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PHD THESIS SUMMARY

IMPROVING QUALITY IN THE DEVELOPMENT OF ERP-TYPE SOFTWARE APPLICATIONS IN TRADITIONAL WORK SYSTEMS AND TELEWORK

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Introduction

The present research is a scientific paper about the quality of telework (**work from home)** in general and about quality improvement in the development of ERP software applications in traditional work systems and telework, in particular. Without claiming to exhaust the topic of **teleworking**, the study is carried out in two stages so that the entire research approach can be captured. In the first stage, the study was conducted in a company developing economic and financial software (ERP - Enterprise Resource Planning) where, since the onset of the COVID-19 pandemic, employees carry out their work tasks from the home office. In the second stage, the study continued in the software development company, with the addition of new elements in research, and in parallel it was also carried out in an electrical company, which carries out office work activities.

We live in the era of computerization, and information technology (IT) finds its application in almost every aspect of our lives, as never before. "Information technology has become an integral part of organizations that have fueled demand for IT professionals and IT companies."

More specifically, the use of ERP programs in the business area increases the ability of organizations to manage and conduct their financial transactions, to make the right decisions at the right time. Through software applications designed specifically for business environments, all data, information and knowledge used to achieve business objectives can be managed according to the needs and strategies of companies.

Software products range from small personal applications to large distributed systems; from common accounting systems to strategic operational systems; from commercial software to open source software (Xu &; Brinkkemper, 2005).

The software industry comprises two major components: software development and services. Both assume quality, and the most costly errors and problems occur in the area of software product development.

At the moment, we are experiencing important changes in the labor market. Accelerated by the Coronavirus pandemic, the migration to the "home office" of employees from large companies and not only, can become an irreversible phenomenon. In this context, there is a need to identify mechanisms for evaluating remote work. With the new organization of companies' activity, managers need strategies and tools to ensure maintaining or even increasing the quality of work done by the employee.

The COVID-19 pandemic has accelerated interest in new software tools to monitor the computer activities of employees working remotely and demand to provide better analytics functionality, focusing on employee performance and work-life balance.

The change based on technological developments, associated with the fourth industrial revolution, that we are currently witnessing has profoundly changed all aspects of life, the way people interact, learn, work and their expectations in general. Unlike the Second Industrial Revolution, which in the nineteenth century led to the migration of people from rural areas to cities to work in factories, now more and more people can work remotely, from home (Mims, 2020). This paradigm shift was facilitated especially by the wide availability of reliable and affordable software solutions developed in the IT field. Today, most households have computers and various devices, connected to the internet and this allows access to a multitude of digital platforms and cloud services, which in turn facilitate remote work (Ogbonnaya, 2020).

The motivation for the research emerged as teleworking became a significant part of working life for many employees and employers around the world, accelerated and reinforced by the COVID-19 pandemic as a quick alternative to limit the spread of the virus.

Thus, on the background of the experience gained in the almost 12 years in which we have worked in the field of development and implementation of integrated software for economic and financial management (ERP applications), starting from the complexity of the phenomenal telework that generates a multitude of unknowns related to productivity, employee satisfaction, maintaining the quality of work performed, but also from the desire to bring valuable contributions to the scientific framework approached, the achievement of of this study.

Also, an essential aspect that led to the realization of this research is the **openness to collaboration**, manifested both by the management team of the company where the research was carried out and by the employees who became participants in the study. Collaboration represented an opportunity especially from the perspective of how data was collected, namely by recording data from computer interaction.

In the current context, in which due to the pandemic production has migrated to work from home, the increase in the quality of the products developed is linked more than ever to the accuracy of the mechanisms for evaluating employees' work. Due to the lack of interaction between the employee and the superior, evaluator, it is necessary to identify new ways of assessing the results obtained by the employee and the work done. It is necessary to design and implement procedures so that teleworking brings satisfaction to the employee, and there is a clear demarcation between personal life and professional activity. Even if the working hours are flexible, the tendency is to exceed the duration of working hours, and this must be limited. The employee must give the same or better performance by working as long as he would have worked in the office.

Previous studies comparing employee performance in the virtual environment (teleworking) with the traditional work environment were usually empirical, being limited to a

single organization (MacRae, 2020), (Angelici, 2020), (Monteiro et al., 2019), or industrial sector (Muralidhar, 2020); an overwhelming proportion of qualitative and quantitative research tools was also noted, but the integration of analytical tools is only at the beginning (Nicolaescu, Florea, Kifor, s.a., 2020), (Huselid, 2018). It is worth noting the recommendations of Eurofound (Eurofound, 2020) and ILO (Ilo, 2020), but also of renowned researchers in the field (Huselid, 2018), (Lismont, 2017) to intensify research in the field of "workforce analytics", by assessing the impact of this way of work on the employee, especially in terms of work-life balance (Ogbonnaya, 2020), (Messenger, 2019), (Reisenwitz, 2020).

