has necessarily been overcome by events, for the world has had to face social isolation and the redefinition of the organization of work because of the global pandemic emergency. Knowledge workers have been "forced" to make a massive use of ICT tools and services in order to continue working remotely, thus reviewing their relationship with them.

4. Dimensions of interest and methods

The analyses presented in this chapter are intended to describe the context and intensity of use of ICT services and tools available to non-academic research personnel who performed agile working during the COVID-19 pandemic period. The focus is on the characteristics of the individual adoption of ICT resources in response to out-of-office working setting, regardless of the degree of ICT equipment offered by organizations. The latter aspect will be explored only in terms of services offered, without delving into the provision of physical resources.

The research questions that lead the investigation are:

i. How did the research personnel approach the use of ICTs during agile working in emergency, taking into account their personal preferences and individual and organizational preparation?
ii. What was the research personnel experience with ICT tools and services during agile working, and which tools or services showed the potential to transform the individual work organization?
iii. What were the major obstacles they faced when utilizing ICTs during agile working?

The empirical base comes from the survey created within the project *Agile working in research institutions: organizational factors and individual behaviors in the production of knowledge*, developed by CNR-IRCrES (see Fabrizio et al., 2021; Fabrizio et al., § Chapter 2). Data from the survey will be first used to determine the importance of the office setting in performing research activities prior to the COVID-19 emergency, as well as how the organizations have introduced research personnel to agile working. Subsequently, the analysis will take a picture of the availability of ICT tools and services at home, including the type of internet connection available. These contextual data will help to better interpret the research personnel actual experiences with different ICT services and tools during agile working. For the purposes of this chapter, a selection of common ICT tools and services that can be used to perform agile working will be considered (see Table 6.1). A special emphasis will be put on the early use of ICT tools/services and their potential to change the organization of research personnel's work. Finally, data on technical limitations and difficulties encountered by respondents will be presented.

Table 6.1. List of ICT tools and services considered for the analyses presented in this chapter

ICT service/tool	Definition
Commercial cloud storage with private access	A data storage platform accessible by the user through private subscription or for free, which allows to sync and share data and collaborate. Physical storage is typically spread across multiple servers, and the physical environment is typically owned and managed by a hosting company. Some examples are Apple iCloud, Dropbox and Google Drive. It can be accessed through desktop client software, a web browser or an app.
Cloud storage made available by the organization	A data storage platform managed directly by the organization. It can be self-hosted or leased.
Virtual Private Networking (VPN)/ Proxy server	A method of securely accessing network resources by connecting to a remote access server through an encrypted connection. A proxy server allows access to the services of a private network from a public network upon authentication. This service can be used to connect the home computer to the office network, for example.
Programs for audio/ video conferencing	Programs for taking part in an online meeting or conference with two or more participants in different locations. Through a conferencing software, participants can see, talk and hear each other in real-time. Moreover, there are features like chat, screen sharing and recording. Some examples are Zoom and GoToMeeting.
Chat programs	Real-time communication between two or more users via networked-connected computers. In this category the survey included programs used for communication with a limited number of participants, e.g. Skype.
IT support service/ help desk	An information and assistance resource that troubleshoots problems with computers OS and application software, printers, network and other devices. The helpdesk can be provided by remote services, e-mail, phone and dedicated web pages info.
Shared online planning for research teams	Application for scheduling meetings and events quickly and receiving task reminders. They can be used for teams, making it simple to share schedules and create multiple calendars for use by other users. Some examples are Google Calendar and Teamup.
Use of specific software on the institution's server	Network services made available by the organization and run on the institution's server.
Remote access to databases	Access to resources bought by the organization (electronic journals, databases, e-books) from any workstations outside one's own organization.

A subset of the survey data has been elaborated with the SPSS software. The CUN scientific areas were grouped into the three research macro sectors established by the European Research Council (ERC sectors): Physics and Engineering (PE)[5]; Life Sciences (LS)[6]; Social Sciences and Humanities (SSH)[7]. All analyses consider the entire research personnel from CNR and INAF who took part in the survey (2,921 respondents). It should be remembered that almost all the INAF respondents (388 units) belong to the CUN 2 area (Physics) and therefore to the PE sector, while the CNR respondents (2,533 units) are distributed over multiple ERC sectors. In addition,

[5] Including the following CUN areas: 1 Mathematics and Informatics; 2 Physics; 3 Chemistry; 4 Earth Sciences, 8 Civil Engineering and Architecture; 9 Industrial and Information Engineering; Humanities.
[6] Including the following CUN areas: 5 Biology; 6 Medicine; 7 Agricultural and Veterinary Sciences.
[7] Including the following CUN areas: 10 Antiquities, Philology, Literary Studies, Art History; 11 History, Philosophy, Pedagogy and Psychology; 12 Law Studies; 13 Economics and Statistics; 14 Political and Social Sciences.

different numbers of respondents refer to each ERC sector (1,982 for PE; 706 for LS and 233 for SSH).

Data breakdowns were made based on age cohorts, gender (37 respondents were excluded from this type of analysis because they did not indicate their gender), ERC domain, type of activity and workplace's geographical location. For categorical variables, percentages were calculated using the number of valid responses as the denominator. An additive index was created based on weights applied to response percentages about the intensity of use of ICT tools/services (see Par. 5.3).

5. ANALYSES

5.1. Value of office setting and preferences for virtual modes before the emergency

In non-emergency times, research activities are carried out not only at the office but in a variety of locations: in fact, the Italian working rules on the autonomy of research personnel enable employees to work off-site, self-certifying the activities (see Chapter 3). In addition, working time is normally managed even outside the canonical office hours, with tasks frequently carried out at home[8]. Nevertheless, how important are the resources specifically present in the office, such as IT equipment like computers and printers or services like a fast internet access, in terms of the work needs of research personnel? In this regard, the survey included a general question about the need to rely on resources and materials available in the office. Although this question does not specifically address IT tools and services, it does provide insight into the predisposition to work remotely, which necessitates the use of different ICT resources.

In general, research personnel do not consider the office as essential to the performance of work. They have only a slight preference for using the resources available in the office (21.8% much, 35.5% enough), but the intensity of preference varies depending on the age cohorts, the ERC sector and the type of activity (Table 6.2). The importance given to office setting by the older cohort (55+) is greater than that attributed by the younger cohort (under 45): as age increases, the percentages attributed to the answers "important enough" and "much important" increase, while the percentages attributed to the answers "not at all" and "little important" decrease. As for the ERC sectors, working in an office setting is an almost essential factor for LS (28.5% much, 39.4% enough), whereas the preference from PE respondents is more muffled, with 36% of them reporting that it is of little importance. SSH respondents practically split in half (49.8% not at all plus little; 50.2% enough plus much), denoting a greater predisposition to the use of materials and resources that may not be present in the office. The difference between those who conduct experimental activities and those who conduct non-experimental activities is also significant. For the former, moving away from office resources is less preferable than for the latter.

[8] According to the data presented in Chapter 3, the preferred workplace for task performance is the office in any case, but with varying percentages depending on the task. Notably, between 20-30% of interviewees reported being indifferent to the place of work, whereas the "at home" mode represented more than a quarter of the choices for drafting papers and peer reviewing.

Table 6.2. "How important is the possibility to access materials and resources in the office?" Percentages on total respondents by age cohort, ERC sector and type of activity

	Not at all	*Little*	*Enough*	*Much*
30-44 age cohort	10.1	36.7	34.0	19.3
45-54 age cohort	10.2	33.0	35.4	21.4
More than 55 years cohort	6.4	31.2	37.2	25.2
LS	5.8	26.3	39.4	28.5
PE	9.6	36.0	34.6	19.8
SSH	13.3	36.5	30.9	19.3
Experimental activities	6.4	30.3	38.3	25.0
Non-experimental activities	13.6	40.9	29.8	15.7
Total	**9.0**	**33.7**	**35.5**	**21.8**

Note: LS = Life Sciences; PE = Physical Sciences and Engineering; SSH = Social Sciences and Humanities.

Even prior to the emergency and implementation of agile working, some research activities could be carried out without the need for physical presence. As we will see in section 5.3, chat or streaming software and services, such as Skype or Zoom, were already used by research personnel: they could be used to participate remotely in conferences or project meetings, carry out scientific dissemination through seminars, or even perform experimental activities such as field investigations or the implementation of operational research tasks. To what extent were streaming modes used in place of "in presence" modes for performing the aforementioned tasks before the emergency situation? In this regard, the survey asked respondents about their preference for streaming modes or their lack of preference between streaming or "in presence" modes.

Data reveal that the preference for streaming was doubtlessly marginal for all activities, with percentages never exceeding 5% of respondents (Figure 6.3). Preference for streaming modalities is in general lower for the older cohort (respondents over 55) than for the other age cohorts, but only for project meetings there is a significant difference (2.7% vs 6.1% for the 45-54 cohort and 5.5% for the under-45 cohort). In-person meetings were clearly preferred, and only project meetings and scientific dissemination were allowed to take place virtually in some cases. Participating in conferences in streaming mode was substantially not taken into account, but this data must be read in relation to the ability to connect remotely, provided by conferences in various disciplines. However, the percentages coming from the lack of preference between "in-presence" mode and streaming mode for project meetings are interesting: indeed, there is a noteworthy openness towards streaming modes (36% of respondents) particularly in the PE sector (38%), but also in the LS and SSH sectors (31.7% and 30.9%). As for scientific dissemination, the PE sector is the only one that shows some openness (38%). The SSH sector is the only one that considers the experimental activity remotely or via streaming: this could be consistent with the conduct of qualitative interviews at a distance.

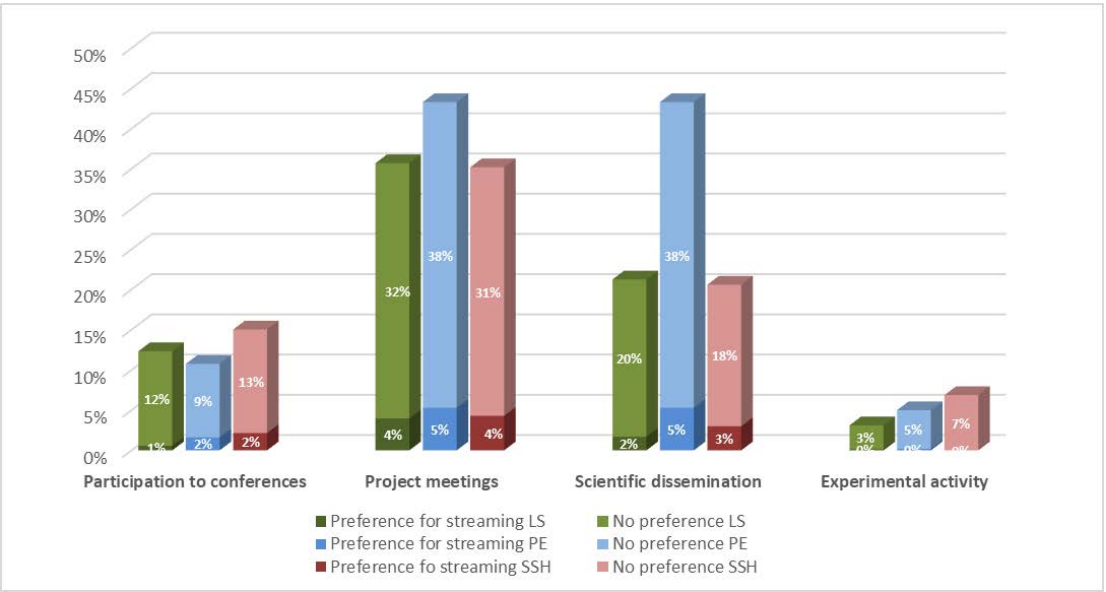

Figure 6.3. Respondents who preferred (before the COVID-19 emergency) to carry out some research activities in streaming mode instead of in presence or did not have specific preference between streaming mode and "in-presence" mode. Percentages of total respondents by ERC sector.

5.2. Introduction to remote work and availability of ICT tools and services

The health emergency prevented all personnel from CNR research institutes and INAF personnel who had not previously experimented with agile working[9] from being gradually introduced to the new working mode through courses or initiatives that would have facilitated adaptation to remote work, particularly in terms of the use of ICT resources appropriate to the specific needs.

Figure 6.4 shows that three out of five respondents undertook agile working without prior training on the ICT resources proposed by their organization, and neither they were interested in attending one on their own initiative. Only 5.1% of respondents reported that their institute/organization provided one or more specific online training sessions for the use of certain services or tools (14.2% of INAF respondents and 3.7% of CNR respondents). The indication of a webpage dedicated to agile working with a list of tools and services emerged in about 7% of responses, and 5.6% of respondents attended courses on their own initiative. Finally, it is interesting that 23% of respondents did not want to inquire about training activities eventually proposed from their institute/organization and reported that they did not know whether their organization offered courses or seminars on ICT tools and services.

[9] Before the COVID-19 pandemic emergency, INAF was already experimenting with agile working (see Reale etal., 2020) so that 23 respondents had prior experience with agile working.

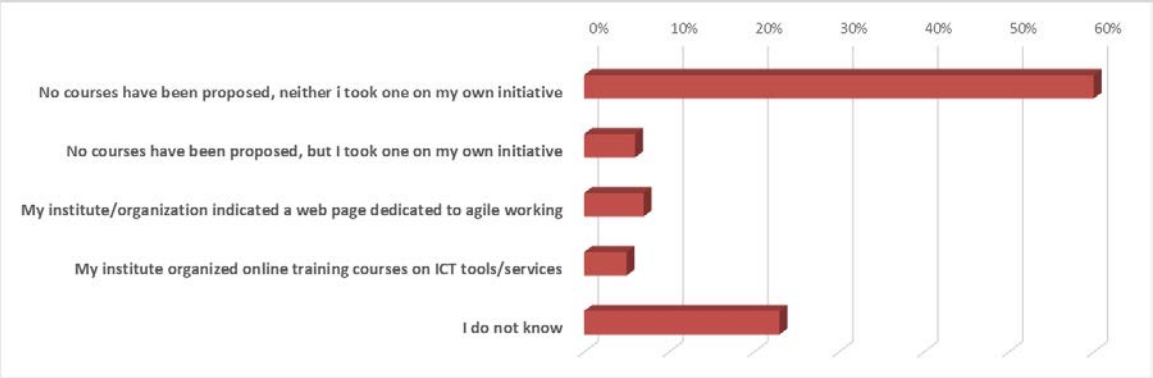

Figure 6.4. "Has your institution/research institute offered you training to introduce you to ICT services and tools useful for carrying out agile working?" Percentages of total respondents.

