Article

Teleworking as an Eco-Innovation for Sustainable Development: Assessing Collective Perceptions during COVID-19

Francesca Loia [1,*] and Paola Adinolfi [2]

[1] Department of Economics, Management and Institutions, Federico II University of Naples, 80126 Naples, Italy
[2] Department of Management & Innovation Systems, University of Salerno, 84084 Fisciano, Italy; padinolfi@unisa.it
* Correspondence: francesca.loia@unina.it

Abstract: Due to the spread of COVID-19, new challenges and opportunities for business innovation have emerged, including the way work is organized and designed. In particular, pandemic created the conditions for the most extensive mass teleworking experiment in history. While there is a wide literature on the effects of teleworking as a business innovation, mainly from an environmental perspective, there are few studies investigating the public perceptions regarding teleworking and, in particular, studies that draw from social media analyses. Based on these considerations, a big data analysis has been carried out in order to frame the public perceptions about teleworking on Twitter. The six-months sentiment analysis of about 11,000 tweets shows that the ecological value of telework is not perceived by people; surprisingly, in a pandemic context of growing ecological concern, there is no significant evidence of environmental awareness in relation to teleworking. However, the positive and negative concepts which emerge in relation to teleworking and similar terms can be assimilated to the benefits and pitfalls highlighted in the literature, which are related to economic or social sustainability. This has important implications for practice in organizations employing teleworking, which are highlighted in the conclusion, together with the limitations and future research avenues.

Keywords: teleworking; sustainable development; eco-innovation; COVID-19; sentiment analysis

1. Introduction

Due to the spread of COVID-19, new challenges and opportunities for business innovation have emerged, including the way work is organized and designed. While in the last ten years telework increased slowly because considered as an occasional work pattern, during the pandemic, both organizations that were previously familiar with teleworking, and organizations that have not experimented with teleworking before, were sending their employees home, creating the conditions for the most extensive mass teleworking experiment in history.

It is widely accepted that well-designed telework arrangements can support development policies aimed at shifting from automobile dependency to sustainable travel and at reducing electricity in the workplace [1–3]. This means that teleworking has some potential to reduce energy consumption and associated emissions both in terms of reducing commuter travel and displacing office-related energy consumption. In light of this, teleworking could be included among eco-innovations, defined as "innovations that consist of new or modified processes, practices, systems and products which benefit the environment and so contribute to environmental sustainability" [4].

As efficaciously observed by Alos-Simo, Verdu-Jover and Gomez-Gras [5] (p. 3), eco-innovations can be considered as "'win-win' strategy, that benefits both the business and the environment" [6], "a key tool for the organization's long-term survival" [7], "an important key to growth [8] that improves the firm's reputation and market position" [9].

There is a wide literature that illustrates the effects of teleworking on the business and the environment, as well as on the organizations' survival and growth. There are indeed

few studies investigating the public perceptions regarding these effects. As Sandberg and Targama ([10], p. 33) show, "while it is regarded as important to figure out what effects changed conditions have on human behavior, how people understand these effects is typically treated as a black box."

In particular, while it is premature to find an adequate volume of scientific articles on the contemporary mass teleworking experiment generated by the pandemic, it is striking not to find a number of large scale social media analyses [11–14]. For this reason, this paper aims to analyze public perceptions about teleworking during the pandemic by using one of the most common applications of Natural Language Processing, namely Sentiment Analysis. This work investigates which are the benefits and pitfalls of teleworking and assesses if there is a general awareness of the potential environmental benefits, as emerged from the mainstream studies. Therefore, this work is based on the following hypothesis: people's perceptions are in line with the finding of most recent studies, in particular those that highlight the benefits of teleworking from a sustainability perspective.

After a synthetic literature review on teleworking and its advantages/disadvantages, we illustrate the research methodology and the main findings. We then discuss the results and highlight the main implications and limitations of the research.

2. Literature Review

2.1. Teleworking: Benefits and Pitfalls

There is a wide variability in the definition of telework among scientific studies, resulting from the evolutionary nature of the practice. A large part of studies have used the term "teleworking" (mostly used in the European literature) interchangeably with other terms, such as "telecommuting" (more common in American literature), but also "home-working" and "remote working" [15]. Nowadays, a commonly accepted definition of telework includes any type of distributed work enabled by the use of Information and Communication Technologies (ICTs) [16].

In the last fifty years, the concept of teleworking has been the subject of significant attention in the field of managerial, organizational and sustainability research and in the context of ICTs studies [15,17–21]. During the 1950s, the revolutionary advances in telecommunications and computing technology enabled companies to organize the work away from the traditional office by means of alternative work arrangements [22]. Starting from these technological changes, the term "teleworking" was coined by Nilles [17] to conceptualize in a single word two relevant aspects: remote working and innovative working practices. With hardware and software IT fast developments, teleworking became widespread and more and more perceived as the "next workplace revolution" [23]. New generation of modems, ISDN (Integrated Services Digital Network) systems, advanced and sophisticated personal computers and laptops and similar technology, along with a significant reduction in the cost of equipment, and in particular, the decreasing cost of telecommunication, definitely marked the beginning of teleworking [24]. Other studies starting from the late 1990s defined teleworking as an "alternative mode of work" or "flexible work arrangements" [25,26]. Based on these considerations, teleworking attracted the global attention of different categories of stakeholders such as employees, employers, transportation planners, communities, the telecommunications industry and many others [27].

There is a rich literature as regards the benefits and pitfalls related to the adoption of teleworking practices.

First, there are studies that emphasize the social benefits of teleworking [15]: it is widely accepted that teleworking offers the possibility to improve the integration of family life and work through a more flexible organization of work-related tasks, and, from this point of view, teleworkers can feel more satisfied compared to those who are office-based [11,12,28,29]. On the other hand, successes, failures and misunderstandings in its usage are intermeshed with cultural issues in organizations that foster or hinder such experiences; furthermore, the implementation of remote work might have a negative social

influence by leading to social isolation, which in turn can lead to decreased perceived work productivity and work satisfaction [30,31]. Additionally, from a health point of view, the adoption of teleworking can result in negative consequences: somatic complaints, stress, emotional exhaustion, cholesterol increases, gastrointestinal disorders and cardiovascular disease could have devastating effects on occupational health [32–35]. Linked to this, another negative impact is technostress, intended as psychosomatic illness caused by working with information technologies on a daily basis [36]. This negative experience can be caused by constant connectivity, information surplus, frequent system changes and subsequent uncertainty, continual relearning and consequent job-related insecurities related to technical problems in the use of ICTs [37].

Secondly, Illegems et al. [12] show that teleworking practices could bring several advantages in economic terms by improving productivity, enhancing the organization's recruiting potential and increasing the positive influence on the reputation of the company. On the other hand, negative considerations regarding the adoption of teleworking in terms of productivity have also emerged [12], with reference to increased work hours for teleworkers, less loyal employees, low security of internal data.