A new "revolution" is apparently about to happen in the current times, by transferring the masses of employees back to their homes, but also to other locations from which they will operate. However, it seems that this "remote work revolution" that has led to new concepts and approaches such as teleworking, working from home, smart office, flexible work, etc., including at the level of legislative regulations, is only at the beginning and that it will take years to truly understand the phenomena and implications (Mims, 2020).

In the current context, working from home tends to replace office work, especially in the IT field, so new tools are needed to ensure the quality of developed products. Employees are no longer supervised by the team leader and there is no longer direct contact between members of the development team. Direct communication has been replaced by online meetings, and evaluating employees and measuring labor productivity is becoming a challenge. Proper assessment of the work done by the employee is the first step in the process of improving the quality of the resulting product.

The actuality of the research and the need to study teleworking - The notion of teleworking or working from home appeared in the literature many years ago, but the phenomenon has not experienced a significant evolution. The pandemic has accelerated the adoption of teleworking globally, causing companies to adapt quickly to this work model, which makes teleworking research topical and especially necessary in the continuously evolving context of the labor market and technology. Research is needed to better understand the experience of employees and employers in this setting and to assess the long-term effects.

Many employees want workplace flexibility and the ability to work from home or remotely, and teleworking research can help understand their requirements and preferences and develop appropriate policies.

It is essential to understand whether teleworking affects employee productivity and performance, and this study can provide data to assess these aspects and identify factors contributing to their increase or decrease.

Relevance of teleworking research - In the field of teleworking research, there are still many gaps and unexplored topics, as it is no longer news that teleworking has seen significant growth in recent years. There are still many important aspects that need attention, starting from understanding how this working model will evolve in the long run to understanding what its effects will be on employees, employers, the quality of work performed and the economy as a whole. In this context, the scientific approach remains highly relevant.

A well-developed research methodology is essential to ensure the validity and reliability of research results. The establishment and elaboration of the research methodology, this essential step that directs the course of the study, started from the identified research problem. The set of methods used started with the study, analysis and synthesis of literature relevant to the chosen field, in order to understand what methods and approaches have been previously used in the field, but also to identify gaps or unaddressed problems. Then, in the first stage of the study, a keylogger application was used as a data collection tool, a computer application that records any user interaction with the computer. For the second stage of the study, in addition to collecting data from computer interaction, the sociological survey method based on the questionnaire technique was added. The data processing part was done with the help of an application developed in Java, created especially for this purpose. Data analysis, to draw conclusions and answer research questions, involved the use of statistical applications Minitab (Minitab, 2023) and IBM SPSS (SPSS, 2023), but also Excel from the Microsoft Office software package.

The determination of the sample was not random, but depended primarily on the degree of computer use by employees to perform their job duties, which must be high.

The context in which research can be applied – The benefits of research can be observed from various perspectives. Thus, the results obtained can provide important information, answers, confirmations or clarifications for those companies where telework takes place or can be an encouragement or starting point for those companies where remote work is to be implemented. The study is conducted in two different fields of activity, software development and implementation and design of electrical installations, but the research is not limited to these, it can have applicability in any field where employee activity involves large interaction with the computer.

As the "unknowns" of teleworking are elucidated, the reluctance to adopt it decreases and continuity of services can be considered to be ensured. The fact that a company can operate efficiently in various ways, including teleworking, ensures that customers are comfortable. They are guaranteed to receive ongoing services and support, even in exceptional situations (such as pandemics or natural disasters).

Offering teleworking options can make an organization more attractive to talented professionals who want flexibility in the workplace, which can help attract and retain the best employees.

The basic objective of the doctoral thesis is to conduct a scientific study to obtain consistent and credible results and conclusions about the habits and activity carried out by employees who perform their work tasks in teleworking, in order to contribute to improving quality in the development of ERP applications in traditional work systems and teleworking.

Building on the basic objective, the following specific objectives are outlined:

– Identifying and summarizing the most important regulations and achievements (studies, reports, legislative norms, research studies, scientific papers, etc.) in the field of teleworking, with emphasis on evaluating employee performance and satisfaction;

– Establishing the wishes of employers (human resources and management structures) regarding the evaluation of employees in the telework system, KPIs - key performance indicators, analyzes conducted in comparison with traditional work;

– Outlining the socio-demographic profile of employees and their perception about teleworking, the level of satisfaction in the telework system, analyzes by comparison with office work, work-life balance;

– Design conceptual models that can integrate different tools and applications, to monitor the activity of study participants and serve different purposes and assessments based on organization-specific objectives.