Given that most of the research personnel were unable (or unwilling) to receive training on ICT tools and services for performing agile working, what is their level knowledge on some of them? Figure 6.5 summarizes data on those who have reported an absolute lack of knowledge about selected services or tools[10]. Among the lesser-known services are the "use of remote servers for the use of specific software" (38.4%) and the "remote IT support" (35.3%). These services are more unfamiliar for the respondents from the age cohort 44-54. Also noteworthy is the percentage of those who reported ignorance of the VPN/proxy server service (27%), with a large incidence for the older age cohort, and the cloud spaces of the organization to which they belong, if available (23.4%). On the other hand, the percentage of people who are unfamiliar with chat programs and audio/video conferencing programs is very small. Generally, the weights between different cohorts are not remarkable.

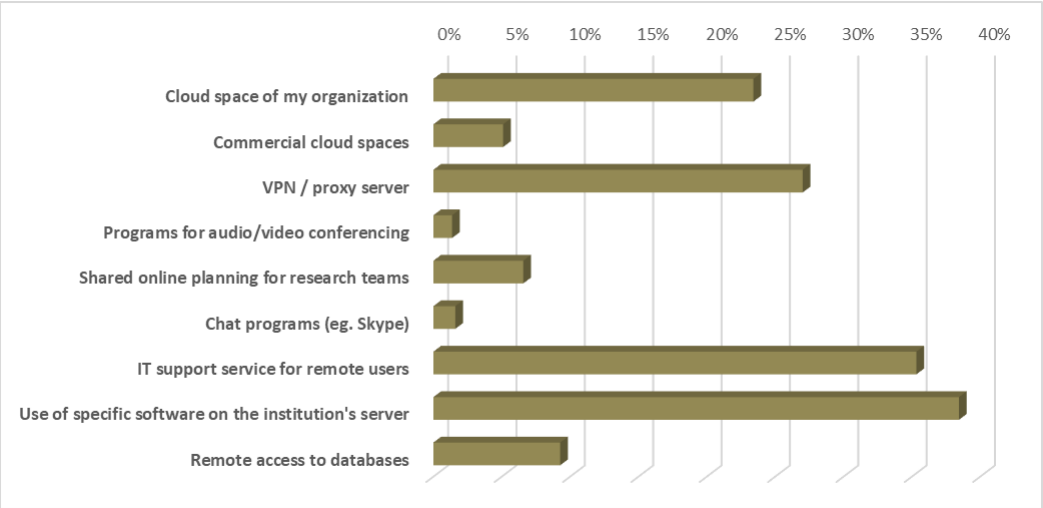

Figure 6.5. Lack of knowledge of ICT services/tools. Percentages of total respondents.

[10] It should be specified that the survey presented the option of lack of knowledge as an alternative to the "availability, but no use" or "availability and use (at different intensities)", so the answer "I don't know this tool/service" must be considered free of the availability bias in the specific organization/research institute seats.

Moving to the actual availability of ICT tools and services, it is interesting to understand how much the research personnel could have access to them from the institute/organization.

Table 6.3 summarizes the percentage of respondents who stated they would use certain ICT tools or services because they know their potential for work, but they are not available at their workplace or provided by their institute/organization. It was discovered that 14% of respondents reported the unavailability of a cloud service provided by their organization, while 12% expressed dissatisfaction about the unavailability to obtain specific software for use on the institution's servers. Low percentages were found regarding the unavailability of VPN/proxy servers (7% of respondents reported it) and IT support services for remote users (8%). As regards the first service, the territorial element acquires a more marked importance for respondents from the North-West (11%), whereas the provision of help-desk structures is less frequent in the Center (10%). The percentage of those who cannot obtain remote access to databases is limited. Overall, the IT equipment made available to the research staff appears satisfactory and net of some shortcomings, and the territorial differences do not appear particularly significant.

Table 6.3. Impossibility of using some ICT tools/services because of unavailability at the workplace: territorial differences. Percentages of respondents who reported knowledge of the tool/service

	North-West	***North-East***	***Center***	***South and Islands***	***Total***
Cloud space of my organization	12	14	16	15	**14**
Use of specific software on the institution's server	14	11	10	13	**12**
IT support service for remote users	7	6	10	7	**8**
VPN / proxy server	11	5	7	7	**7**
Remote access to databases	2	2	2	4	**3**

In any case, the ability of the research personnel to be adequately trained and equipped in terms of ICT tools or services comes second to the ability to have a reliable and fast home connection, which constitutes the necessary requirement for carrying out many of the activities in agile working, ranging from communication with colleagues to the ability to access bibliographic resources or virtually access network resources in the office via VPN.

As shown in Figure 6.6, while more than half of respondents have an ADSL connection via fiber (58.5%) and nearly another quarter have one via cable, 18.5% do not have either one or the other at home (Figure 6.6). This percentage of respondents relies on a smartphone hotspot (8.5%), an independent SIM card (4.3%), or ADSL via antenna (5.9%). Overall, subscriptions to internet service providers (Figure 6.7) are “flat” type (93.2%); however, in a small number of cases, the connection provides pay-as-you-go rates (6.8%). As a result, the situation related to the type of internet connection and subscription is not uniform among respondents, and for a portion – albeit limited – of the workers it can result in an increase in costs and potential difficulties with connection stability.

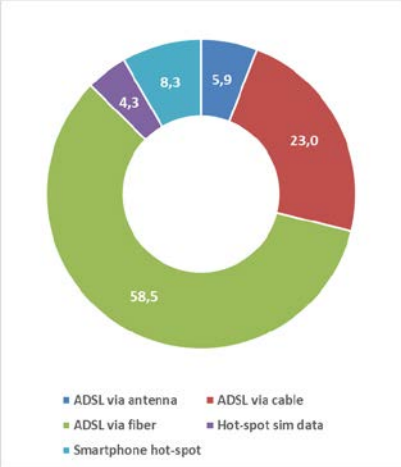

Figure 6.6. "What kind of internet connection do you mainly use for your agile working?" Percentages of total respondents.

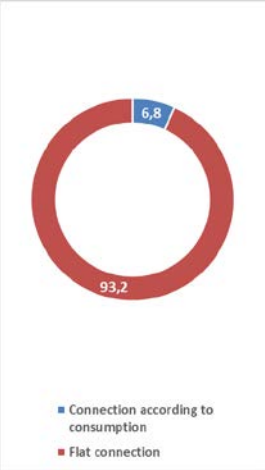

Figure 6.7. "Which type of subscription do you use for your internet connection?" Percentages of total respondents.

5.3. Use experience and potential for the transformative role of ICT services and tools

A scale of use experience was needed to understand the actual utilization of the ICT resources experienced by research personnel during agile working, as well as their potentially transformative role in work organization. Within the survey, the following scale was created for each ICT service/tool, with the respective coefficients (reported in brackets) being used to calculate their potential to have a transformative role in terms of work organization:

"I did not use [the service/tool] during agile working" (0);
"I have used [the service/tool] in agile working *to the same extent as* when I'm at office" (0.25);
"I have used [the service/tool] in agile working *more* than I usually do at office" (0.75);
"I have been using [the service/tool] *since I am in agile working*" (1).

The intensity of use of each service/tool is calculated by adding the percentages of respondents who chose options that admitted both the availability and use of the service/tool; the weighted sum of the above percentages, taking into account the coefficients associated with each response option, yields the scores of transformative power.

When looking at the data (Figure 6.8), it's clear that some services were used more than others and that each has a different potential for transformation in the organization of work. The expansion of use of audio/video conferencing programs, which were employed by 96% of respondents, is particularly significant: 30.1% of respondents were already using them, whereas 28,4% of respondents first used them in agile working. The use of these programs increased in 37.5% of cases when compared to office use, and this translates to a high level of transformative power (64). Chat programs were widely used by 96.7% of respondents, with 33.7% increasing their intensity of use and 8.5% using them for the first time. They show a score of transformative power (47), which is high but noticeably lower than audio/video conferencing programs, mainly because of an expanded use already prior to the agile working period (54,5%). Shared online planning (score 41) was largely used during the agile working period (89.1%) and had an appreciable increase (17.4%) and a noteworthy percentage of first use (11.9%). The score in the transformative index is 40, just below the percentage of chat programs.

A separate consideration must be made for the use of the VPN/proxy server (used by 55.1% of respondents), which was not commonly used prior to the COVID-19 emergency (only 4 out of 10 respondents used it), resulting in the second highest percentage of first uses among the ICT services/tools proposed (15.2%) and an increase in 15.4% of cases. The latter percentages produce a good transformative score for this service (33). The data show that it moved away from its previous ancillary role, but also signal a reliance on outdated technology to access files or software located at the office. The data must be read in parallel with the one on "specific software on the institution's server", a more efficient and less expensive service that allows operations to be run remotely without the use of VPN networks. This option was used by 45.1% of respondents before the pandemic, and a greater use and a first use of agile working were reported by 4.3% and 4.5% of respondents, respectively.

With almost the same score as the VPN, commercial cloud spaces (score 32) and remote access to databases (score 31) had a high intensity of use (88.7% and 84.7%) but proportionally a lower transformative power, as they were used in agile working to the same extent as at the office by 72% and 68% of respondents.

The score of the IT support service for remote users (26) is affected by the low percentage of respondents who knew about this service (see Figure 6.5), but 1 in 10 respondents were able to use it for the first time, and it was used by 52.9% of respondents overall. Finally, internal cloud spaces, used by less than half of the respondents, scored marginal scores in the "transformative" index (17), probably because of the unavailability in many locations (see Table 6.3) and the preference for commercial services.

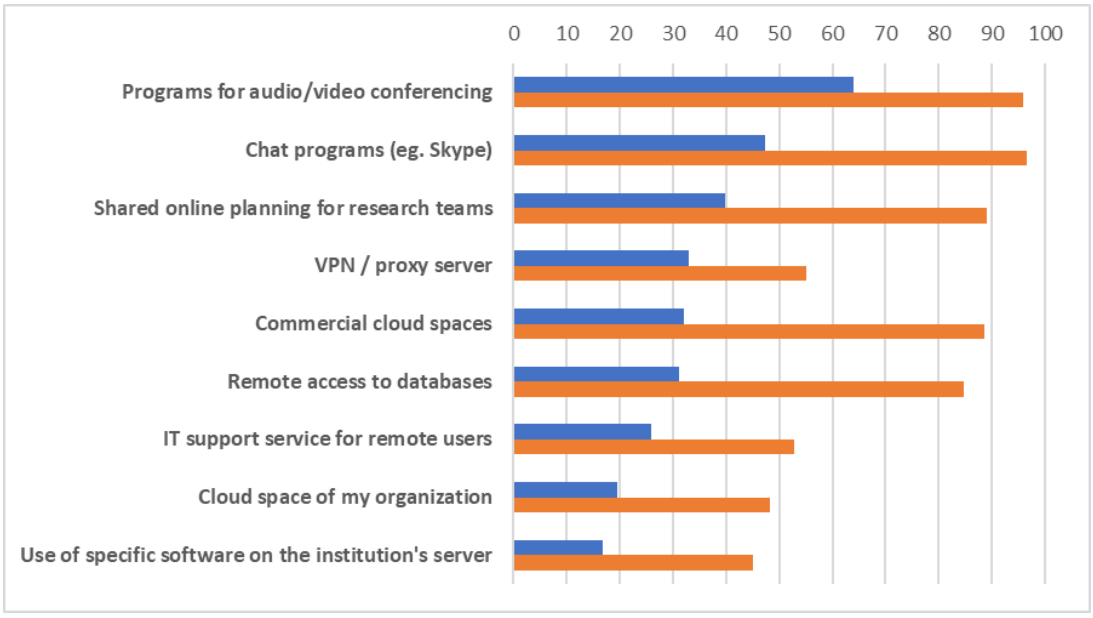

Figure 6.8. User experience of ICT tools or services in agile working. Survey question: "Have you ever used the following ICT tools/services and if so, how much has their use changed with agile working?". Note. In blue: the index of transformative power for each ICT tool/service (score 0-100); in orange: the percentages of respondents who used tools/services in agile working.

To delve deeper into the use of ICT tools/services experienced by respondents from the various ERC sectors, the percentages reported by the two modalities "I have been using it *since I am in agile working*" and "I use it in agile mode *more than at office*" were combined (Figure 6.9).

Audio/video conferencing programs, chat programs and shared online planning for research teams all show a cross-sector increase in usage. This trend is slightly more pronounced in the SSH sector, where the first uses are numerous (especially for the first tool), and slightly less

pronounced in the other sectors. The PE sector is strongly distinguished by the first use or the increased use of VPN/proxy servers (18.4% and 18.8%), even doubling about the percentages reported by the other sectors. As for the commercial cloud spaces, SSH showed greater increased use compared to LS and PE. IT support service for remote users presents a comparable (and low) experience of first or increased use for every sector, with a higher propensity of use for hard sciences. The first or increased use of specific software achieves noteworthy percentages in the SSH sector (6% and 7.3%), which also increases remote access to databases (14.6%).