A significant number of studies emphasize the role of contextual factors, which affect the effectiveness of teleworking. For example, Baruch [11] pointed out that teleworking does not fit every workplace and fewer people than expected found it good for them, both due to individual characteristics or home and family situations. For example, working from home could be perceived in a particular positive way by individuals in critical periods of time or physically disabled persons with a positive impact in terms of social inclusion (e.g., women during pregnancy, men with young children, someone temporarily recovering from an accident, etc.) [11,12,38]. Another situational factor has to do with the employee level of self-discipline: in the case of complex and high-level jobs, inner motivation and consequent self-discipline is crucial; whereas, for rank-and-file jobs, simple and direct control mechanisms are sufficient. An additional aspect, which emerged as a key factor for the success of teleworking programs, is the availability of space at home such as a separate study or room destined to business hours; this implies that many people, especially in lower socio-economic classes, could consider teleworking as an uncomfortable situation [11].

On the whole, the highlighted benefits and pitfalls have a positive or negative impact on the economic sustainability of teleworking, but they are also related to the concepts of social sustainability. Sustainable development can be declined in social terms through the principle of social sustainability, which refers to a society where people are not subject to conditions that systematically undermine their capacity to meet their needs (e.g., the abuse of political and economic power). Trust, shared meanings, capacity of learning, capacity of self-organization, inclusion and diversity have been identified as essential aspects of the social system in terms of sustainable development [39]. Thus, social sustainability has to do with the quality of a company's relationships with its stakeholders. In this regard, teleworking can be considered as a way of working that can be used for proposing organizational transformations that target the seventeen sustainable development and social sustainability goals set by the United Nations [14].

2.2. Teleworking and Environmental Sustainability

Environmental sustainability considerations are at the foundation of the emergence of teleworking [3]: the problem of road congestion, pollution, along with the diffusion of laws to discourage private use of transportation provided support to the initial adoption of teleworking [15]. Public policy initiatives that promoted telework were initially conceived and designed to reduce traffic and resultant levels of pollution by alleviating the number of vehicles on the road, secondarily to reduce the strain being placed on many public transport systems [40]. An increasing portion of studies has later pointed out the positive impact of teleworking in terms of ecological implications. The scenario of the last twenty years, characterized by major environmental issues such as pollution [41], climate change [42] and energy consumption [43], further emphasizes the need to adopt

teleworking. Teleworking can offer a way to improve environmental sustainability by reducing daily travel and congestion problems, as well as leading to reduced travel demand and consequently economy-wide energy consumption [44,45]; therefore, according to mainstream studies, telework arrangements could support sustainable development policies through the transition from man's automobile dependency to sustainable travel and the reduction of electricity in the workplace [1–3].

On the whole, even considering the so called "rebound effect" (namely the reduction of the expected gains, because of behavioral or other systemic responses), the net environmental impact of teleworking is considered positive by most researchers [46]. Accordingly, teleworking practices are closely related to the green issues in terms of environment, transport, location, office space and resource use for contemporary organizations. Based on these considerations, teleworking can be considered as an eco-innovation for sustainable development, intended as an "innovation in product, service or business management that reduces environmental impact and achieves sustainable goals and improvements based on transformation of business processes" [6].

However, teleworking practices have been slowly adopted over time because considered as an occasional work pattern, therefore they have not yet shown tangible results from an environmental and ecological perspective and concerns related to environmental impact and sustainability have continued to fuel the call for creative solutions to alleviate the detrimental impact of automobile use and commuting.

In the last months, teleworking has reached a very high level of application, mainly due to the diffusion of COVID-19. On the 11 March 2020, the World Health Organization (WHO) categorized the coronavirus outbreak as a pandemic and advised governments around the world to take seriously the question and prepare several drastic measures, such as the national lockdowns [47]. For this reason, a large proportion of the workforce—compatible with teleworking modalities—received instructions to stay home and continue to work remotely. During the pandemic, teleworking has been mainly considered as a way to organize the work able to ensure employees' safety and to provide continuity to economic activity.

In conclusion, albeit recent literature highlights the benefits of teleworking from a sustainability perspective [3,15,29,32], how it is actually perceived during the pandemic and, in particular, whether it is regarded as an eco-innovation, is still an open question.

3. Materials and Methods

A study based on a data driven approach was conducted with the main aim to understand how teleworking is perceived and, in particular, whether it is regarded as a driver of sustainable development.

The collection of the opinions took place on Twitter, which is a social media microblogging characterized by 330,000,000 monthly active users, of which 63% are between 35 and 65 [48]. Twitter is therefore one of the most popular social media platforms in which users from all over the world discuss about popular topics related to major social and environmental issues, such as innovation, environment, corporate social responsibility, technology and energy [49,50].

With the aim to reduce interpretative biases in the tweets evaluations, the analysis was performed within a period of 6 months, from the beginning of September 2020 to the end of February 2021. In this time frame, the global pandemic was still raging across the world. BBC has reported that in early November 2020 there have been 50,000,000 confirmed cases of COVID-19 in 190 countries and more than 1,200,000 million deaths [51].

The method used to analyze social media microblogging data from Twitter is based on a specific dictionary of words, annotated with their semantic polarity. Compared to Machine Learning techniques, a lexicon-based method requires lower efforts in the human-labeled document and does not depend on the quantity and quality of the training dataset [52].

Data was acquired from the Twitter application programming interface (API), which is a backend server that warehouses all individuals' tweets and enables data collection by the public. While there are many methods that can be used to process data, we follow an approach adapted from Miner et al. [53] and use the TwitteR package for the R programming language [54]. TwitteR provides a well-documented and accessible means to extract data into a commonly used data mining statistical program [55].

Specifically, the data collection has been performed by establishing and then implementing specific filters in form of hashtags in order to identify all users' comments related to the topic of the analysis. The hashtag can be defined as a string of characters preceded by a hash (#) character used to synthesize in a single word a concept which is described later in 280 or less characters [56]. In our case, the crawler has taken into account only the tweets containing at least one of the following hashtags: #teleworking, #telecommuting, #remoteworking and #homeworking. In fact, albeit teleworking is generally referred to the activity of working at home, while communicating with the office by phone, email or internet, other terms—such as remote working, telecommuting and home working—are used interchangeably with teleworking, as illustrated in Section 2. The term smart working, albeit in the Italian context has been used as synonym of teleworking, has not been selected as research key because in the international context it has a different meaning, related to work performed in a wide variety of places and at times that are not necessarily the same as office hours [57,58].