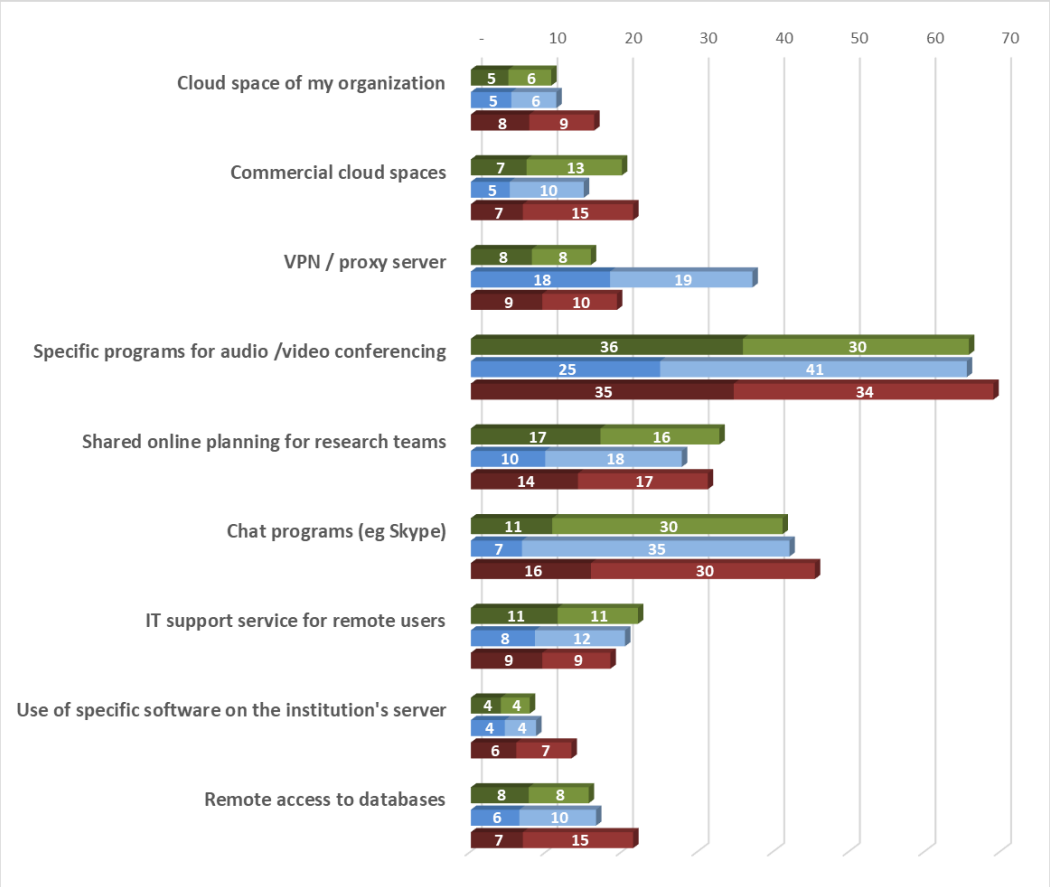

Figure 6.9. Early use (soft color) and increased use (strong color) of services/tools in agile working. Percentages of total respondents by ERC sector. Green = LS; Blue = PE; Red= SSH.

In the case of ICT tools/services that have demonstrated a greater potential for transforming the organization of work for research personnel, breakdowns by age cohort and gender revealed overall a more marked transformative role for the oldest cohort and for women (Table 6.4).

When it comes to audio/video conferencing, chat programs and shared online planning for research teams, the oldest cohort (over 55) has the highest percentage of early adopters (30.8%, 11.1%, 13.4%). The 30-44 and 45-54 cohorts have similar values in terms of tool/service use, with more early adoptions in the latter and a more increased use in the first, attesting to uses that have already been embedded into the habits of the younger cohort. Once again, a separate discussion must be dedicated to VPN/proxy servers, a service that the older cohort does not use frequently and that the younger cohort experimented for the first time in a remarkable number of cases (17.6%).

As for the gender, women significantly increased the use of programs for audio/video conferencing and shared online planning compared to men (respectively 70.2% vs 61.9%, and 32% vs 26.8%) with a greater incidence of early adopters, while men increased the use of

VPN/proxy servers (33.1% vs 28.3%) for which lack of knowledge and non-use are more marked in the female population (43.5% vs 35.5%).

Table 6.4. Use of selected ICT tools or services. Percentages of total respondents by age cohort and gender

	Don't use the tool / service	Early use in agile working	Increased use in agile working
Programs for audio/video conferencing			
30-44	2.2	26.1	41.3
45-54	2.4	28.6	36.9
Over 55	3.2	30.8	34.1
Female	2.3	34.6	35.6
Male	2.8	22.7	39.2
Shared online planning for research teams			
30-44	6.5	10.5	19.0
45-54	8.3	12.1	18.1
Over 55	13.5	13.4	14.8
Female	8.7	14.9	17.1
Male	9.6	9.0	17.8

	Don't use the tool / service	Early use in agile working	Increased use in agile working
Chat programs			
30-44	1.5	6.2	36.4
45-54	2.1	8.3	34.8
Over 55	4.8	11.1	29.5
Female	1.9	10.0	33.3
Male	3.3	7.0	34.2
VPN / proxy server			
30-44	34.4	17.6	18.5
45-54	38.7	14.4	15.7
Over 55	46.0	13.6	11.8
Female	43.5	14.2	14.1
Male	35.5	16.3	16.7

How much experience with ICT tools/services gained during agile working has been translated into an ICT skill empowerment? When respondents were asked which were the top three benefits of agile working, ICT skills improvement was the least chosen option (see Chapter 3): only 5% of respondents reported a remarkable empowerment, which is stronger for women than for men (7% vs 3%). As age increases, however, it is possible to see a higher percentage of respondents reporting benefits in acquiring new ICT skills: from 3% of respondents from the 30-44 cohort to 7% of respondents over 55 (Figure 6.10). As for the ERC sector, the percentage of SSH respondents (10.3%) was quite significant.

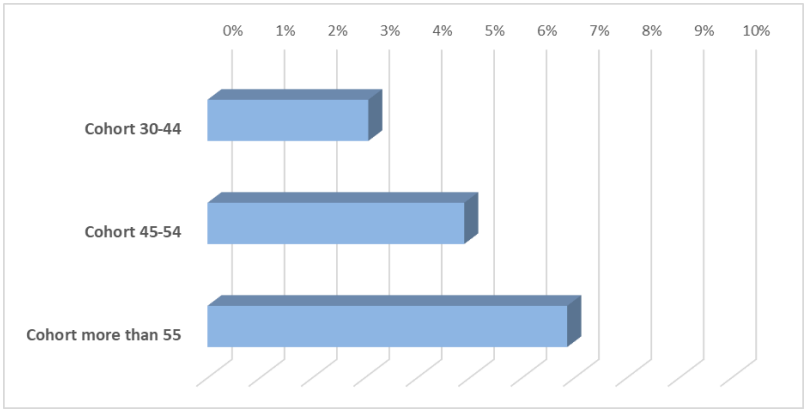

Figure 6.10. Percentage of respondents who indicated an empowerment in ICT skills by age cohort.

5.4. Technical limitations and difficulties

The survey included questions to determine whether research personnel experienced technical problems or other issues while utilizing ICT services and tools in agile working, revealing a difficult adaptation to new working conditions for performing activities. As shown in Figure 6.11, in terms of technical issues, slightly more than half of respondents (51%) reported they had none. Instead, the remaining respondents reported one or more technical problems.

The most recurring problem was related to internet connection, and it affected a third of the interviewees. In the free comments, some respondents complained that the bandwidth of the home connection was lower than that of the office, slowing down data transfers and communications; others reported about their choice for a powerful connection subscribed at their own expenses. Therefore, the instability of the connection has been reported frequently and this is combined with the fact that many respondents do not have a fast connection via fiber or cable (Par. 5.2). In particular, the bandwidth for one of the most used tools, videoconferencing programs, often appeared insufficient for good use (25.9%).

Another issue was the lack of computer processing power (reported by 12.8% of respondents), while the inability to access databases and the lack of functioning of VPN/proxy servers was complained by 7.2% and 6.6% of respondents, respectively. Bad functioning of cloud services (2.7%) was reported to a limited extent.

Other non-technical difficulties were the inability to print due to lack of personal printer (34.1%) and the inability to use multiple computer screens (18.2%). Regarding the last aspect, in the free comments, reference is often made to the small size of the unique monitor.

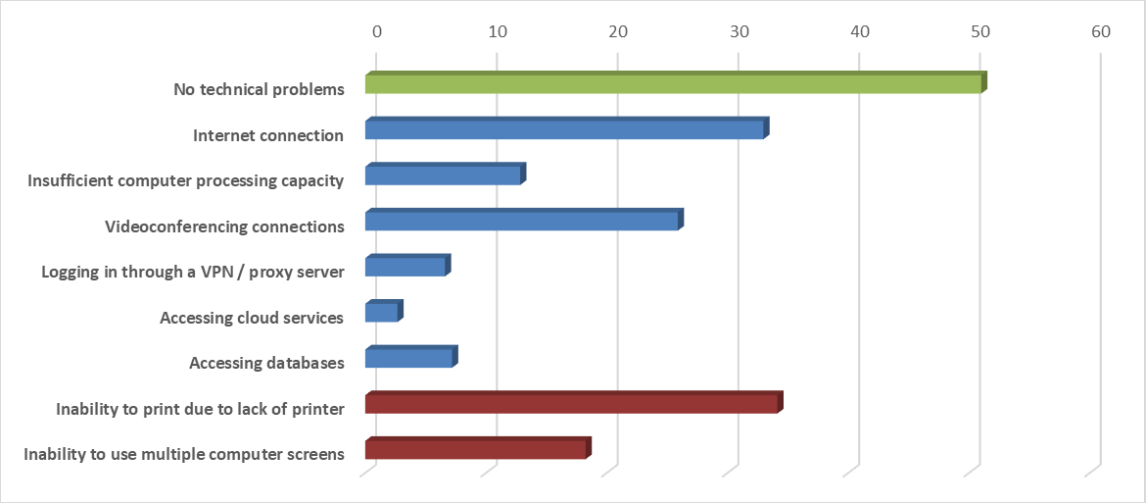

Figure 6.11. Technical problems and other difficulties in performing agile working. Percentages of total respondents.

Some of the issues raised by the respondents were further investigated to see if they were more prevalent in respondents from certain macro sectors than others. As shown in Table 6.5, the inability to use multiple computer screens has a higher number of negative reporting from the PE sector (20.9%), while the difficulty in accessing databases is higher for LS and SSH than for PE.

Table 6.5. Specific problems encountered by respondents during agile working. Percentages of total respondents by ERC sector

	LS	PE	SSH
Insufficient computer processing capacity	13.0	12.8	12.9
Accessing databases	9.2	6.2	9.4
Inability to use multiple computer screens	12.5	20.9	18.2

The presence of technical issues during agile working could have negatively influenced the research personnel productivity. To verify this aspect, the percentage of respondents who reported a decrease in productivity, as measured by the production of papers/monographs, was calculated on the total number of respondents who encountered specific technical problems. The percentages by type of issue are generally not particularly high, as shown in Table 6.6, but they are worth noting. A decrease in productivity, combined with an insufficient computer processing capacity, was reported by almost the same proportion of respondents from the three ERC sectors, with PE slightly prevailing (15.8%). A diminution in productivity was experimented by 17.9% of LS respondents, who reported difficulties in accessing cloud services, and by 16.3% of PE respondents and 13.6% of SSH respondents, who reported issues in accessing databases. Among those who reported issues in the process of logging in via a VPN/proxy server, a decrease in productivity was complained more by PE respondents (12.2%) than LS and SSH respondents.

Table 6.6. Percentages of respondents who reported a diminution of scientific productivity while experiencing specific technical problems in agile working, by ERC sector

	LS	PE	SSH
Internet connection	10.5	12.3	11.3
Insufficient computer processing capacity	13.0	15.8	13.3
Videoconferencing connections	12.0	13.3	13.0
Logging in through a VPN / proxy server	6.3	12.2	7.7
Accessing cloud services	17.9	9.8	11.1
Accessing databases	9.2	16.3	13.6

6. CONCLUSIONS

Because of the COVID-19 pandemic, the implementation of agile working occurred abruptly, forcing the PRO research personnel to experiment a new mode of working for which ICTs are both necessary enablers of organizational change and essential elements for operability. Throughout their experience, research personnel relied mostly on their prior experience with ICT tools and a set of technological services that had been set up quickly and not homogeneously by their respective organizations. Among the public administrations, non-economic bodies including PROs are lagging in providing their employees with adequate equipment for remote work, including hardware and software, and they are characterized by a limited investment in the training targeted to new working practices. Given these factors, data from the survey revealed a significant commitment by research personnel to autonomously adapt to the sudden transformation of working methods based on a massive use of ICTs, particularly among the older age cohorts.

Even in ordinary times, the option of conducting research activities without the office equipment has often been considered by research personnel (above all from the younger age cohorts and with some differences between the ERC sectors), and this has undoubtedly given an advantage in adapting to the use of ICT resources for research activities. The implementation of agile working has therefore forced to intensify the use of some previously experimented ICTs tools and services, while also fostering the early use of new ones. A strong increase in the adoption of audio/videoconferencing programs emerged as a result of the need of holding conferences and project meetings in remote connection. In addition, there has been an increase in the use of chat programs to facilitate communication and collaboration with colleagues. A critical issue concerned the lack of comprehensive training on the various ICTs resources for agile working, which resulted in a lack of awareness of the existence of certain services. In this regard, the use of VPN network was preferred to other technological solutions such as the use of specific software on the institution's server (when available).

The early or intensified use of some ICT tools and services during the emergency can only be partially understood in the terms of the concept of performance expectancy (Venkatesh et al., 2003, see Par. 3). The decision to use some tools over others appears more related to three main factors: the conditions of contingent need; the availability of the tool/service; the awareness of the user. Compared to other ICTs, communication tools and systems to connect to external network have been shown to have an appreciable degree of transformative potential in the organization of work, with the first having a transversal importance across respondents from all the ERC sectors and the latter being more oriented towards the PE sector.

While half of the respondents reported no technical issues with ICTs while performing agile working, it should be noted that the research personnel's personal equipment was not always sufficient to ensure that the work could be carried out without any problem. Particularly, the expanded use of programs for audio/video conferencing produced the major technical difficulties, in many cases due to the characteristics of the internet connection available at home. The presence of specific technical issues could have had some effect on the research personnel productivity, but this aspect requires further and targeted investigations.

Leveraging the experience gained from agile working implemented in emergency, research personnel could take advantage of new ways of performing research activities based on an expanded use of ICTs. In general, research work can be regarded as a fertile ground for experimentation with managing activities associated with the use of new technologies, because it is intrinsically characterized by a high level of flexibility and adaptation to innovations (see National Academy of Sciences, 1989; Borgman, 2007; Arcila-Calderón et al., 2015). Nonetheless, organizations must help by putting more effort through training, communication and the provision of a variety of useful tools and services for remote work.

The rapid transition towards formats of work conducted from remote should be seen as an opportunity to catch up with the innovations required and envisaged by the PNRR (Recovery and Resilience Plan)[11] adapting structures and working methods to the demands of an increasingly digital-oriented knowledge society. The push towards digitalization in scientific institutions, ambivalent and discontinuous in the past decades, can now be re-thought with a view to making investments aimed at innovating knowledge production processes and a greater use of technological tools. Furthermore, this would allow to realize even more completely the flexibility and autonomy that have always been considered the fulcrum of the quality of research activity and a right for the researcher, as well expressed by the European Researchers' Charter according to which:

> Employers and/or funders should ensure that the working conditions for researchers, including for disabled researchers, provide where appropriate the flexibility deemed essential for successful research performance in accordance with existing national legislation and with national or sectoral collective-bargaining agreements. They should aim to provide working conditions which allow both women and men researchers to combine family and work, children and career. Particular attention should be paid,

[11] https://www.governo.it/sites/governo.it/files/PNRR.pdf

inter alia, to flexible working hours, part-time working, tele-working and sabbatical leave, as well as to the necessary financial and administrative provisions governing such arrangements[12].

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Chapter 7
Environmental implications of agile working: an assessment of commuting emissions

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ABSTRACT
Agile working is an organizational innovation that has a significant impact on the business, on the society, and on the environment, too. The latter is the focus of our work, which aims to identify the effects of smart working on CO2 emissions generated by less commuting.
Our study refers to a survey conducted on 2,921 workers at CNR during the pandemic.
According to Istat census, the majority of the Italian workers travels prevalently by car, and our survey confirms it for the R&D worker sample, too. Usually, our sample produces 10,200 kg of CO_2 per each working day made by travelling by car (8,000 kg) and by public transports (2,200 kg). Because of the high CO2 impact of the commuting, we estimated an emissions' saving of 5,000 kg CO2 thanks to the introduction of agile working during the pandemic. The legacy of the pandemic experience is a change in the habits of commuting, partly shifting towards clean transports (additional saving of 89 kg per day).
The results of the paper should be taken into consideration by policy makers as the energy policy and the environmental policy in Italy have to be implemented by different programmes, even supporting new habits for consumers, producers, and workers.

KEYWORDS: environmental sustainability, commuting emissions.

ISBN (online): 978-88-98193-26-4
ISBN (print): 978-88-98193-27-1

HOW TO CITE THIS CHAPTER
Falavigna, G., Rota, F.S., Sella, L., & Vitali, G. (2022). Environmental implications of agile working: an assessment of commuting emissions. In Reale, E. (ed). *Agile working in Public Research Organizations during the COVID-19 pandemic. Organizational factors and individual attitudes in knowledge production* (pp. 101-115). Quaderni IRCrES 14. Moncalieri, TO: CNR-IRCrES. http://dx.doi.org/10.23760/2499-6661.2022.14

1. INTRODUCTION

The widespread adoption of agile working is generally considered an organizational innovation with significant benefits. In recent years, this relatively straightforward and deterministic argument has gained more and more attention, up to the paramount explosion of interest in agile working registered during the first wave of the COVID-19 pandemic. The new challenges that have emerged due to the pandemic led, in fact, to the most extensive mass experiment of agile working in history and allowed testing the implications of this organizational model from many different perspectives (Loia & Adinolfi, 2021).

During the first wave of the pandemic, data from the International Labour Organization, the International Energy Agency, the World Bank and other international organizations converged in indicating that about 20% of the world labour force moved to agile working, with a strong positive correlation with GDP per capita, at the national level, and with worker's salary, at the microeconomic level (OECD, 2020).

Today, two years have passed since the pandemic outbreak, and the availability of vaccines has softened the health emergence and the need for social distancing measures. Thus, in many countries, we observe a diffused return of activities in presence. In such a context, a big argument debated by governments and organizations is the opportunity of introducing agile working in regular job practices and its economic, social and environmental implications.

The spread of agile working can emerge as a solution to safeguard jobs and economic activities, but also as the opportunity to improve the efficacy and quality of the working activity. Agile working can increase firm-level productivity, even if the adverse effects of remoteness on communication, knowledge flows and managerial oversight lead to an inverted U-shaped relationship between agile working and productivity (OECD, 2020). Agile working can also improve workers' satisfaction and organizations' efficiency. However, organizations need to balance agile working properly. The mix of remote and in-presence activities that maximise the effects on workers and productivity is different for the different types of organization and production cycle. The digital attitudes of the workers also emerge as critical prerequisites to ensure that the experiments conducted during the pandemics will develop towards an effective and efficient agile business model (Lake, 2013).

Consistent with this, we observe that investments in digitalisation are one of the pillars of the European Union' plan to exit the COVID-19 crisis. In the perspective of this plan (also known as Next Generation EU), the new reliance on agile working and digital platforms accelerated by the pandemic paves the way for a holistic strategy of digital innovation (Kattami, 2020) that will limit anthropic pressures while supporting economic and social recovery. On the one hand, the EU strategy assumes that environment-friendly lifestyles produce healthier communities, where infectious pathogens are less diffused and dangerous. On the other hand, it recognises the feasibility and opportunity of a more extensive recourse to agile working and digital solutions to make the economy of the European Union more competitive and sustainable. In general, the literature suggests that, at the global level, in 2020 the COVID-19 pandemic led to a drastic reduction of work commuting that reduced both gas emissions (i.e., GHG emissions) and air pollutants (Forster et al., 2020).

The main objective of this study is to establish to what extent the 2020 experience of agile working in Italian Public Research Organizations could affect mobility GHG emissions.

In a perspective of agile working as an eco-innovation, public organizations are likely to be as important as private ones concerning workers' daily mobility and emissions.

Thanks to the high number of the involved employees, the adoption by the public sector of structural forms of agile working is expected to generate a relevant modification of individual and collective mobility behaviours and a positive impact on the environment, comparable with the private counterpart. Public Research Organizations (PROs), in particular, emerge among other types of public organizations for a significant presence of highly-skilled and qualified workers and the adoption of innovative organizational models prone to the public interest and the

environment. In our analysis, PROs thus emerge as ideal candidates for experimenting with agile working practices to promote sustainable development.

The main research questions of the paper are:

- to what extent can agile working in PROs have a positive environmental impact on work mobility emissions?
- how can the new labour organization maximize this positive impact?

Moreover, we consider the possibility that agile working experience will modify in the long-term run the environmental attitude of workers towards more eco-friendly transportation habits.

To shed light on these questions, this study exploits the opportunity given by the questionnaire distributed to researchers and technologists (R&Ts) at CNR, the National Research Council of Italy, and INAF, the National Institute for Astrophysics, during the first wave of the COVID-19 pandemic (in year 2020).

The structure of this paper is as follows. Section 2 provides an overview of the literature about the relationships between agile working and transport emissions, whereas section 3 reviews the methodology applied in Italy to assess the impact of agile working on the environment. Section 4 presents the results of the sections of the questionnaire that capture the environmental behaviour of about 3.000 researches of CNR and INAF, i.e. two PROs under the supervision of the Italian Ministry of University and Research (see Fabrizio et al., 2021 for details). Finally, section 5 draws some considerations about the use of agile working as an organizational innovation supporting the sustainable development of our society.

2. AGILE WORKING AND ENVIRONMENT: EMERGING ISSUES

Most of the arguments used by the scientific and policy debate to support the adoption of agile working were already present in the 1970s and 80s, when remote working started being experimented as a solution to the oil crisis and employees' potential inability to get to work (Torten et al., 2016). Then, subsequent advancements in the information and communication technologies (ICTs) contributed to turn agile working into a viable and competitive alternative to traditional working. Particularly, agile working proved to be effective in leading to cost advantages – to both employees and employers – and improvements in productivity, working motivations and environmental impacts (Turetken et al., 2011). Despite its slow adoption over time – delayed by organizational and cultural prejudices that labelled it as an occasional work pattern (Loia & Adinolfi, 2021) –, the interest in agile working kept on growing (Tortenet al., 2016). Since the beginning of the new millennium, it started to be considered a manifestation of the broader digital/network restructuring of the contemporary economy and society (Castells, 2000).

At the very beginning, the debate on agile working mainly focussed on the savings in time and costs it enabled. Soon, however, environmental sustainability considerations on the positive effects of agile working started to diffuse (Loia & Adinolfi, 2021; Belzunegui-Eraso & Erro-Garcés, 2020). In the public policy debate, namely, the adoption of agile working started to be discussed as a solution to the diseconomies of road congestion (Harpaz, 2002). Public policies for agile working were initially conceived and designed to reduce the excessive recourse to private means of transport to get to work (car commuting), causing congestion, noise, pollution, waste of time and overall inefficiency of the local transport system. Later, an increasing portion of studies has pointed out the positive ecological implications of agile working (Loia & Adinolfi, 2021).

In the last twenty years, agile working gained attention due to the fast worsening of the global environmental scenario and the new centrality assumed by the risks of pollution, climate change and the consumption of natural resources. In Europe, the interest to agile working as a practice for environmental sustainability has emerged also from an intense production of public policies

such as the "Smart cities and communities' strategy" and other initiatives pushing investments in digitalisation to fulfil sustainable growth objectives.

The economic literature considers the shift from in-presence to agile working as an organizational innovation favourable to environmental sustainability. In the private and the public sector, agile working can in fact allow a consistent net reduction in daily commuting, which constitutes an advantage for the environment. Some authors celebrate this positive dimension even further, defining agile working as an eco-innovation for sustainable development (Loia & Adinolfi, 2021).

In 2020, the extraordinary number of organizations and workers compelled to experience agile working due to the pandemic allowed an unprecedented amount of information to evaluate the effects of this working organizational model from many different perspectives and points of view (Fabrizio et al., 2021).

As a first outcome, these analyses produced a widespread recognition that a massive, intensive and prolonged recourse to agile working implies disadvantages as well as advantages (see Chapter 5). Consistent with Harpaz (2002), if we simultaneously consider the multiple dimensions of agile working, which include social, economic and environmental issues, the evaluation of the balance of pros and cons is far from an easy task. Also when we focus on a single aspect (i.e. the implications of agile working on the environment) it is difficult to differentiate among local effects and overall impacts. The need for a more complex and critical approach thus arose (Moos et al., 2006), producing different analytical approaches.

On the one hand, the attention of scholars and practitioners focused on the measurement of the reduction of traffic pollutants agile working enabled during the lockdown, as the main proof of its sustainability. In countries that are still largely dependent on private (Fountas et al., 2020) fossil-fed transport solutions, reduced mobility and air emissions are the most evident positive outcome of the agile working.

On the other hand, studies on agile working stopped focussing on work mobility only. Moving from the recognition that commuting is not the only cause of the environmental burden produced by the working activity, an increased number of authors started criticising the idea that agile working automatically produces a positive net balance in GHG emissions: in many cases, the commuting travels avoided by agile working are replaced with others, even more emissive (Moos et al., 2006). The consumption of gas, electric energy, food and consumables that occur during the working activity also produces an environmental pressure that varies according to the way the work is organised.

This approach also considers the substitution and spillover effects that accompany the adoption of agile working. For instance, we observe from the literature that the energy savings allowed by the reduction of daily travels are at least partly counterbalanced by the additional consumption of energy determined by the extra hours spent working at home. Where the workplace is re-designed to reduce space per employee and the worker respect the usual working time of the office then there can be substantial additional energy savings as a result (Banister et al., 2007; Hook et al., 2020).

In 2006, Moos, Andrey and Johnson already claimed for a more comprehensive framework on agile working, capable of considering also how overall lifestyles and behavioural changes translate into a net environmental impact. As the authors observed agile working create far-reaching changes in participants' lives, with potentially important environmental impacts. To say it differently, workers that experience agile working are subject to adjustments in their life-styles affecting numerous consumption categories; but this makes it difficult to assess the overall implications of agile working for the environment (Moos et al., 2006).

An issue still open to the debate – which is here only introduced as a future research agenda – is the possibility that the experience of agile working during the pandemic will push individuals to assume environmentally responsible attitudes. Working from home, could have favoured in the remote workers a higher level of awareness on the costs (energy, consumables etc.) of the working activity and a new attention towards the preservation of the world ecosystem.

3. AGILE WORKING AND TRANSPORT EMISSIONS: ASSESSMENT OF THE CO_2 REDUCTION

Exploiting the COVID "laboratory" (Loia & Adinolfi, 2021; Sen & Al-Habaibeh, 2020), many studies have tried to estimate the reduction of the environmental burden of the working activity allowed by a massive adoption of agile working. Our study aims at contributing to this stream of the literature focussing on a specific type of organization experiencing agile working during the pandemic, i.e. PROs, and a specific type of environmental implication, i.e. the reduction of commuting flows and related GHG emissions.

In order to analyse the implications of agile working in PROs, we focus on the replies to the questionnaire that describes the environmental attitudes of respondents during and after the 2020 lockdown. We quantify the decrease of emissions due to the reduced daily travel of workers during the lockdown and develop a scenario analysis based on their preferences for the future.

The methodology to assess the agile working impact on transport emissions in Italy can be derived from studies about the diffusion of agile working within the Italian economy as well as the European one.

For example, in Germany, Bachelet et al. (2021) showed that the direct effects of an agile working organization for 15% of total work force would reduce 4.5 million tons of CO_2 due to the car commuting decrease. It is about 3% of total CO_2 emissions in transports.

In UK, Banister et al. (2007) show that on average the UK agile worker spend 28 kilometres every day to commute to the office. The distance is higher than the result of the National Census (14 kilometres a day) because of the selection criteria of the agile working employee, as they usually live far from the office. One day a week of agile working would save each year about 217 kilogrammes of CO_2 per capita, due to a CO_2 consumption of 200 grammes of CO_2 per kilometre by car.

Carbon Trust and Vodafone Institute for Society and Communication (2021) studied the characteristics of agile working in six countries (Czech Republic, Germany, Italy, Spain, Sweden and the United Kingdom) by analysing the amount of carbon emissions saved by working remotely before, during and after the first wave of the pandemic.

In the pre-COVID situation it is noted that in some countries the use of agile working was higher than the average (Germany and Spain) while in others it was much lower (Italy). During the lockdown all the indicators went up, and there were huge CO_2 savings. Estimates on post-COVID savings consider the work organization and the energy structure in each country. For example, the savings in commuting depend on the use of the car, which in Italy is higher than in other countries, while the overall savings also depend on the building efficiency of offices and homes. The flexibility of the work organization has a direct impact, too. In fact, it is necessary that the offices can reduce consumption according to the number of people on-site, and that public transports adapt the supply to the changes in the demand. For example, agile working has a positive net effect only if the energy consumption at home is lower than at office.

Otherwise, what you consume at home is added to the fixed consumption you have in the office or in public transport (if you do not use the car for commuting).

Estimates indicate that Italy will have a huge environmental benefit (8.7 million tons of CO_2 saved) if agile working continues to be adopted after the pandemic, thanks to the higher use of cars for commuting, the greater energy efficiency of homes compared to offices, and the lower use of agile working in the pre-COVID situation. This generates a net saving of 1.8 tons of CO_2 per agile worker each year.