For data collection and mining we used the methodological framework elaborated by Younis [59], shown in Figure 1. The main phases are the following:

- Data Access: by means of TwitteR package, twitter messages are collected by selecting specific keywords;
- Data Cleaning: by means of additional packages, data is cleaned by removing stop (nonfunctional) words, spaces, punctuation, URLs and by performing stemming (namely, getting the root of the words). The output of this step is a structured representation of tweets called "Term-Document Matrix".
- Data Analysis: the structured representation produced in the previous step allows for performing the mining process, such as finding more frequent terms and association rules, as well as performing sentiment analysis through the lexicon-based approach, which uses a set of positive and negative words and assigns a score to each tweet through a scoring function. The emotional content of the text is highlighted, by means of emotion lexicons, a list of English words associated with eight basic emotions (anger, fear, anticipation, trust, surprise, sadness, joy and disgust) and two sentiments (negative and positive) [60,61].
- Visualization: the word-cloud package and bar plots are showed in order to depict the frequency of words in the tweets collected and the sentiment and emotional scores.
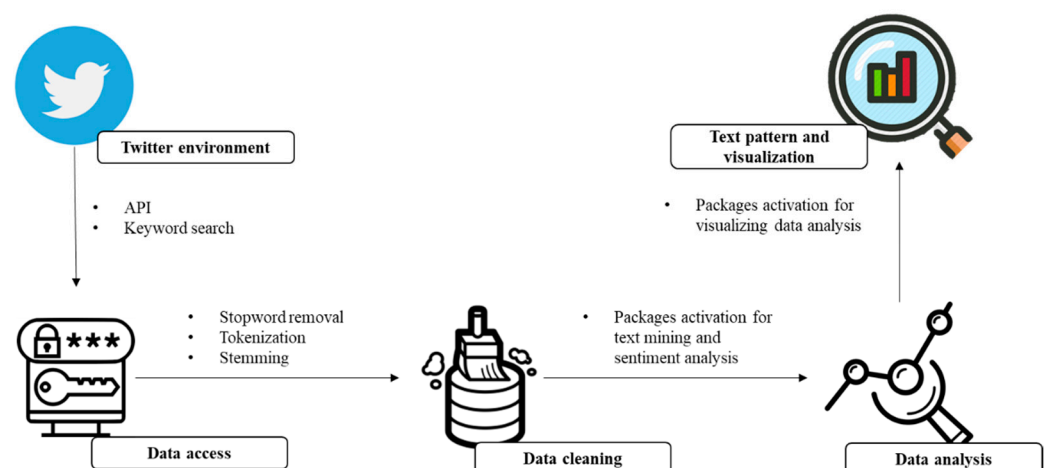

Figure 1. Methodological framework in Twitter using R Language adapted by Younis [59].

All the text mining processes previously mentioned have been defined and operationalized in R, an open-source statistical environment based on a programming language and a specific development environment for the statistical analysis of data [62].

4. Results

Overall, thanks to the data-driven analysis carried out on Twitter, the data flow regarding teleworking published on Twitter by users from all over the world has been analyzed in the time interval taken into consideration. Specifically, to provide an answer to the research questions, only tweets containing the hashtag #teleworking, #telecommuting, #remoteworking and #homeworking have been collected. This filter has enabled the consideration of about 11,000 tweets which have been cleaned and analyzed according to the methodology previously exposed.

Figure 2 shows a word cloud containing the terms which are most frequently used by Twitter users in their posts about teleworking, without considering stop words: the size of the words represented in the figure is directly proportional to the number of times they have been extracted by the web crawler on Twitter. In detail, the words are remarked in red or in blue, according to their positive or negative connotation. It is striking that the most frequent words are markedly negative words—such as emergency, disaster, panic, threats, crisis—highlighting the association of telework with an extraordinary event, which has forced the adoption of a new work organization. On the other hand, these preliminary results provide also a picture of some positive perceptions associated with teleworking related to keywords such as: "secure", "successfully", "safe", "flexible", "benefits", "trust", "love", "happy" and "gains". Overall, in line with recent studies [63,64], negative perceptions emerge in a powerful way and are more intense, compared with positive ones.
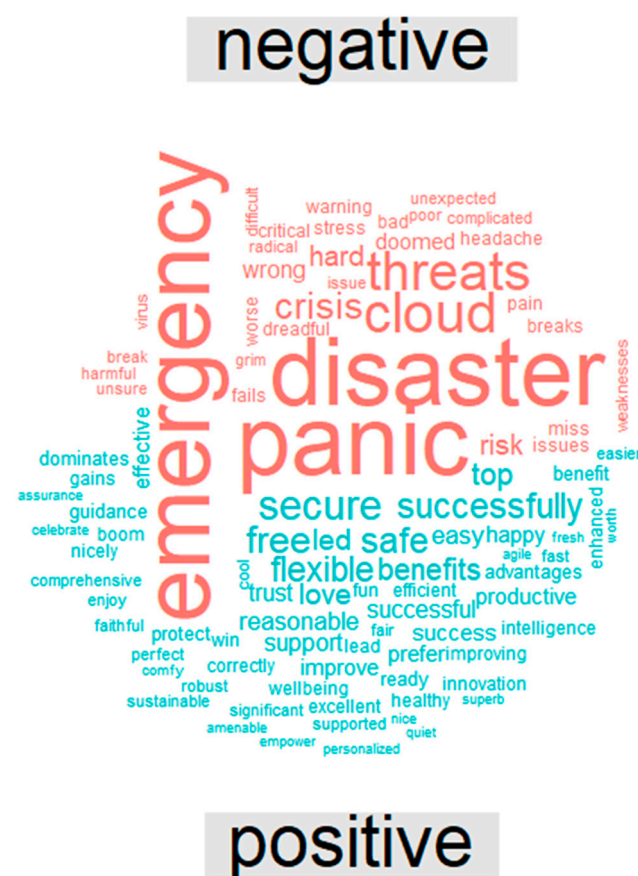

Figure 2. Word cloud of most used words in tweets related to teleworking, telecommuting, remote working, homeworking.

From the point of view of users' emotions, the emotional content of the most recurrent words associated with teleworking is highlighted in Figure 3. The analysis sheds light on the impact of an extraordinary global change in living standards and circumstances affecting people's emotional state. Without a doubt, by evaluating the most recurrent words, such as "pandemic", "government" and "emergency", negative emotions outweigh the positive ones. Along these lines, sadness (associated with keywords such as "disaster", "tax", "isolation") and fear emotions (related to "change", "panic", "defense") are very recurrent feelings in the period covered by the analysis. However, albeit it is evident that the COVID-19 pandemic is amplifying negative emotions and reducing positive emotions globally [65,66], there is evidence of a trusting and positive attitude by users. It is interesting to highlight that the most recurrent words are, as regards trust, "team", "management" and "top" and, as regards positive, "productivity", technology" and "learn". In this regard, homeworking during the pandemic, by implying the establishment of strong and trustworthy relationships within the organization, can be perceived as a positive experience by employees [67,68]. In particular, the anticipation highlights the great potential of teleworking: if, on the one hand, it can cause anxiety, because it is an innovative work organization in many companies, on the other hand, it offers a new way of working, implying more autonomy, flexibility and better adaptation to the individual circumstances and preferences. In this sense, "time", "top", "start" and "success" are recurrently used by the users thus expressing a kind of excitement regarding homeworking [69].

The data collected has been evaluated by means of the sentiment analysis module which allows to identify people's perceptions about teleworking: the most frequently words have been grouped into homogeneous categories based on the affinity of their meanings, and have been compared to a sentiment lexicon in order to establish their positive or negative potential. This has enabled the identification of 11 main concepts about teleworking by Twitter's users: five perceived in a positive way (occupational safety and health; flexible working organization; performance management; proactive engagement; social inclusion) and six perceived negatively (depression and mental health; digital and cyber security; technostress; lack of work life balance; isolation from organizational/social relations; lost productivity), as shown in Tables 1 and 2. All the concepts are strictly related to the concept of sustainability: the positive concepts are mainly related to the concept of social sustainability, with the exception of performance management, which impacts the economic sustainability. On the other hand, the negative concepts affect the social sustainability, apart from digital and cyber security and loss of productivity, that affect the economic sustainability.

Table 1. Ranking of the positive concepts expressed with regard to teleworking, homeworking, remote working, telecommuting.

Ranking	Positive Impact on Sustainable Development	Positive Concepts	Sub-Concepts
1st	Social sustainability	Occupational safety and health	Safe Safety Wellbeing Secure Privilege
2nd	Social sustainability	Flexible working organization	Free Flexible Smart Smarter Agile

Table 1. *Cont.*

Ranking	Positive Impact on Sustainable Development	Positive Concepts	Sub-Concepts
3rd	Economic sustainability	Performance management	Top Productive Success Successfully Effective Effectively Easy Enhance Talent Improve
4th	Social sustainability	Employee's engagement	Innovation Enjoy Trust Happy Love Engaging Prefer
5th	Social sustainability	Social inclusion	Inclusion

Table 2. Ranking of the negative concepts expressed with regard to teleworking, homeworking, remote working, telecommuting.

Ranking	Negative Impact on Sustainable Development	Negative Concepts	Sub-Concepts
1st	Social sustainability	Depression and mental health	Panic Crisis Degradation Disruption Pain Worry Twisted Cry
2nd	Economic sustainability	Digital and cyber security	Cloud Risk Attack Fraud
3nd	Social sustainability	Performance management	Hard Issues Difficult Stress Deaf Noise Doomed
4th	Social sustainability	Lack of work-life balance	Overlook Concern Tired

Table 2. *Cont.*

Ranking	Negative Impact on Sustainable Development	Negative Concepts	Sub-Concepts
5th	Social sustainability	Isolation from organization/social relations	Miss Missed Losing Loneliness Lonely Isolation Clash
6th	Economic sustainability	Lost productivity	Lazy Slow Disrupt Disruption Slack

In detail, between the positive concepts, occupational safety and health appears to be the most important: the element of security, quite absent in the pre-pandemic literature on teleworking, is the most prevalent as a clear effect of pandemic. In fact, the complex situation due to the spread of COVID-19 does not make possible for the entire workforce to return safely to the employer's premises and teleworking is considered necessary for at least some part of the workforce, especially for high-risk and vulnerable groups. On the other hand, flexible work organization, which includes words such as "free" and "flexible", refers to the possibility, during teleworking, of a more flexible schedule for workers which are free to work from an alternative location, away from the premise of the employer. Furthermore, performance management, by referring to sub-concepts as "top", "productive" and "success", highlights that teleworking not only ensures business continuity and the required level of production, but also can improve employee performance. In addition, employee engagement alludes to the possibility to boost the levels of employee satisfaction and engagement (for example, see the keywords "innovation", "enjoy" and "trust"). Lastly, teleworking is associated to social inclusion (as indicated by the keyword "inclusion").

Among the negative concepts, depression and mental health is the most recurrent and refers to people who have been quarantined during the pandemic and have reported depression and negative mood as a result of homeworking (e.g., see the most recurrent words "panic", "crisis" and "degradation"). Secondly, the concept of digital and cybersecurity appears to play an important role for most users. In fact, teleworking involves digital and cybersecurity risks and employee are aware of cyber-attacks. Additionally, technostress, by referring to sub-concepts such as "hard", "issues" and "difficult", is one of the negative concepts and defines the post-traumatic stress disorder symptoms, anger and emotional exhaustion due to the combination of technology and job. On the other hand, lack of work-life balance emerges from the analysis, which includes keywords such as "overlook" and "concerns", evoking the risk for employees of not disconnecting and working more hours than usual. Further, among the concepts that are perceived negatively, the isolation from organizational/social relations, related to the keywords "miss", "losing" and "lonely", highlights the sense of solitude that employees can feel in relation to the organizational or social isolation. Finally, lost productivity highlights the possibility that telework can affect employee's performance ("lazy", "slow", etc.).
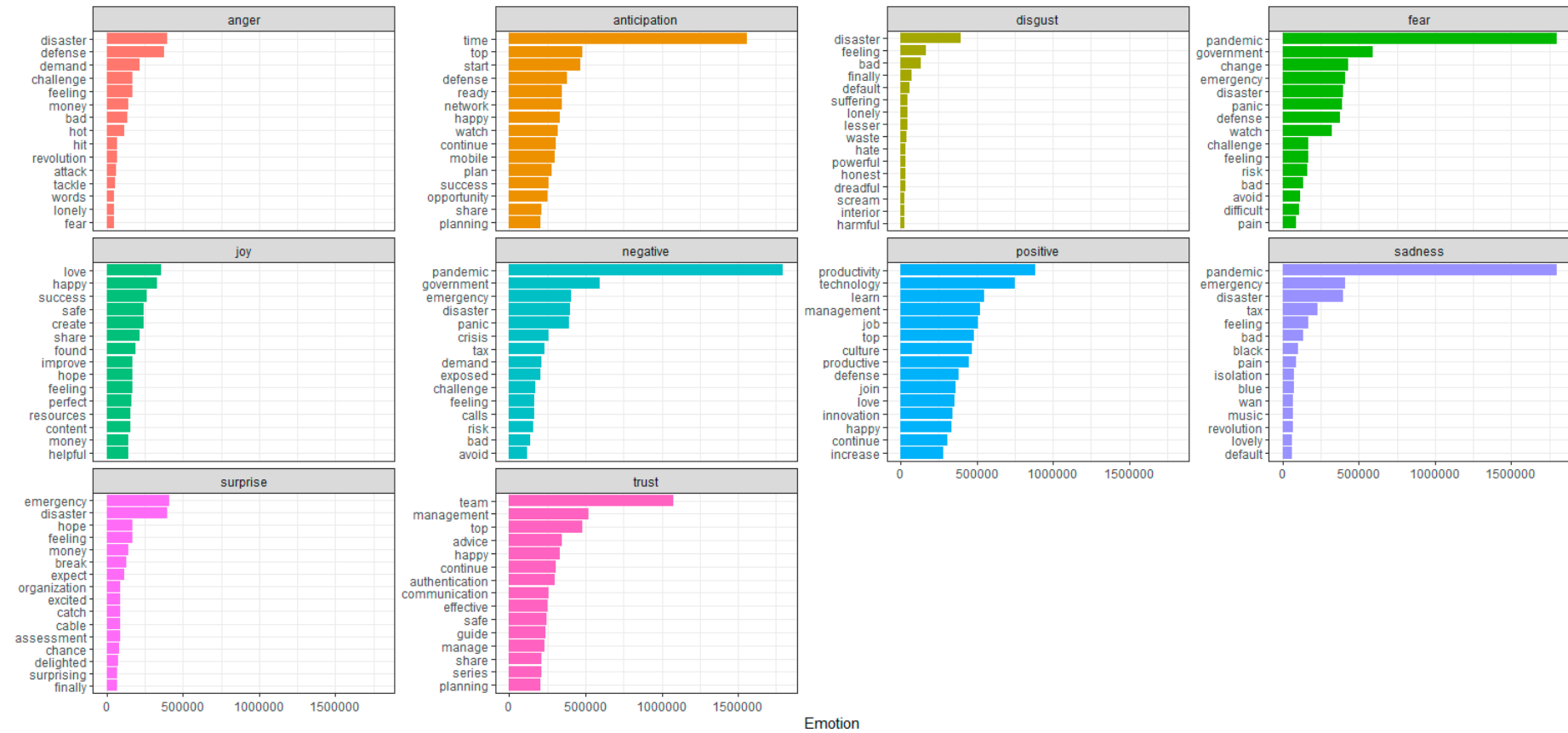
Figure 3. Emotional analysis of the most recurrent words in tweets related to teleworking, telecommuting, remote working and homeworking.