In any case, the Carbon Trust & Vodafone report (2021) underlines that their assessment depends on several variables, very difficult to control, as they differ not only from country to country, but also within the same country and city, because the personal habits directly affect the individual saving.

As far as the Italian case is concerned, several studies tried to assess the relationship between agile working and the benefits for the environment (Noussan & Jarre, 2021; Rovetta, 2021). It is difficult to compare them as they propose different methodologies and samples, nevertheless it is interesting to show their results.

The Polytechnic of Milan estimates that the application of 2.5 days per week of agile working will lead to lower emissions of about 1.8 million tons of CO_2 for each agile worker, in addition to the savings of 123 hours in traffic jams, and 1,450 euros in car fees (Politecnico di Milano, 2021).

The report also highlights some critical issues, due to the non-homogenous distribution of this innovative organization: large companies are going to implement agile working at a larger extension in comparison to small firms and Public Administration, because of a lack of managerial culture in the latter.

ENEA (Penna et al., 2020) studied agile working in 29 Italian Public Administrations, involving 3,387 remote workers out of 5,550 total workers, in a pre-COVID period (2015-2018), and it could be considered one of the first extensive studies on this issue.

The study shows that agile workers' houses are pretty far away from the office, as they save about 30 km and 90 minutes of commuting every day. This is mainly due to the sample selection, as the ENEA agile working rules give privileged access to the workers who live the farthest[1]. In the 2015-2018 period, the ENEA report estimates total savings of 46 million of commuting kilometres and 4 million euros of non-purchased fuel. The benefit for the environment is about 8,000 tons of CO_2 reduction in the period.

A study about the workers at the Municipality of Brescia (Gorlani, 2021) shows that 800, out of 1,600 total employees experienced the agile working in 2021. As about 70% of agile workers used to commute by car, making 44 minutes and 21 kilometres of travel every day, the total environment benefit is estimated in 565 tons of CO_2 reduction in a year. On average, they saved 2,9 kg of CO_2 per day, i.e. about 140 gr CO_2 per kilometre, in the commuting.

FORUM PA (2020) made a survey on public employees during the COVID-19 lockdown, to check to what extent the Public Organizations implemented the agile working procedure. As far as the impact of agile working on the environment, the FORUM PA sample shows that workers saved about 90 minutes and 20 kilometres for commuting every day. If only 40% of public employees would work from home for 2.5 days a week, they would avoid 128 million hours of time commuting (made by over 880,000 cars travelling 1 billion of kilometres), saving about 121,000 tons of CO_2 into the atmosphere, and 384 million euros of fuel per year. On average, each worker – aboard on a small car (120 gr per km of CO_2 consumption), for a 20-kilometre round trip – would save 230 euros per month and avoid emitting 72 kg of CO_2.

Bringme – a carpooling startup born in 2011 at the business incubator of the Politecnico di Torino – has quantified that during the COVID-19 lockdown in March and April 2020 its clients saved 90 minutes of commuting time from home to work per capita. On the whole, all the clients saved 10,000 hours of free time and over 60 tons of CO_2 not released in the atmosphere (Rullo, 2020).

Variazioni srl, a consulting company based in Mantova, in a survey involving 850 employees working from home one day per week, estimated at least 40 hours of free time, and 135 kg of CO2 less emitted into the environment each year per worker (Illarietti, 2018).

UBI Bank since 2015 gave to employees the opportunity to work from home, saving per day two hours of commuting, 102 kilometres of driving and 20 euros of costs on average. On the whole, the experience avoided 450,000 kilometres of travel and 50 tons of CO_2 emissions (Castellucci, 2018).

SNPA – the Federation of the Regional Agencies for the Protection of the Environment – is a public organization that in the period March-May 2020 conducted a survey to its employees to assess the benefits of the agile working. SNPA processed a sample of 2,966 questionnaires (out of 10,480 total employees), where 80% of workers drive a car to commute to the office. As SNPA workers spend on average 28 kilometres in commuting, the total amount of CO_2 reduction saved during the March-May 2020 period is about 1,884 tons. This means a saving of 794 kg of CO_2 per capita (SNPA, 2020).

A similar survey was conducted by the Environmental Agency of the Aosta Valley, in 2020 during the COVID-19 lockdown. The results are even more interesting, as they reflect a different kind of society and habits. The survey was about 1,600 workers that spent 46 days in agile

[1] This is the so-called "telelavoro" contract.

working organization. During this period, they saved 1.5 million kilometres of commuting and 386 tons of CO_2, which correspond to 20 kilometres and 2.45 kilograms of CO_2 each day per worker. It represents about 2% of the total amount of CO_2 emissions in the Aosta Valley (Arpa Valle d'Aosta, 2020).

Finally, the INPS study (2021) on the agile working experience of its employees has found a clear direct relationship between the desire to work remotely and the distance home-office. The savings in terms of private expenses, that workers indicated as one of the benefits coming from agile working, could be considered as an environmental saving as well.

Altogether, these studies show the variety of the variables involved in the assessment of the environmental implications of agile working: social habits, labour market characteristics, industrial structure, public transport organizations, structure of consumption, structure of the energy grid, and many other determinants could affect the final results.

For example, the workers' labour contract matters: civil servants (considered in the studies by ENEA, FORUM PA and Politecnico di Milano) have a more rigid contract and governance than private workers (considered in the UBI example). Also, public organizations experienced a great amount of remote workers for the first time in 2020, during the COVID-19 lockdown, whereas the private ones have been already experienced agile working since long, although with a reduced number of workers involved. Therefore, per capita savings in public organizations are higher than in the private sector: in the first case the marginal effects are completely new, in the other case they are just additional.

Secondly, the home-office distance and the efficiency of local public transports are relevant. Office sites in the city centre reduce the commuting time in comparison with office sites in the country, where the number of workers using the car and the home-office distance are high.

Finally, the method for selecting the remote employees is important. When the selection is strict, because only few workers are eligible for the agile working, the worker sample is mainly composed of employees located very far from the office, as the home-office distance is usually a strong criterion for the selection of the available positions. This is why the home-office distance is higher in the UBI bank case, in comparison with the Brescia Municipality one: in the first one, they selected only few workers, using family and location criteria, whereas in other case all the employees were admitted to the agile working. As a result, the CO_2 saving is higher in the first case.

4. RESULTS

The web-based survey analysed in our study investigates the pre-pandemic commuting habits of PROs researchers and technologists (R&Ts), as well as the expected modifications in a future post-pandemic era. The aim is to assess the environmental impact implied by different organizational scenarios, introducing agile working in regular job practices. All tables and figures in this section are authors' elaboration from survey data.

4.1. Commuting costs of a regular research day

This section calculates a very rough cost of commuting in a working day by considering workers' prevalent means of transport, the distance covered, and the usual duration of their travel to work. Table 7.1 summarizes travelling habits of the respondents: the great majority of respondents travels by car (i.e., car/SUV and economy car: 60.4%), covering a shorter distance by using smaller vehicles (29.2 km for economy car vs. 40.6 km for car/SUV). About one worker over five travels by public transports (train, bus, tramway), covering 60 km in one hour and a half round-trip. Electric vehicles are very rare (2.1% of total respondents), whereas short trips are travelled using motorbikes or hybrid vehicles (16 km in half an hour, on average). Finally, 12

workers over 100 are fully eco-friendly, travelling by bicycle or on foot and covering on average 6 km in 25 minutes.

Table 7.1. Summary statistics by prevalent means of transport (per day).

Means of transport	Users (persons)	Users (%)	Travel duration (h)	Average duration (min/pers)	Distance covered (km)	Average distance (km/pers)
Car/SUV	353	12.1%	289.0	49.1	14,322.0	40.6
Economy car	1,412	48.3%	1,009.9	42.9	41,257.1	29.2
Bike/On foot	362	12.4%	150.7	25.0	2,201.3	6.1
Electric vehicle	61	2.1%	44.9	44.1	1,596.0	26.2
Scooter/Motorbike/Hybrid	180	6.2%	96.7	32.2	2,861.1	15.9
Public transport (Train/Metro/Bus)	553	18.9%	900.3	97.7	34,074.4	61.6
Total	2,921	100.0%	2,491.5	51.2	96,311.9	33.0

According to the survey, commuting in a regular pre-pandemic working day burns 51 minutes per person on a 33 km round-trip, and R&Ts totally spend about 2,500 life-hours in the traffic.

As we mentioned in section 3, environmental costs can be estimated in terms of CO_2 emissions. Table 7.2 shows a rough calculation of per day emissions based on CO_2 average emissions per type of prevalent vehicle (column 1, see Section 3): a regular working day in Italian PROs emits 10.3 tons CO_2, equivalent to 3.6 kg per R&T.

Table 7.2. CO_2 emissions by means of transport (per day)

Means of transport	CO_2 emissions (gr/km)	CO_2 emissions (kg)	Average emission (kg/pers)	CO_2 emission std dev
Car/SUV	250	3,400.9	9.8	12.5
Economy car	110	4,424.3	3.2	3.7
Bike/On foot	0	0.0	0.0	0.0
Electric vehicle	43	68.6	1.1	1.2
Scooter/Motorbike/Hybrid	80	228.9	1.3	1.6
Public transport (Train/Metro/Bus)	70	2,224.8	4.1	4.4
Total		10,347.5	3.6	6.0

Note: Emissions are calculated removing outliers (7 Car/SUV, 12 Economy car, 9 Public transport).

According to the survey in section 3, per capita CO_2 emissions are highly in line with other Italian public administrations (FORUM PA, 2020) and very similar to the city of Brescia (Gorlani, 2021) and Aosta Valley. Average distance is akin to ENEA (Penna et al., 2020) and SNPA (2020), but R&Ts travel duration is shorter.

However, Table 7.2 (column 3) shows that differences by means of transport are very relevant: SUV drivers emit about 10 kg per day, 3 times more than a small-car driver; public transport travellers emit 4 kg per day, while motor-bikers, hybrid- and electric-drivers are charged about 1 kg per day. Figure 7.1 shows that 76% total commuting emissions are due to cars (i.e., 33% for car/SUV +43% for economy car) and 21% by public transport; the rest is practically irrelevant.

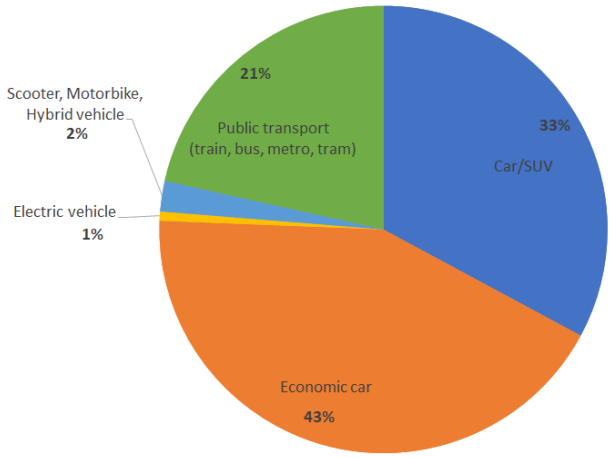

Figure 7.1. CO_2 emissions by means of transport, %.

This is confirmed by Figure 7.2, plotting the frequency distribution of individual commuting emissions per day by prevalent means of transport. Each histogram refers to a different means of transport; the last panel depicts total emissions. Each bin represents an emission class, ranged on the x-axis; the number of users/respondents falling in that specific class is reported on the y-axis. The largest per-day emissions and number of users refer to cars, both SUV and economic ones; then public transport, principally due to long-distance travels. Finally, users and emissions are considerably lower in the case of motorbikes, hybrid and electric vehicles.

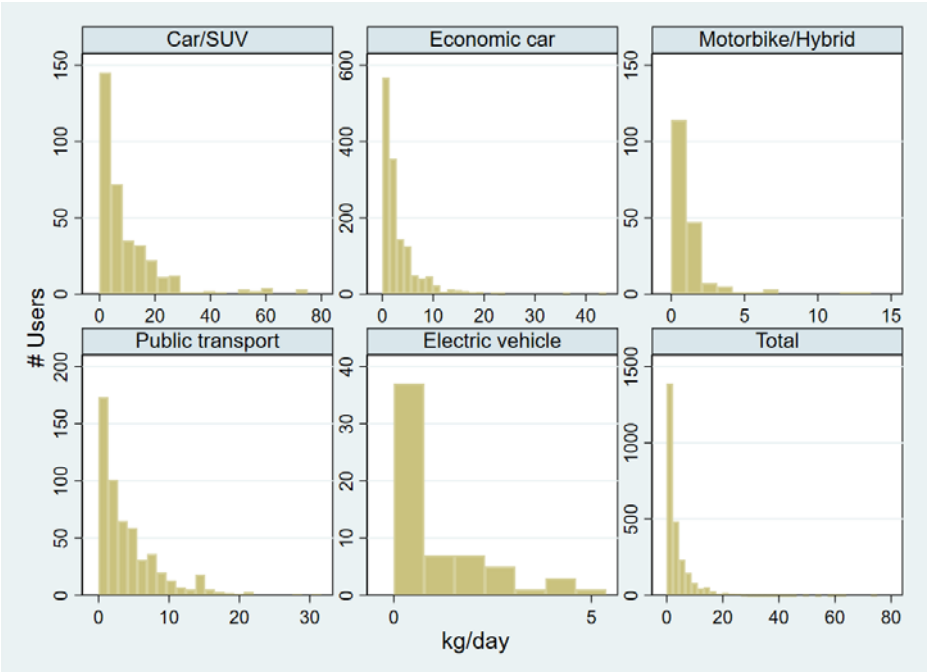

Figure 7.2. Frequency distribution of workers' CO_2 emissions per day by prevalent means of transport.

4.2. Environmental savings: future scenarios of agile working

The pandemic shock forced the whole population of R&Ts to stop commuting and start experiencing agile working. In many cases, adaptation to this new work setting, its tools and practices, was neither immediate nor effortless: about one worker over four declared scarce ability to adapt at the beginning, coupled with a sense of isolation (51.8% respondents) and excessive work-load (37.0%)[2]. By the way, the great majority acknowledges convenience in terms of commuting savings (76.6%) and environmental advantages (50.8%).

Hence: what if agile working is regularly implemented in the post-pandemic era? The previous section roughly estimates per-day savings from commuting: we are talking of about 2,500 hours, 10.3 tons CO_2 emissions and a total distance of one and a half Earth's circumference (i.e., more than 96,000 km). However, the survey points out that, if they can choose, R&Ts would prefer on average 2.1 agile working days per week.