5. Discussion

The results of the sentiment analysis are surprising: it is striking that, in a pandemic context of growing ecological concern, there is no public perception of the environmental benefits of teleworking. However, the positive and negative concepts which emerge in relation to teleworking and similar terms can be assimilated to the benefits and pitfalls highlighted in the literature, which are related to economic or social sustainability.

5.1. Advantages of Teleworking and Sustainability

The positive concepts emerged from the analysis, as showed in Table 1, are: occupational safety and health, flexible working organization, performance management, employee engagement and social inclusion.

The concept of occupational safety and health is an ontological foundation of sustainability in general and social sustainability in particular [70]. The importance of safety has been highlighted in the literature as a clear effect of pandemic [71]: working away from the office, given the health risks, has offered workers, who perform tasks and activities that are compatible with homeworking arrangements, the possibility to be eligible to these practices during the crisis, including those in temporary employment and interns. Another positive concept is the flexible working organization, which is also considered as a fundamental part of social sustainability [72]. This is perfectly in line with mainstream studies, according to which teleworking may include identifying objectives, tasks, milestones and monitoring progress without overly burdensome reporting, allowing employees for the flexibility and autonomy to work without the manager having to constantly check on progress [13,21,26,27,73]. This improves conciliation and supports a better work-life balance by reducing the stress of commuting to the office and allowing for more time with loved ones [15]. Another positive concept, which can be put in relation to social sustainability, is the employees' engagement. This is in line with consolidated and recent studies indicating the increase of teleworkers' engagement because of the improvement of their satisfaction [11,12,28,29,69]. Additionally, the sentiment analysis shows that teleworking during the pandemic can have a positive impact also regarding the social inclusion, which is particularly relevant in terms of social sustainability [74]. In fact, according to the type of jobs, workers with disabilities are currently more likely to work from home and many may benefit from expanded work-at-home opportunities [12,39,75]. Additionally, pregnant workers and new mothers, which are particularly vulnerable during any health crisis and more concerned about becoming infected or transmitting the virus to others, perceive teleworking practices as an inclusive way for designing working practices [76]. This may also concern the vulnerable groups within the workforce, such as workers with underlying health problems or older workers, who may face a higher risk of developing serious health issues.

On the other hand, performance management, which is a positive concept emerged from the analysis, is related to the economic sustainability, which refers to the long-term economic growth. This concept is also in line with the literature, as illustrated in Section 2: not only teleworking practices during the pandemic have ensured continuation of activities and productivity in the organizations, but also have led, in some cases, to the improvement of performance [13]. Once arranged a good environment and good physical, psychological and ergonomic conditions, it is possible to improve performance, especially in tasks that require high mental concentration [11].

5.2. Disadvantages of Teleworking and Sustainability

The results of the sentiment analysis show six negative concepts which affect the social sustainability, as illustrated in Table 2: depression and mental health, digital and cyber security, technostress, lack of work life balance, isolation from organizational/social relations and lost productivity.

First, teleworking, especially during the pandemic, has led great imbalances to employee mental health, mainly in terms of depression, thus affecting the social sustainability

of these working practices [77]. Working from home can cause people to feel isolated, and loneliness can lead to depression and other mental health issues. This is in line with consolidated literature [32–35] and more recent surveys which have revealed the rising levels of mental health problems among workers [78,79]. Strictly related to the above concept, the concept of technostress emerged from the analysis, which affects in a negative way the social sustainability of teleworking practices. As highlighted in the literature [36,37], technostress refers to psychosomatic illness caused by working with ICTs on a daily basis, which can increase fatigue, irritability and the inability to switch off from work and rest properly. It is a negative experience resulting from constant connectivity, information surplus, frequent system changes and related uncertainty, continual relearning and consequent job-related insecurities related to technical problems in the use of information technologies. Another negative concept emerged from the analysis is the lack of work life balance, which negatively impacts the social sustainability, too [80]. In fact, whereas teleworking, as previously discussed, represents an opportunity for better conciliating work and private life, it is important to strike a balance and contain activities within regular working hours, in order not to further blur the line between working time and private time. Literature shows that, albeit home working practices are aimed at allowing employees for a satisfactory work–life balance [12,13,29], teleworking might result in increased workload, due to the expectation that flexibility should be reciprocated with extra effort. In addition, problems might emerge for female workers, who might be led to a disproportionate amount of housework and childcare compared to male workers. At the same time, according to the analysis carried out, the isolation from organizational/social relations is an important element, which may produce adverse effects on social sustainability [81]. As highlighted in the literature, loneliness and isolation may involve severe depression [33]. In working environments, the lack of direct contact can affect coworker relationships and could generate more conflict potential, less possibility of control for team leaders and less feedback about team processes.

In regards to economic sustainability, two main negative concepts emerged. First, digital and cyber security was widely discussed by the users and perceived as an emerging problem related to teleworking practices. Most studies [13,82] point out that ICT devices at homes, being generally perceived as poorly configured compared to the office devices, are highly prone to cyber-attacks, especially in the COVID-19 pandemic era. In such a scenario, cyber criminals or hackers may benefit from the unsecure off-site routers, modems, unsecure network devices and poorly configured home network devices to exploit the vulnerabilities associated with teleworkers and then compromising the security of organizations and government agencies [83]. Furthermore, teleworking arrangements can affect the organizations' efficiency by causing lost productivity and consequently undermining its economic sustainability [84]. This negative consequence, that has been highlighted in most studies on teleworking, affects particularly those teleworkers who give importance to social relationships and therefore are less engaged and motivated when working from home [31]. Another reason for the loss of productivity can be the difficulty of monitoring employee work, that is a problem identified by some studies, mostly in the case of low level of self-discipline and inadequate leadership styles [12], as highlighted in Section 2.

6. Implication, Final Remarks and Conclusions

In a time when millions of people all over the world are subjected to unhealthy levels of pollution, telework can clearly play a significant role in the long-term solution of environmental problems.

While studies from various disciplinary domains have demonstrated the societal impact of telecommuting in terms of reduction in global carbon emissions, and, even more, post-pandemic ecological-footprint analyses have highlighted the large environmental benefits of teleworking, thanks to the real-time experiment of adopting it on a large scale, the environmental value of telework is not perceived by people: surprisingly, our six-month

sentiment analysis shows no significant evidence of environmental awareness in relation to teleworking.