Table 7.3 summarizes savings by prevalent means of transport if each R&T could choose his preferred quantity of agile working per week (from 0 to 5 days). It is evident the positive correlation between desired quantity of agile working and the average time devoted to commute: workers using public transports have the longest trips (98 minutes on average) and would prefer the highest quantity of agile working (2.4 days per week). If implemented, their desired quantity would save 4.2 hours of free time per person, more than double with respect to car users. However, the largest emission savings would concern car users, who are the most numerous and cover the longest total distance.

Table 7.3 – Savings if the desired quantity of Agile working (AW) per individual is implemented (per week).

Means of transport	AW days, average (days per week)	CO_2 emissions savings (kg)	Commuting time savings (h)	Average time savings (h/pers)
Car/SUV	2.2	8,538.9	708.1	2.0
Economy car	2.0	10,154.3	2,294.0	1.6
Bike/On foot	2.0	0.0	335.7	0.9
Electric vehicle	2.1	168.3	104.0	1.7
Scooter/Motorbike/Hybrid	2.0	524.7	216.0	1.2
Public transport (Train/Metro/Bus)	2.4	5,992.5	2,344.9	4.2
Total	2.1	25,378.8	6,002.7	2.1

Preferences about agile working days are quite similar across gender. In particular, 17% workers do not want agile working, but one out three would choose two days per week, and the 37% three or more days (Figure 7.3). If everyone is satisfied, it means 25.4 tons of emissions saved and about 6,000 hours out of the traffic per week, i.e. 2.1 hours per worker.

[2] See Chapter 5 for details on wellbeing analysis.

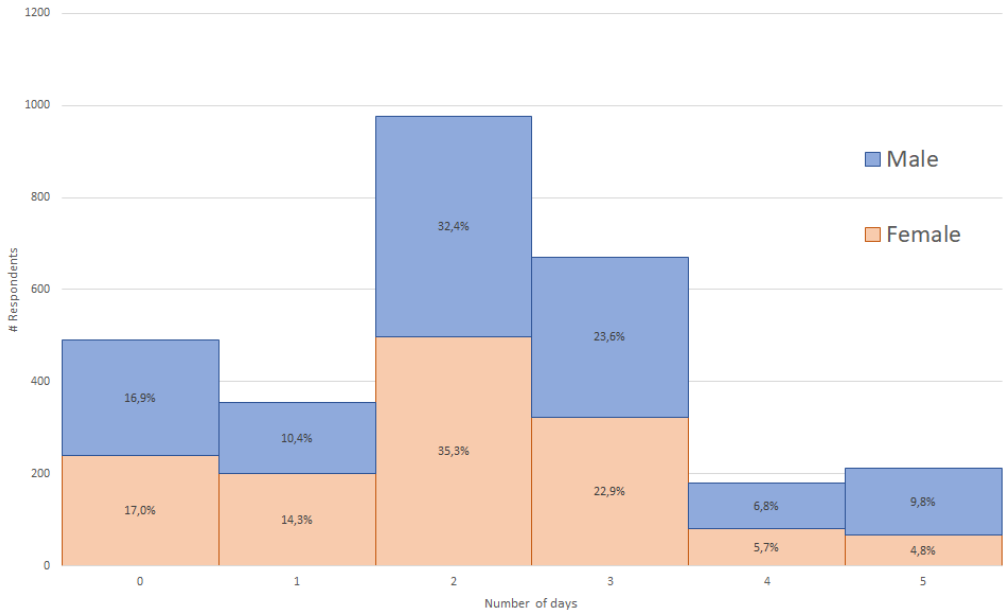

Figure 7.3. Number of agile working days preferred in post pandemic, by gender.

Finally, the pandemic experience itself is expected to produce an impact on workers' habits. Although the expected changes involve a very small fraction of respondents (8.5%), the overall balance favours eco-friendly behaviour. A specific question of the survey referred to the willingness to change habits in means of transport after the pandemic period. Considering these replays, figure 7.4 represents the expected variations in emissions due to the future adoption of a different means of transport (over the same way to work): the horizontal axis describes the actual means of transport, while the vertical axis describes the expected means of transport in the post-pandemic future. Hence, the main diagonal represents stable situations (same emissions), while the upper left matrix represents eco-friendly transitions.

This analysis presents a not so promising result. Considering workers changing from car (car/SUV and economy car) to public transport, the emission saving is about 198 kg (i.e., 112+86), but considering R&Ts that will change their habits from public transport to economy car, the emissions will increase of about 230 kg, then the net impact is an increasing pollution of about 32 kg (i.e., 230-198) per regular day. The situation changes only when considering the increasing adoption of bicycle or foot as commuting means for reaching the workplace. However, we expect an overall net saving of 89 kg CO_2 emissions per regular day, even in the case agile working is completely neglected.

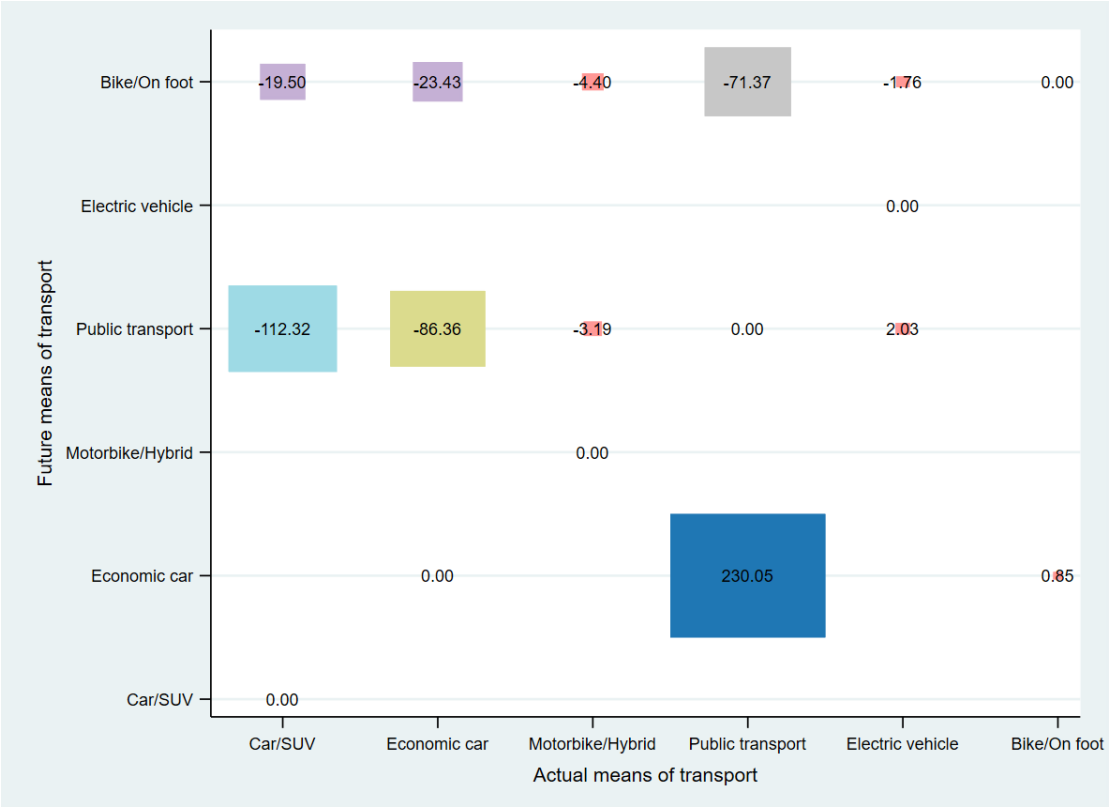

Figure 7.4. Expected variation in means of transport and expected CO_2 savings (kg/day).

5. Conclusions

The pandemic period due to COVID-19 has led to significant changes in the lifestyles of people all over the world and has stimulated the adoption of agile working organization both in the public and in the private sectors.

The results of the present study refer to a survey conducted on a specific typology of Italian workers. Indeed, the working population here analysed concerns scientific research, and, in particular, the Italian Public Research Organizations represented by 2,921 respondents to a questionnaire that has been filled in during the 2021 (see Chapter 2 for details).

The goal of our contribution is to evaluate the agile working effects on commuting habits, highlighting the impact of emission savings.

There are two main questions we have answered in this specific case-study: from the one hand, we have investigated if the agile working has a decreasing impact on transport emissions; from the other hand, we have proposed a simulation on possible future impact of agile working organization in terms of transport emissions.

Starting from survey responses, without agile working and then before the COVID-19 pandemic, the majority of PROs workers (i.e., about 1,800 respondents) travels prevalently by car (i.e., car/SUV or economy car) producing about 8,000 kg of CO_2 emissions per regular day. Considering also R&Ts travelling by public transports (i.e., 550 respondents), the emissions increase of about 2,200 kg per regular day, for a total of 10,200 kg of CO_2.

With the introduction of agile working as usual organizational procedure, the simulation based on the survey answers on the preferred number of agile working days for the post-pandemic period, suggests that we can estimate an emissions' saving of 25,000 kg per week. In addition, the experience of agile working organization during pandemic can change the preferences of PROs workers for transport habits: the questionnaires confirm a small but clear change in future transport habits, as we can expect an additional saving of 89 kg of CO_2 emissions per regular day, i.e. about 450 kg per week. Many PROs workers will change their commuting means from car

(i.e., car/SUV and economy car) to public transport, but, at the same time, many others declare they will reach their workplace by car, leaving the public transport. The evolution towards a larger use of ecologic means of transport is positive but not so strong, and it confirms that the level of public awareness on this environmental potential is not very high, even in a high-skilled population as R&Ts. Recently, Loia & Adinolfi (2021) developed a six-month sentiment analysis of about 11,000 tweets that showed that the ecological value of agile working is not well perceived by people: "surprisingly, in a pandemic context of growing ecological concern, there is no significant evidence of environmental awareness in relation to teleworking".

In any case, a new contract of Italian public administration is going to provide the adoption of agile working in PROs, and from the results of our study, we can expect that this innovation will improve not only the well-being and productivity of workers (see Chapters 4 and 5), but also the environment, reducing the CO_2 emissions due to fewer trips to the workplace and, at the same time, due to the changes in habits of commuting means. These results should be taken into consideration by policy makers because the estimates of emission savings are consistent.

In the perspective of our analysis, a more holistic approach on agile working and its outcomes paves the way to promising future research agendas. Indeed, it is necessary to consider the "net balance" of the agile working impact on the environment and not only the CO_2 savings from the commuting. Several aspects can decrease the environmental benefits due to agile working, as the new household consumptions could be added to the fixed consumption in the office or in public transport. For example, to avoid a reduction in net benefits, the workplace must be re-designed to adapt space and energy consumptions to the varying number of employees. But also, other characteristics of our society have to change to take full advantage from a higher use of agile working, such as the energy efficiency of the houses, the flexibility of the public transports, new business models for bars and restaurants that were previously linked to commuting workers, and so on. All these changes have an impact on the environment and affect the final net balance.

In any case, from the results of the present analysis, we can conclude that the adoption of agile working could have a positive net impact on CO_2 emissions due to fewer trips to the workplace and, at the same time, due to the changes in habit reductions, contributing to the process of ecological transition and sustainability that our societies try to implement.

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Chapter 8
Concluding remarks

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ABSTRACT
The COVID-19 pandemic has led to the introduction of a different way of working, whose effects show that existing rules at the PROs need a profound rethinking. However, according to the evidence presented in this volume, what we need is not only to maintain the possibility of smart working, but to acknowledge the importance of this disrupting innovation that is likely to emerge from the pandemic event. Agile working needs appropriate solutions to cope with the organizational transformations related to knowledge production.

KEYWORDS: agile working, COVID-19 pandemic, Public Research Organisations.

ISBN (online): 978-88-98193-26-4
ISBN (print): 978-88-98193-27-1

HOW TO CITE THIS CHAPTER
Reale, E. (2022). Concluding remarks. In Reale, E. (ed). *Agile working in Public Research Organizations during the COVID-19 pandemic. Organizational factors and individual attitudes in knowledge production* (pp. 117-121). Quaderni IRCrES 14. Moncalieri, TO: CNR-IRCrES. http://dx.doi.org/10.23760/2499-6661.2022.14

This book is aimed at understanding the value of the autonomous organization of individual work with respect to the production of new scientific knowledge in Public Research Organizations. The focus was on the agile working modes introduced during the COVID-19 pandemic, and the processes of individual adaptation/reaction to the implementation of these assets which informed the autonomous behavior of the researcher, also with reference to the social containment measures. The emergency implementation of this relatively uneven working mode in public research organizations occurred in a context where only a few organizations had previously experimented with it (Reale et al., 2020), and it was found to be a necessary solution aimed at reconciling the public health interests with the continuity of public administration action. During the health emergency agile working became the ordinary mode of working and, at the early stages of the pandemic, it was characterized by the confinement of work activities within the home, rather than assuming the configuration of a hybrid mode, with an alternation of remote and in-presence work.

The investigation was conducted through a web-based survey that was launched one year after the beginning of the emergency implementation of agile working and was targeted to the researchers and technologists of two public research organizations in Italy, namely the National Research Council (CNR) and the National Institute of Astrophysics (INAF). The survey reported the answers of 2,921 respondents, with a good balance by gender, age, and disciplinary field (see Chapter 2).

The analysis was developed around four main items and their related research questions linked to the implementation of smart working during the emergency caused by the COVID-19 pandemic, namely:

- positive and negative effects on the organization of scientific work (autonomy, productivity, research collaborations, mobility);
- effects on the personal and social well-being of research personnel, distinguishing where possible between the ordinary application phase of agile working and the phase related to the COVID-19 emergency;
- effects linked to environmental and work organization advantages;
- enabling conditions for agile working, with reference to the use of ICTs in research work.

There are some important reasons for deepening the effects of smart working on researchers and technologists working in the PROs.

First, PROs play a significant role in the Italian research system, as the R&D expenditures of universities and public research institutions in some OECD countries demonstrate (Consiglio Nazionale delle Ricerche, 2021). Italy, with Germany, France, and Spain, are the European countries where the PROs are very important actors in the public sector of research.

Secondly, despite their importance, the researchers and technologists of the PROs have different work regulations with respect to the academics, with some contractual constraints as to where they can perform the research activities. The mentioned constraints foresee that the time spent on research activities carried out at home could not be computed as working hours, because the research can be done either at the office or in other places outside the office, but not at home.

Third, the research profession is characterized by high levels of creativity, flexibility, and directionality towards achieving the planned results; researchers generally need wide spaces of autonomy to decide when, how, and where performing their activities. It means that we can expect a high capability of individuals to adapt to the new regime imposed by the pandemic event and the constraint to perform either all the activities at home or mainly at home.

We can now try to sum up the most important results emerging from the analysis.

Autonomy and productivity

The obvious granting of more flexibility and freedom to workers to decide when and where to work has been largely acknowledged in the European surveys on working conditions (Eurofound

& the International Labour Office, 2017) and largely documented by the literature on work flexibility (Angelici & Profeta, 2020), which also find positive effects of smart working on productivity, work-life balance, and well-being (Choudhury et al., 2021). Our investigation demonstrated that working at home was already in the habits of researchers and technologists of the PROs, notwithstanding the limitations imposed by the regulation. The COVID-19 emergency pushed toward the transfer of all the activities at home (especially at a first stage of the pandemic), and this event found people ready to operate at home despite the need to adapt to several changes in the work organization. Researchers and technologists have enjoyed the advantages of using a wider space of autonomy, which has relaxed the application of regulations that are not adapt to highly creative professions. Scholars often increased or at least maintained stable the productivity, but at the same time remained conscious of the limitations linked to the lack of personal contacts with the other colleagues. Surprisingly, the mentioned characteristics are visible in all the scientific fields, in people involved in both experimental and non-experimental activities, although with different rate and pace.

The value of personal contacts

It is a clear outcome of our investigation, that the possibilities for the digital scholarship have been substantially improved as a consequence of the new platforms, services and tools that had been widely used in the period of the COVID-19 pandemic. It means that we are facing a deeper transformation concerning how academics work and collaborate together. However, it is important to recall that the research profession cannot exist in isolation. Social and professional isolation is a threat deriving from smart working (Canal et al., 2022), which was highlighted very clearly in our survey. The number of free textual comments collected thanks to the questionnaire was impressive, and several statements pointed out the problem. Saying differently, the respondents, both male and female, claimed the need to balance working at home with working in presence, because research outcomes and research collaborations increase and improve only through physical contacts and social interactions, which are unavoidable in science work.

Is there a gender issue?

Several papers demonstrate a decrease in women's paper production, the first-authorship on preprints (Andersen et al., 2020; Vincent-Lamarre et al., 2021; Squazzoni et al., 2021), and a lower participation in academic citizenship activities (Minello et al., 2021) compared to men during the COVID-19 lockdown, mainly because the special condition exacerbates the existing gender disparities in science work by increasing family responsibilities such as caring children and older relatives. (Myers et al., 2020; Utoft, 2020; Reardon, 2022). Our survey does not present strong differences between attitudes and perceptions of men and women in terms of productivity and well-being. However, the deepening of the data has allowed us to figure out that negative attitudes towards smart working are generally associated with women, with problems related to the disconnection from work and the maintenance of the boundaries between working and family duties. Finally, the presence of a high share of respondents with stable productivity and minor children at home in the age cohort 30-44 years old, suggest the reason for negative perceptions which often characterized the answers of young women.

Was smart working during the emergency improving the researchers' well-being?

Researchers and technologists have been largely positive towards the benefits of smart working as to its capability to improve the family and the work life, as well as in the balance between the two. However, smart working is not without negative effects, such as difficulties in the planning of activities, the stress, and the fragmentation of working time. The mentioned negative perceptions are distributed between the respondents without significant differences for disciplinary fields or career attainments, but as mentioned, with differences linked to the age of the respondents, with a worse situation of young scholars with respect to the elderly.

Can we foresee a positive impact on the environment from the adoption of smart working in research?

The simulation carried out using the survey results demonstrate the positive effects of smart working, as to the decreasing impact on transport emissions, with the possibility of future changes in the habits of the respondents, which are likely to use more ecologic transportations. However, a complete answer to this question needs to consider other types of changes that should go with the reduction of CO2 emissions to have positive effects on the environment. These types of effects, in fact, are related to the introduction of solutions to reduce the energy consumption at home and at work, and more in general to new assets of social life following the transformations brought by the introduction of a new organization of work.

In sum, The COVID-19 pandemic has led to the introduction of a different way of working, whose effects show that existing rules at the PROs need a profound rethinking. However, according to the evidence presented in this volume, what we need is not only to maintain the possibility of smart working, but to acknowledge the importance of this disrupting innovation that is likely to emerge from the pandemic event. Agile working needs appropriate solutions to cope with the organizational transformations related to knowledge production.

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Annex
Questionnaire

On the following pages, the questionnaire created for the survey is presented in its entirety. The CAWI methodology and Lime Survey statistical survey software, which was integrated into the CNR survey platform, were used to develop the data collection (see Chapter 2). The paper version presented here is the result of automatic statistical software processing.

Sezione A:

A1. Qual è il suo ruolo professionale all'interno dell'ente di ricerca?

- ☐ Direttore o dirigente di ricerca
- ☐ Ricercatore o tecnologo
- ☐ Amministrativo o tecnico
- ☐ Associato di ricerca
- ☐ Assegnista di ricerca, borsista, ospite

Sezione B: SEZIONE 1

B1. Secondo lei quale delle seguenti definizioni corrisponde al lavoroagile:

- ☐ modalità di esecuzione del rapporto di lavoro che si realizza a condizione che l'Ente abbia preventivamente verificato la conformità alle norme generali di prevenzione e sicurezza delle utenze domestiche; la postazione e i collegamenti telematici devono essere messi a disposizione, installati e collaudati a cura e a spese dell'Ente
- ☐ modalità di esecuzione del rapporto di lavoro stabilita mediante accordo tra le parti, anche con forme di organizzazione per fasi, cicli e obiettivi e senza precisi vincoli di orario o di luogo di lavoro, con il possibile utilizzo di strumenti tecnologici
- ☐ Non so

Sezione C: SEZIONE 2

C1. Genere:

- ☐ Donna
- ☐ Uomo
- ☐ Preferisco non rispondere

C2. Fascia d'età:

- ☐ meno di 30 anni
- ☐ 30-44 anni
- ☐ 45-54 anni
- ☐ 55-65 anni
- ☐ più di 65 anni

C3. In quale provincia vive?

- Agrigento ☐
- Alessandria ☐
- Ancona ☐
- Aosta ☐
- Arezzo ☐
- Ascoli Piceno ☐
- Asti ☐
- Avellino ☐
- Bari ☐
- Barletta-Andria-Trani ☐
- Belluno ☐
- Benevento ☐
- Bergamo ☐
- Biella ☐
- Bologna ☐
- Bolzano ☐
- Brescia ☐
- Brindisi ☐
- Cagliari ☐
- Caltanissetta ☐
- Campobasso ☐
- Caserta ☐
- Catania ☐
- Catanzaro ☐
- Chieti ☐
- Como ☐
- Cosenza ☐
- Cremona ☐
- Crotone ☐

C4. A quale fascia demografica appartiene il suo comune?

- ☐ meno di 5.000 abitanti
- ☐ da 5.000 a 9.999 abitanti
- ☐ da 10.000 a 19.999 abitanti
- ☐ da 20.000 a 59.999 abitanti
- ☐ da 60.000 a 250.000 abitanti
- ☐ oltre 250.000 abitanti

C5. Può indicarci la dimensione approssimativa, in metri quadri, dell'abitazione dove svolge prevalentemente il lavoro agile?

☐☐☐

C6. Con chi convive nella sua abitazione?

- ☐ Vivo da solo/a
- ☐ Con partner/coniuge
- ☐ Con figli minorenni
- ☐ Con figli maggiorenni
- ☐ Genitore/i
- ☐ Con altre persone che non fanno parte della famiglia

C7. Con quante persone convive nella sua abitazione? Vivo da solo/a

In questo campo possono essere inseriti solo numeri da 1 a 10

Inserire numero ☐☐

C8. Con quante persone convive nella sua abitazione? Con partner/coniuge

In questo campo possono essere inseriti solo numeri da 1 a 10

Inserire numero ☐☐

C9. Con quante persone convive nella sua abitazione? Con figli minorenni

In questo campo possono essere inseriti solo numeri da 1 a 10

Inserire numero ☐☐

C10. Con quante persone convive nella sua abitazione? Con figlimaggiorenni

In questo campo possono essere inseriti solo numeri da 1 a 10

Inserire numero ☐☐

C11. Con quante persone convive nella sua abitazione? Genitore/i

In questo campo possono essere inseriti solo numeri da 1 a 10

Inserire numero ☐☐

C12. Con quante persone convive nella sua abitazione? Con altre personeche non fanno parte della famiglia

In questo campo possono essere inseriti solo numeri da 1 a 10

Inserire numero ☐☐

C13. In riferimento alla sua attività lavorativa, che tipo di contratto ha attualmente in essere col suo Ente di appartenenza?

- ☐ Tempo indeterminato full-time
- ☐ Tempo indeterminato part-time
- ☐ Tempo determinato full-time
- ☐ Tempo determinato part-time

C14. Qual è il suo inquadramento professionale?

- ☐ Direttore/Dirigente
- ☐ Ricercatore I° livello
- ☐ Ricercatore II° livello
- ☐ Ricercatore III° livello
- ☐ Tecnologo I° livello
- ☐ Tecnologo II° livello
- ☐ Tecnologo III° livello

C15. Su quale area CUN indirizza il suo lavoro di ricerca?

- Area 1 – Scienze matematiche e informatiche ☐
- Area 2 – Scienze fisiche ☐
- Area 3 – Scienze chimiche ☐
- Area 4 – Scienze della terra ☐
- Area 5 – Scienze biologiche ☐
- Area 6 – Scienze mediche ☐
- Area 7 – Scienze agrarie e veterinarie ☐
- Area 8 – Ingegneria civile e architettura ☐
- Area 9 – Ingegneria industriale e dell'informazione ☐
- Area 10 – Scienze dell'antichità, filologico-letterarie e storico-artistiche ☐
- Area 11 – Scienze storiche, filosofiche, pedagogiche e psicologiche ☐
- Area 12 – Scienze giuridiche ☐
- Area 13 – Scienze economiche e statistiche ☐
- Area 14 – Scienze politiche e sociali ☐

C16. Che tipo di attività svolge?

- Ricerca sperimentale ☐
- Ricerca non sperimentale ☐
- Supporto tecnico sui progetti ☐
- Supporto tecnico in laboratorio ☐

C17. Nella sua attività lavorativa ordinaria, <u>prima dell'emergenza COVID-19</u>, aveva generalmente l'opportunità di decidere...

	si	no	in parte
Dove svolgerla, scegliendo il luogo che ritengo più idoneo	☐	☐	☐
Quando svolgerla, decidendo autonomamente i tempi di lavoro	☐	☐	☐
Come svolgerla, scegliendo le modalità organizzative più adatte	☐	☐	☐

C18. Rispetto alle esigenze del suo lavoro, quanto valuta importante:

	per niente	poco	abbastanza	molto
Organizzare le proprie attività per scadenze e obiettivi	☐	☐	☐	☐
Avere la possibilità di consultare materiali o risorse in ambiente di ufficio	☐	☐	☐	☐
Disporre della maggiore autonomia operativa possibile	☐	☐	☐	☐
Avere opportunità di confronto costante con colleghi o supervisor	☐	☐	☐	☐

C19. Nella sua attività di lavoro ordinaria, <u>prima dell'emergenza COVID-19</u>, dove preferiva svolgere le seguenti attività?

	In sede di lavoro	A casa	In altre sedi	Sede indifferente	Non applicabile
Stesura di paper o monografie scientifiche	☐	☐	☐	☐	☐
Peer review per riviste scientifiche	☐	☐	☐	☐	☐
Elaborazione e analisi dati	☐	☐	☐	☐	☐
Consultazione di documenti / letteratura	☐	☐	☐	☐	☐
Gestione dei progetti di ricerca	☐	☐	☐	☐	☐

C20. In altre sedi (specificare)

C21. Nella sua attività di lavoro ordinaria, <u>prima dell'emergenza COVID-19,</u> quale formula prediligeva per svolgere le seguenti attività?

	Principalmente in presenza	Principalmente in streaming	Sia in presenza che in streaming	Non applicabile
Partecipazione a convegni	☐	☐	☐	☐
Incontri legati a progetti di ricerca	☐	☐	☐	☐
Divulgazione scientifica tramite seminari e lezioni	☐	☐	☐	☐
Attività sperimentale / indagine sul campo	☐	☐	☐	☐

Sezione D: SEZIONE 3

D'ora in poi per lavoro agile intenderemo la modalità di esecuzione del rapporto di lavoro subordinato, disciplinata dalla Legge n. 81/2017, "stabilita mediante accordo tra le parti, anche con forme di organizzazione per fasi, cicli e obiettivi e senza precisi vincoli di orario o di luogo di lavoro, con il possibile utilizzo di strumenti tecnologici per lo svolgimento dell'attività lavorativa".

Dalla fine del mese di febbraio 2020, la situazione di emergenza sanitaria legata alla diffusione dell'epidemia da COVID-19 e le conseguenti disposizioni governative intraprese per il suo contenimento hanno reso ordinaria l'esecuzione del lavoro agile nelle pubbliche amministrazioni, anche in assenza di accordi individuali, al fine di ridurre la presenza dei dipendenti presso le sedi e di limitarne gli spostamenti.

D1. Esprima il suo grado di accordo con le seguenti affermazioni sul lavoro agile

	Per nulla d'accordo	poco d'accordo	D'accordo	Molto d'accordo
È una modalità che valorizza l'autonomia del lavoro	☐	☐	☐	☐
È una modalità che favorisce l'efficienza del lavoro	☐	☐	☐	☐
È una modalità che, se non attentamente regolamentata, può provocare conseguenze negative	☐	☐	☐	☐
È un'opportunità per una migliore organizzazione del lavoro in collaborazione	☐	☐	☐	☐
È una modalità di lavoro che permette di conciliare meglio tempo di lavoro e vita privata	☐	☐	☐	☐

D2. In questo spazio può inserire eventuali commenti:

D3. <u>Prima dell'emergenza COVID-19</u>, aveva già sperimentato il lavoro agile nel suo Ente di appartenenza?