Nevertheless, the positive and negative concepts which emerge from the analysis are related, as has been highlighted in the discussion, to the social and economic sustainability, which is a universal feature that transcends geographic borders and boundaries. If, in the context of a growing environmental awareness, this indirect link with sustainability as well as the direct impact that telework produces on ecological sustainability, were clearly perceivable by workers, there would probably be more propensity to accept and engage in teleworking on the part of workers, since their need for meaning would be satisfied, as well as their desire to make a purposeful contribution to society.

This has important implications for practice in organizations employing teleworking: leaders need to become aware that teleworking has a positive impact on carbon emissions and should actively shape and strengthen this kind of awareness among employees. In the provision of orientation services for those transitioning into telework arrangements, organizations should clearly communicate the environmental benefits of high-intensity teleworking arrangements, so as to increase workers' sense of belonging to a green organization and to make their telework more meaningful. In this sense, human resource department assumes a leading role by actively contributing to the communication of ecological benefits related to teleworking practices at all organizational levels [85,86]. This would provide two kinds of benefits: on the one hand, it would increase workers' sense of purpose and pride for working from home as well as their propensity to accept telecommuting and its discomforts; on the other hand, it would enhance their environmental-friendly behavior and lifestyle, thus reducing the 'rebound effects' that erode the potential environmental benefits from telework. In addition, organizations should seek to develop accountability practices concerning the social and environmental outcomes of company teleworking policies, such as environmental accountability reports and indicators, so as to increase their reputation and market position.

While filling an important gap in knowledge, this study contains some limitations, besides the typical limitations of sentiment analysis. First, the list of keywords might be incomplete. In particular, it was decided not to consider, among the keywords, "smart working", given that it is a quite different concept from teleworking. We might have missed the tweets from people who mistakenly define teleworking arrangements as "smart working" (this misconception is widespread in Italy). Secondly, the analysis was performed over a six-month period: a longer period (covering the whole pandemic crisis) would widen the scope of public awareness of the total picture of the mass telework experiment. Furthermore, large scale data analysis does not enable the collection of detailed information about the users' sample such as nationality, gender, occupation and age. Finally, the analysis collected data from twitter only. For these reasons, further research could use other resources such as mass media or other data sources in addition to social media information.

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References

1. Elldér, E. Telework and daily travel: New evidence from Sweden. *J. Transp. Geogr.* **2020**, *86*, 102777. [CrossRef]
2. Wang, K.; Ozbilen, B. Synergistic and threshold effects of telework and residential location choice on travel time allocation. *Sustain. Cities Soc.* **2020**, *63*, 102468. [CrossRef]

3. Belzunegui-Eraso, A.; Erro-Garcés, A. Teleworking in the Context of the Covid-19 Crisis. *Sustainability* **2020**, *12*, 3662. [CrossRef]
4. Oltra, V.; Jean, M.S. Sectoral systems of environmental innovation: An application to the French automotive industry. *Technol. Forecast. Soc. Chang.* **2009**, *76*, 567–583. [CrossRef]
5. Alos-Simo, L.; Verdu-Jover, A.J.; Gomez-Gras, J.M. Does activity sector matter for the relationship between eco-innovation and performance? Implications for cleaner production. *J. Clean. Prod.* **2020**, *263*, 121544. [CrossRef]
6. Ghisetti, C.; Marzucchi, A.; Montresor, S. The open eco-innovation mode. An empirical investigation of eleven European countries. *Res. Policy* **2015**, *44*, 1080–1093. [CrossRef]
7. Santos-Vijande, M.L.; Álvarez-González, L.I. Innovativeness and organizational innovation in total quality oriented firms: The moderating role of market turbulence. *Technovation* **2007**, *27*, 514–532. [CrossRef]
8. Bigliardi, B.; Bertolini, M.; Doran, J.; Ryan, G. Regulation and firm perception, eco-innovation and firm performance. *Eur. J. Innov. Manag.* **2012**, *15*, 421–441.
9. Eiadat, Y.; Kelly, A.; Roche, F.; Eyadat, H. Green and competitive? An empirical test of the mediating role of environmental innovation strategy. *J. World Bus.* **2008**, *43*, 131–145. [CrossRef]
10. Sandberg, J.; Targama, A. Shared understanding: The basis for collective competences and its development. In *Managing Un-derstanding in Organizations*; SAGE: London, UK, 2007; pp. 89–108.
11. Baruch, Y. Teleworking: Benefits and pitfalls as perceived by professionals and managers. *New Technol. Work. Employ.* **2000**, *15*, 34–49. [CrossRef]
12. Illegems, V.; Verbeke, A.; S'Jegers, R. The organizational context of teleworking implementation. *Technol. Forecast. Soc. Chang.* **2001**, *68*, 275–291. [CrossRef]
13. Coenen, M.; Kok, R.A. Workplace flexibility and new product development performance: The role of telework and flexible work schedules. *Eur. Manag. J.* **2014**, *32*, 564–576. [CrossRef]
14. Gálvez, A.; Tirado, F.; Martínez, M.J. Work–Life Balance, Organizations and Social Sustainability: Analyzing Female Telework in Spain. *Sustainability* **2020**, *12*, 3567. [CrossRef]
15. Baruch, Y. The status of research on teleworking and an agenda for future research. *Int. J. Manag. Rev.* **2001**, *3*, 113–129. [CrossRef]
16. López-Igual, P.; Rodríguez-Modroño, P. Who is Teleworking and Where from? Exploring the Main Determinants of Telework in Europe. *Sustainability* **2020**, *12*, 8797. [CrossRef]
17. Nilles, J. Telecommunications and Organizational Decentralization. *Ieee Trans. Commun.* **1975**, *23*, 1142–1147. [CrossRef]
18. Pratt, J.H. Home teleworking: A study of its pioneers. *Technol. Forecast. Soc. Chang.* **1984**, *25*, 1–14. [CrossRef]
19. Davenport, T.H.; Pearlson, K. Two cheers for the virtual office. *Mit Sloan Manag. Rev.* **1998**, *39*, 51.
20. Morgan, R.E. Teleworking: An assessment of the benefits and challenges. *Eur. Bus. Rev.* **2004**, *16*, 344–357. [CrossRef]
21. Torten, R.; Reaiche, C.; Caraballo, E.L. Teleworking in the new milleneum. *J. Dev. Areas* **2016**, *50*, 317–326. [CrossRef]
22. Jones, J.C. Automation and design (1–5). *Design* **1957**, *103*, 104–106.
23. Kelly, M.M. Next workplace revolution: Telecommuting. *Superv. Manag.* **1985**, *30*, 2–7.
24. Watad, M.M.; DiSanzo, F.J. Case study: The synergism of telecommuting and office automation. *Mit Sloan Manag. Rev.* **2000**, *41*, 85.
25. Drucker, P.F. Knowledge-Worker Productivity: The Biggest Challenge. *Calif. Manag. Rev.* **1999**, *41*, 79–94. [CrossRef]
26. Peiperl, M.; Baruch, Y. Back to square zero: The post-corporate career. *Organ. Dyn.* **1997**, *25*, 7–22. [CrossRef]
27. Handy, S.L.; Mokhtarian, P.L. The future of telecommuting. *Futures* **1996**, *28*, 227–240. [CrossRef]
28. Dima, A.-M.; Țuclea, C.-E.; Vrânceanu, D.-M.; Țigu, G. Sustainable Social and Individual Implications of Telework: A New Insight into the Romanian Labor Market. *Sustainability* **2019**, *11*, 3506. [CrossRef]
29. Fonner, K.L.; Roloff, M.E. Why Teleworkers are More Satisfied with Their Jobs than are Office-Based Workers: When Less Contact is Beneficial. *J. Appl. Commun. Res.* **2010**, *38*, 336–361. [CrossRef]
30. Venkatesh, V.; Speier, C. Creating an effective training environment for enhancing telework. *Int. J. Hum. Comput. Stud.* **2000**, *52*, 991–1005. [CrossRef]
31. Toscano, F.; Zappalà, S. Social Isolation and Stress as Predictors of Productivity Perception and Remote Work Satisfaction during the COVID-19 Pandemic: The Role of Concern about the Virus in a Moderated Double Mediation. *Sustainability* **2020**, *12*, 9804. [CrossRef]
32. Duxbury, L.E.; Higgins, C.A.; Mills, S. After-Hours Telecommuting and Work-Family Conflict: A Comparative Analysis. *Inf. Syst. Res.* **1992**, *3*, 173–190. [CrossRef]
33. Adams, G.A.; King, L.A.; King, D.W. Relationships of job and family involvement, family social support, and work–family conflict with job and life satisfaction. *J. Appl. Psychol.* **1996**, *81*, 411. [CrossRef]
34. Golden, T.D. Avoiding depletion in virtual work: Telework and the intervening impact of work exhaustion on commitment and turnover intentions. *J. Vocat. Behav.* **2006**, *69*, 176–187. [CrossRef]
35. Madsen, S.R. The effects of home-based teleworking on work-family conflict. *Hum. Resour. Dev. Q.* **2003**, *14*, 35–58. [CrossRef]
36. Suh, A.; Lee, J. Understanding teleworkers' technostress and its influence on job satisfaction. *Internet Res.* **2017**, *27*, 140–159. [CrossRef]
37. Tarafdar, M.; Tu, Q.; Ragu-Nathan, T.S. Impact of Technostress on End-User Satisfaction and Performance. *J. Manag. Inf. Syst.* **2010**, *27*, 303–334. [CrossRef]

38. Haddon, L. The experience of teleworking: A view from the home. In *Teleworking: New International Perspectives from Telecommuting to the Virtual Organisation*; Jackson, P.J., van der Wielen, J.M., Eds.; Routledge: London, UK, 1998.

39. Missimer, M.; Robèrt, K.-H.; Broman, G. A strategic approach to social sustainability—Part 1: Exploring the social system. *J. Clean. Prod.* **2017**, *140*, 32–41. [CrossRef]

40. Harpaz, I. Advantages and disadvantages of telecommuting for the individual, organization and society. *Work. Study* **2002**, *51*, 74–80. [CrossRef]

41. Mekonnen, M.M.; Pahlow, M.; Aldaya, M.M.; Zarate, E.; Hoekstra, A.Y. Sustainability, Efficiency and Equitability of Water Consumption and Pollution in Latin America and the Caribbean. *Sustainability* **2015**, *7*, 2086–2112. [CrossRef]

42. Lundgren, K.; Kjellstrom, T. Sustainability Challenges from Climate Change and Air Conditioning Use in Urban Areas. *Sustainability* **2013**, *5*, 3116–3128. [CrossRef]

43. Zaharia, A.; Diaconeasa, M.C.; Brad, L.; Lădaru, G.-R.; Ioanăș, C. Factors Influencing Energy Consumption in the Context of Sustainable Development. *Sustainability* **2019**, *11*, 4147. [CrossRef]

44. Mello, J.A. Managing Telework Programs Effectively. *Empl. Responsib. Rights J.* **2007**, *19*, 247–261. [CrossRef]

45. Pérez, M.P.; Sánchez, A.M.; Carnicer, M.P.D.L.; Jiménez, M.J.V. The environmental impacts of teleworking. *Manag. Environ. Qual. Int. J.* **2004**, *15*, 656–671. [CrossRef]

46. Hook, A.; Court, V.; Sovacool, B.K.; Sorrell, S. A systematic review of the energy and climate impacts of teleworking. *Environ. Res. Lett.* **2020**, *15*, 093003. [CrossRef]

47. WHO (World Health Organization). *WHO Director-General's Opening Remarks at the Media Briefing on COVID-19, 11 March 2020*; WHO: Geneva, Switzerland, 2020.

48. Lin, Y. 10 twitter statistics every marketer should know in 2021. 2021. Available online: https://www.oberlo.com/blog/twitter-statistics#:~{}:text=Here\T1\textquoterights%20a%20summary%20of%20the,are%20between%2035%20and%2065Retrived01/03/2021 (accessed on 2 March 2021).

49. Merle, M.; Reese, G.; Drews, S. Globalcitizen: An explorative twitter analysis of global identity and sustainability commu-nication. *Sustainability* **2019**, *11*, 3472. [CrossRef]

50. Pilař, L.; Stanislavská, L.K.; Pitrová, J.; Krejčí, I.; Tichá, I.; Chalupová, M. Twitter Analysis of Global Communication in the Field of Sustainability. *Sustainability* **2019**, *11*, 6958. [CrossRef]

51. BBC News. Covid-19: Global coronavirus cases pass 50 million. 2020. Available online: https://www.bbc.com/news/world-54867793 (accessed on 9 November 2020).

52. Hailong, Z.; Wenyan, G.; Bo, J. Machine learning and lexicon based methods for sentiment classification: A survey. In 2014 11th web information system and application conference. *IEEE* **2014**, *9*, 262–265.

53. Miner, G.; Elder IV, J.; Fast, A.; Hill, T.; Nisbet, R.; Delen, D. *Practical Text Mining and Statistical Analysis for Non-Structured Text Data Applications*; Academic Press: London, UK, 2012.

54. Gentry, J. Twitter client for R. 2013. Available online: https://cran.r-project.org/web/packages/twitteR/twitteR.pdf (accessed on 2 March 2021).

55. KDnuggets.com. What Analytics, Data Mining, Big Data Software You Used in the Past 12 Months for a Real Project? 2012. Available online: http://www.kdnuggets.com/polls/2012/analytics-data-mining-big-data-software.html (accessed on 2 March 2021).

56. Tsur, O.; Rappoport, A. What's in a Hashtag? Content Based Prediction of the Spread of Ideas in Microblogging Communities. In Proceedings of the Fifth ACM International Conference on Web Search and Data Mining, Seattle, WA, USA, 8–12 February 2012; pp. 643–652.

57. Menshikova, M.; Fedorova, A.; Gatti, M. Introducing Smart-Working in the Conditions of Digital Business Transformation: Analysis of an Employee's Experience. In *Lecture Notes in Information Systems and Organisation*; Metzler, J.B., Ed.; Springer: Berlin, Germany, 2020; pp. 59–71.

58. Torre, T.; Sarti, D. Themes and Trends in Smart Working Research: A Systematic Analysis of Academic Contributions. *Indig. Afr. Enterp.* **2019**, *23*, 177–200.