- ☐ No, e non ne avevo fatto richiesta
- ☐ No, ma avevo richiesto il lavoro agile senza ottenerlo
- ☐ No, ma avevo richiesto il lavoro agile ed ero in attesa di risposta
- ☐ Sì, avevo già sperimentato il lavoro agile

D4. In questo spazio può inserire eventuali commenti:

D5. Per quanti mesi ha svolto il lavoro agile prima dell'emergenza COVID-19?

D6. In che luogo ha prevalentemente sperimentato il lavoro agile prima dell'emergenza COVID-19?

- Casa ☐
- Altro luogo ☐

D7. Altro luogo, specificare

D8. La sua condizione di lavoratore agile è stata accolta con diffidenza:

	Si	No
Dai colleghi tecnico-amministrativi del mio Ente	☐	☐
Dalle figure dirigenziali del mio Ente (es. direttore, responsabile del personale)	☐	☐
Dai colleghi ricercatori e tecnologi del mio Ente	☐	☐

D9. In merito alla sua esperienza di lavoro agile durante l'emergenza COVID-19, esprima il suo grado di accordo con le seguenti affermazioni:

	Per nulla d'accordo	Poco d'accordo	D'accordo	Molto d'accordo
L'ente attua procedure di controllo e verifica del lavoro agile molto stringenti	☐	☐	☐	☐
Il ricercatore in lavoro agile viene incluso in nuove attività di ricerca condivise	☐	☐	☐	☐
Il lavoro agile compromette lo scambio relazionale utile al lavoro di ricerca	☐	☐	☐	☐

D10. Durante l'emergenza COVID-19, vi sono situazioni o circostanze che rendono (o possono rendere) difficile il lavoro presso la sua abitazione?

- Sì ☐
- No ☐

D11. In base alla sua esperienza, indichi i LIMITI più rilevanti del lavoro agile <u>durante l'emergenza COVID-19</u>:

Selezionare al massimo 3 risposte

- ☐ Sovraccarico lavorativo
- ☐ Percezione di un limitato riconoscimento della mia produttività
- ☐ Eccessiva autonomia sulle mie attività
- ☐ Slittamento delle scadenze e delle attività lavorative
- ☐ Aumento dei costi delle utenze/ connessione internet a proprio carico
- ☐ Sensazione di isolamento
- ☐ Frammentazione del lavoro a causa delle necessità domestiche e di cura familiare
- ☐ Altro

Altro

D12. In base alla sua esperienza, indichi i VANTAGGI più rilevanti del lavoro agile <u>durante l'emergenza COVID-19</u>:

Selezionare al massimo 3 risposte

- ☐ Risparmio di tempo per gli spostamenti casa/lavoro
- ☐ Vantaggi per l'ambiente (meno spostamenti)
- ☐ Maggiore autonomia lavorativa
- ☐ Possibilità di godere maggiormente della famiglia lavorando da casa
- ☐ Gestione flessibile dei tempi e dei modi di lavoro
- ☐ Aumento della produttività
- ☐ Rafforzamento delle competenze tecnologiche
- ☐ Altro

Altro

D13. Quanto considera variate le seguenti attività dal periodo "pre COVID-19" al periodo "emergenza COVID-19"?

	È diminuita	È aumentata	È rimasta invariata
Elaborazione di paper o monografie scientifiche	☐	☐	☐
Studio della letteratura scientifica	☐	☐	☐
Partecipazione a convegni o web conference	☐	☐	☐
Incontri legati a progetti di ricerca in presenza o virtuali	☐	☐	☐
Divulgazione scientifica tramite seminari, lezioni o webinar	☐	☐	☐
Peer review per riviste scientifiche	☐	☐	☐

D14. Durante l'emergenza COVID-19, quanto hanno influito sui cambiamenti nella produzione scientifica:

	Per niente	Poco	Abbastanza	Molto
La difficoltà di svolgere alcune attività lavorative	☐	☐	☐	☐
Le indicazioni specifiche ricevute dalla Direzione del suo Ente	☐	☐	☐	☐
La logistica degli spazi domestici da dedicare esclusivamente alle attività lavorative	☐	☐	☐	☐
La riorganizzazione dei tempi e delle attività lavorative	☐	☐	☐	☐

Sezione E: SEZIONE 4

E1. Quale tipo di connessione internet utilizza principalmente per il suo lavoro agile?

- Hot-spot smartphone ☐
- Hot-spot sim dati (saponette) ☐
- ADSL via fibra ☐
- ADSL via cavo ☐
- ADSL via antenna ☐

E2. Di quale abbonamento fruisce per la sua connessione internet?

- Connessione a consumo ☐
- Connessione flat ☐

E3. Lo svolgimento del lavoro in modalità agile può richiedere l'utilizzo di strumenti o servizi ICT; alcuni di questi vengono utilizzati anche nel lavoro da ufficio. Può indicarci, per ognuno dei seguenti strumenti o servizi, se ne fruisce e quanto è cambiato il suo utilizzo con l'attivazione del lavoro agile?

	Non conosco questo strumento/ servizio	È fornito dal mio Ente, ma non lo uso in modalità agile	Lo userei, ma non è ancora disponibile nel mio Ente	Lo uso da quando sono in lavoro agile	Lo uso in modalità agile come quando sono in sede	Lo uso in modalità agile più che in sede
Spazi cloud commerciali (es. Google Drive, Dropbox)	☐	☐	☐	☐	☐	☐
VPN/proxy server	☐	☐	☐	☐	☐	☐
Programmi specifici per audio/videoconferenza/ conference rooms (Gotomeeting, Join.me…)	☐	☐	☐	☐	☐	☐
Planning online condiviso per team di ricerca (es. Teamup, Google Calendar, Doodle…)	☐	☐	☐	☐	☐	☐
Programmi per chat (es. Skype, Ryver, Slack,…)	☐	☐	☐	☐	☐	☐
Servizio di supporto informatico utenti da remoto (mail dedicata, con software tipo Teamviewer…)	☐	☐	☐	☐	☐	☐
Utilizzo di software specifici su server dell'Ente	☐	☐	☐	☐	☐	☐
Accesso a banche dati da remoto	☐	☐	☐	☐	☐	☐
Spazio cloud del mio Ente	☐	☐	☐	☐	☐	☐

E4. Il suo Ente le ha proposto una formazione per introdurla ai servizi e agli strumenti ICT utili allo svolgimento del lavoro agile?

- ☐ No, non ne ha proposti, né ho seguito corsi di mia iniziativa
- ☐ No, non ne ha proposti, ma ho seguito uno o più corsi di mia iniziativa
- ☐ Sì, ha indicato pagine web di Ente dedicate al lavoro agile con un elenco strumenti e servizi (guide online, FAQ, ecc.)
- ☐ Sì, ha organizzato uno o più corsi di formazione online specifici per l'utilizzo di alcuni servizi/strumenti
- ☐ Non so

E5. Ha riscontrato problemi tecnici nello svolgimento del lavoro agile?

- ☐ Problemi nella connessione internet
- ☐ Insufficiente capacità di elaborazione del computer
- ☐ Problemi nei collegamenti in videoconferenza (problemi audio/video, ecc.)
- ☐ Problemi di accesso attraverso VPN/proxy server
- ☐ Problemi di accesso ai servizi di cloud
- ☐ No, nessun problema tecnico
- ☐ Problemi di accesso alle banche dati

Altro ☐

Altro

E6. Ha riscontrato <u>altri problemi</u> nello svolgimento del <u>lavoro agile?</u>

No, nessun problema ulteriore ☐

Impossibilità di stampare causa assenza di stampante ☐

Problemi dovuti ad assenza di formazione specifica per l'utilizzo di servizi o strumenti ICT ☐

Non ho avuto la possibilità di utilizzare più schermi per computer come faccio in ufficio ☐

Sezione F: SEZIONE 5

F1. Pensando al suo tempo di lavoro, in relazione alla modalità di lavoro agile <u>durante l'emergenza COVID-19</u>, lavora:

Prevalentemente negli stessi orari in cui lavoravo prima ☐

Negli stessi orari in cui lavoravo prima e qualche volta in orari o giorni non abituali ☐

Prevalentemente in orari o giorni non abituali ☐

Con orari frammentati in base alle esigenze familiari ☐

F2. Pensando al suo tempo libero, in relazione al lavoro in modalità agile, <u>durante l'emergenza COVID-19:</u>

Ho più tempo libero dal lavoro rispetto a prima e riesco a goderne maggiormente ☐

Ho più tempo libero dal lavoro rispetto a prima ma riesco a goderne solo parzialmente ☐

Ho lo stesso tempo libero dal lavoro di prima e ne godo allo stesso modo ☐

Ho meno tempo libero dal lavoro rispetto a prima e riesco a goderne solo parzialmente ☐

Ho meno tempo libero dal lavoro rispetto a prima e non riesco a goderne ☐

F3. <u>Durante l'emergenza COVID-19,</u> in che modo il lavoro agile influisce sul rapporto tra il tempo libero/familiare e quello lavorativo?

Favorisce la conciliazione del tempo familiare/libero e del tempo lavorativo ☐

Determina una ridefinizione del tempo familiare/libero a discapito di quello lavorativo ☐

Determina una ridefinizione del tempo lavorativo a discapito di quello familiare/libero ☐

Lascia invariata la ripartizione tra i due tempi ☐

F4. Durante il lavoro agile <u>in emergenza COVID-19</u>:

- ☐ Mi risulta difficile godere del diritto alla disconnessione
- ☐ Mi risulta facile godere del diritto alla disconnessione
- ☐ Non saprei stabilire se riesco a godere o no del diritto alla disconnessione

F5. Durante il lavoro agile <u>in emergenza COVID-19:</u>

Se non si riconosce con nessuna delle affermazioni, scriva NESSUNA nella casella ALTRO

- ☐ Non riesco a stabilire se ho difficoltà ad adattarmi poiché la mia percezione varia
- ☐ Riesco a pianificare bene le attività lavorative
- ☐ Lo stress mi impedisce di concentrarmi sul lavoro come vorrei
- ☐ Ho minori capacità di problem solving
- ☐ Non ho particolari problemi
- ☐ Ho maggiori difficoltà a pianificare le attività lavorative
- ☐ Ho avuto problemi iniziali ma poi ho saputo adattarmi alla situazione
- ☐ Ho perso l'interesse che provavo prima nei confronti del mio lavoro
- ☐ Altro

Altro

Sezione G: SEZIONE 6

G1. Indichi il numero di km del suo tragitto abituale casa-lavoro-casa:

☐☐☐

G2. Indichi il tempo del tragitto abituale casa-lavoro-casa (in minuti):

☐☐☐

G3. Con quale mezzo di trasporto raggiunge <u>prevalentemente</u> la sede di lavoro?

- ☐ Mezzo elettrico privato o in sharing (auto, bici, moto, monopattino, ecc.)
- ☐ Automobile piccola o media privata o in sharing (non elettrica)
- ☐ Automobile grande/SUV privata o in sharing (non elettrica)
- ☐ Scooter/moto privata o in sharing (non elettrici) o auto ibride
- ☐ Treno, autobus (anche navetta aziendale), metropolitana, tram
- ☐ Bicicletta/piedi

G4. <u>Passata l'emergenza COVID-19</u>, come si modificheranno le sue abitudini per andare al lavoro?

- ☐ Non si modificheranno
- ☐ Utilizzerò meno mezzi pubblici a favore dell'automobile/motociclo
- ☐ Utilizzerò meno mezzi pubblici a favore di bicicletta/piedi/monopattino
- ☐ Utilizzerò meno mezzi privati, a favore dei mezzi pubblici

G5. <u>Passata l'emergenza COVID-19</u>, pensa che utilizzerà maggiormente mezzi elettrici?

- ☐ No
- ☐ Si, in sharing
- ☐ Si, privati

G6. <u>L'emergenza COVID-19</u>, rispetto al periodo precedente, come ha modificato i suoi consumi legati all'attività lavorativa?

Graduare ognuno dei fattori indicati in grassetto

	Non è cambiato	è diminuito	è aumentato	Non so stimarlo
Consumo di carta	☐	☐	☐	☐
Consumo elettrico	☐	☐	☐	☐
Riscaldamento/ climatizzazione	☐	☐	☐	☐
Altro	☐	☐	☐	☐

G7. Altro, specificare:

Sezione H: SEZIONE 7

H1. Le piacerebbe fruire della modalità lavoro agile anche <u>al termine dell'emergenza COVID-19:</u>

- Sì ☐
- No ☐

H2. Per quanti giorni la settimana?

I numeri devono essere compresi tra 1 e 5

H3. Perché?

H4. Ritiene di poter svolgere in modalità agile efficacemente:

- La quasi totalità delle mie mansioni ordinarie ☐
- Più della metà delle mie mansioni ordinarie ☐
- Meno della metà delle mie mansioni ordinarie ☐
- Non so stimarlo attualmente ☐

H5. Stiamo lavorando a ulteriori approfondimenti sull'esperienza di lavoro agile. Se è disponibile a fornire la sua collaborazione, la preghiamo di indicare la sua e-mail nello spazio sottostante:

Il questionario è concluso, grazie per la sua collaborazione!

ISSN (online): 2499-6661
ISSN (print): 2499-6955

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2017

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2016

- Vol. 1, n. 1 Emerging costs deriving from blackouts for individual firms: evidence from an Italian case study. Clementina Bruno, Ugo Finardi, Azahara Lorite-Espejo, Elena Ragazzi

This volume presents the results of a web-based survey carried out by CNR-IRCrES to deepening the effects of the agile working implemented during the COVID-19 pandemic in the context of the Italian Public Research Organizations (PROs). The survey was launched one year after the beginning of the emergency implementation of agile working and was targeted to the researchers and technologists of two PROs, the National Research Council (CNR) and the National Institute of Astrophysics (INAF). Investigating attitudes and opinions of PRO researchers and technologists allowed to shed light on the value of autonomous organization of individual scientific work, an activity that is characterized by a very high level of creativity, and it is commonly organized by projects and goals to be achieved, with a flexible mode of working. The contents focus on how agile working during the pandemic affected several aspects of research work – including autonomy and creativity in knowledge production, scientific productivity, researchers' well-being, use of ICT tools and services – and on the environmental implications that could be expected. The analysis allowed for a deeper understanding of the processes of individual adaptation/reaction to the implementation of agile working, which is supposed to be maintained and whose regular implementation needs a rethinking of the existing rules within the PROs.
Pros and cons of the experience of agile working in PROs during the COVID-19 pandemic supply interesting evidence to the decision makers for designing the future of this different way of working.

ISBN (online): 978-88-98193-26-4

ISBN (print): 978-88-98193-27-1