59. Younis, E.M. Sentiment analysis and text mining for social media microblogs using open source tools: An empirical study. *Int. J. Comput. Appl.* **2015**, *5*, 112.

60. Mohammad, S.M.; Turney, P.D. Crowdsourcing a word-emotion association lexicon. *Comput. Intell.* **2012**, *29*, 436–465. [CrossRef]

61. Hu, M.; Liu, B. Mining and summarizing customer reviews. In Proceedings of the Proceedings of the 2004 ACM SIGKDD international conference on Knowledge discovery and data mining–KDD '04; ACM: New York, NY, USA, 2004; pp. 168–177.

62. Saini, S.; Punhani, R.; Bathla, R.; Shukla, V.K. Sentiment Analysis on Twitter Data using R. In Proceedings of the 2019 International Conference on Automation, Computational and Technology Management (ICACTM), London, UK, 24–26 April 2019; pp. 68–72.

63. 2020 Sentio Solutions. Our Emotions Are Changing during the Covid-19 Pandemic 2020. Available online: https://uploads-ssl.webflow.com/596c68356dc5b2598b09b912/5eb3cfae67bd4c51e0cfe1a4_COVID%20-19%20STUDY%20by%20Feel.pdf (accessed on 2 March 2021).

64. Restubog, S.L.D.; Ocampo, A.C.G.; Wang, L. Taking control amidst the chaos: Emotion regulation during the COVID-19 pandemic. *J. Vocat. Behav.* **2020**, *119*, 103440. [CrossRef] [PubMed]

65. Wang, K.; Goldenberg, A.; Dorison, C.; Miller, J.; Lerner, J.; Gross, J.; A Global Test of Brief Reappraisal Interventions on Emo-Tions during the COVID-19 Pandemic. Leibniz Institut für Psychologische Information und Dokumentation (ZPID). 2020. Available online: https://pubmed.ncbi.nlm.nih.gov/33415997/ (accessed on 10 March 2021).

66. Manucci, M. How People Come Back to Workplaces during the Pandemic: Three dimensions of intervention for new emotional performance conditions. *Hum. Resour. Dev. Int.* **2021**, 1–8. [CrossRef]

67. Contreras, F.; Baykal, E.; Abid, G. E-Leadership and Teleworking in Times of COVID-19 and Beyond: What We Know and Where Do We Go. *Front. Psychol.* **2020**, *11*, 590271. [CrossRef]

68. Cartmill, C. *New Survey Shows 87% of Staff Wish to Work from Home in Post Lockdown World*; Belfast News Letter: Belfast, North Ireland, 2020.

69. Gálvez, A.; Tirado, F.; Alcaraz, J.M. "Oh! Teleworking!" Regimes of engagement and the lived experience of female Spanish teleworkers. *Bus. Ethic A Eur. Rev.* **2019**, *29*, 180–192. [CrossRef]

70. Eizenberg, E.; Jabareen, Y. Social Sustainability: A New Conceptual Framework. *Sustainability* **2017**, *9*, 68. [CrossRef]

71. Schall, M.C., Jr.; Chen, P.; Evidence-Based Strategies for Improving Occupational Safety and Health among Teleworkers during and after the Coronavirus Pandemic. Human Factors; SAGE Publishing. 2021. Available online: https://www.psycharchives.org/handle/20.500.12034/2577 (accessed on 10 March 2021).

72. Blake-Beard, S.; O'Neill, R.; Ingols, C.; Shapiro, M. Social sustainability, flexible work arrangements, and diverse women. *Gend. Manag. Int. J.* **2010**, *25*, 408–425. [CrossRef]

73. Sánchez, A.M.; Pérez, M.P.; Carnicer, P.D.L.; Jiménez, M.J.V. Teleworking and workplace flexibility: A study of impact on firm performance. *Pers. Rev.* **2007**, *36*, 42–64. [CrossRef]

74. Dujon, V.; Dillard, J.; Brennan, E.M. (Eds.) *Social Sustainability: A Multilevel Approach to Social Inclusion*; Routledge: London, UK, 2013.

75. Schur, L.A.; Ameri, M.; Kruse, D. Telework after COVID: A "silver lining" for workers with disabilities? *J. Occup. Rehabil.* **2020**, *30*, 521–536. [CrossRef] [PubMed]

76. Hamouche, S. COVID-19 and employees' mental health: Stressors, moderators and agenda for organizational actions. *Emerald Open Res.* **2020**, *2*, 15. [CrossRef]

77. Rogers, D.S.; Duraiappah, A.K.; Antons, D.C.; Munoz, P.; Bai, X.; Fragkias, M.; Gutscher, H. A vision for human well-being: Transition to social sustainability. *Curr. Opin. Environ. Sustain.* **2012**, *4*, 61–73. [CrossRef]

78. Bérard, E.; Kai, S.H.Y.; Coley, N.; Bongard, V.; Ferrières, J. Lockdown-related factors associated with the worsening of cardiovascular risk and anxiety or depression during the COVID-19 pandemic. *Prev. Med. Rep.* **2021**, *21*, 101300. [CrossRef]

79. Peretti-Watel, P.; Alleaume, C.; Léger, D.; Beck, F.; Verger, P. Anxiety, depression and sleep problems: A second wave of COVID-19. *Gen. Psychiatry* **2020**, *33*, e100299. [CrossRef] [PubMed]

80. Mushfiqur, R.; Mordi, C.; Oruh, E.S.; Nwagbara, U.; Mordi, T.; Turner, I.M. The impacts of work-life-balance (WLB) challenges on social sustainability. *Empl. Relat.* **2018**, *40*, 868–888. [CrossRef]

81. Boyer, R.H.W.; Peterson, N.D.; Arora, P.; Caldwell, K. Five Approaches to Social Sustainability and an Integrated Way Forward. *Sustainability* **2016**, *8*, 878. [CrossRef]

82. Ahmed, E.M. Modelling Information and Communications Technology Cyber Security Externalities Spillover Effects on Sustainable Economic Growth. *J. Knowl. Econ.* **2021**, *12*, 412–430. [CrossRef]

83. Abukari, A.M.; Bankas, E.K. Some cyber security hygienic protocols for teleworkers in COVID-19 pandemic period and beyond. *Int. J. Sci. Eng. Res.* **2020**, *11*, 1401–1407.

84. Fedulova, I.; Voronkova, O.; Zhuravlev, P.; Gerasimova, E.; Glyzina, M.; Alekhina, N. Labor productivity and its role in the sustainable development of economy: On the example of a region. *Entrep. Sustain. Issues* **2019**, *7*, 1059–1073. [CrossRef]

85. Reina, R.; Scarozza, D. Human Resource Management in the Public Administration. In *Organizational Development in Public Administration*; Decastri, M., Battini, S., Buonocore, F., Gagliarducci, F., Eds.; Palgrave Macmillan: London, UK, 2021; pp. 61–101.

86. Torre, T.; Sarti, D. Into Smart Work Practices: Which Challenges for the HR Department? In *Working in Digital and Smart Organizations*; Ales, E., Curzi, Y., Fabbri, T., Rymkevich, O., Senatori, I., Solinas, G., Eds.; Palgrave Macmillan: London, UK, 2018; pp. 249–275.