In order to adopt a balanced contextual approach and achieve the proposed objectives, the thesis is structured in four large chapters which are in turn divided into subchapters. The presentation of the structure of the doctoral thesis is useful to provide a clear picture of the essential elements and sections necessary for an academic work of this type. **The first chapter**, the introduction, presents the general context of the research, establishes its objectives, relevance, timeliness and importance in the field studied.

The second chapter represents the definition of the fundamental concepts underlying the research, through an extensive analysis of the specialized literature. This section provides a summary of previous and relevant research in the field, highlighting existing gaps and justifying the need for research carried out. Through our review of existing literature, we identified unexplored areas, unasked questions, and issues that required greater attention.

The **third chapter** is devoted to the description of the study conducted. The study was carried out in two stages, treated separately within the thesis, and these were described with all the stages that composed them as follows:

- The purpose of the study, which clearly describes the objectives and research questions we addressed;
- Developed conceptual models;
- Research methodology used to answer research questions. Includes information describing the study design, participant selection, data collection procedures and tools used;
- Study sample – describes the details of establishing the studied sample;
- Data collection and processing - describes how the data was collected, the choice of tools used and the details of the development and use of the application for processing the collected data;
- Data analysis – the analysis procedures, the statistical tools used, how the results were interpreted and how they answer research questions are described.

The fourth chapter, entitled *Conclusions and Personal Contributions,* is the summary and final synthesis of the results and their interpretation, based on research objectives and questions. These conclusions provide a clear understanding of the main findings and their impact on the field studied. It highlights how the study carried out contributes to the research field and existing knowledge, as well as the importance of the results in the academic and practical context. Starting from the idea that it is important to recognize any constraint, difficulty or aspect that could affect the interpretation or generalization of the results, this chapter also deals with the limits of the research carried out. Also, the paper naturally ends with the description of future research directions, highlighting possible directions and aspects that could be investigated in the future, based on the discoveries and limitations identified in current research.

Analysis of employee activity and performance in traditional work systems and teleworking

Analysis and synthesis of the literature shows that there are still many aspects of teleworking that require further research to better understand the impact and implications of this evolving way of working, but also to make meaningful contributions and develop better practices and policies for the future.

Therefore, in the inspection of research about working from home, there are no concrete aspects about employees' habits, so questions and curiosities arise about the distribution of professional activities during a working day, about the periods of the day when employees are more productive or inactive.

It would also be useful to find out if there are different work routines in teleworking compared to those in traditional work, in the office, if the activity of employees in teleworking is influenced by certain elements of the employee's profile and last but not least, if there is a balance between managers' opinion about teleworking and that of those who carry it out, namely employees.

These are just some of the unexplored, or explored, but not enough, aspects I have focused on, which I believe can contribute to a deeper understanding of teleworking, a vast and ever-changing field, and to the development of better practices to support the workforce of the future.

All these insufficiently explored aspects led to establishing **the basic objective of the doctoral thesis**, that of conducting a scientific study to obtain consistent and credible results and conclusions about the habits and activity carried out by employees who perform their work tasks from the home office, in order to contribute to improving quality in the development of ERP applications in traditional work systems and teleworking.

Analysis of employee activity and performance in traditional work systems and teleworking. PILOT study for a company specialized in developing ERP software applications

This study focuses on employees who work remotely and analyze employees' working lives, seeking to answer the following research questions (RQs):

RQ1: How professional activities are distributed throughout the working day?

RQ2: What are the most productive intervals in the working day and when are the longest periods of inactivity recorded?

RQ3: It is a different working day in teleworking compared to working in the office?

Conceptual model for analyzing employee activity and performance

To answer research questions (RQs), we have developed a conceptual model, a graphical transposition of ideas and milestones for human resources analysis (Figure 1), which comes with a structured approach and can integrate different tools and applications, to monitor employee activity and serve different purposes and assessments based on company-specific objectives.

According to the Oxford dictionary, the model is a representation of reality in which the main features of a particular aspect of the real world are presented in simplified terms to make that aspect easier to understand and often to facilitate predictions. (Allaby, 2020)

The starting point of the proposed model is to configure the conceptual elements and navigate between them.

Knowledge generation is carried out in four phases: collecting, processing, organizing and analyzing data to create valuable insights for the organization.

The model can process large amounts of data resulting from monitoring a large number of employees for longer periods of time.
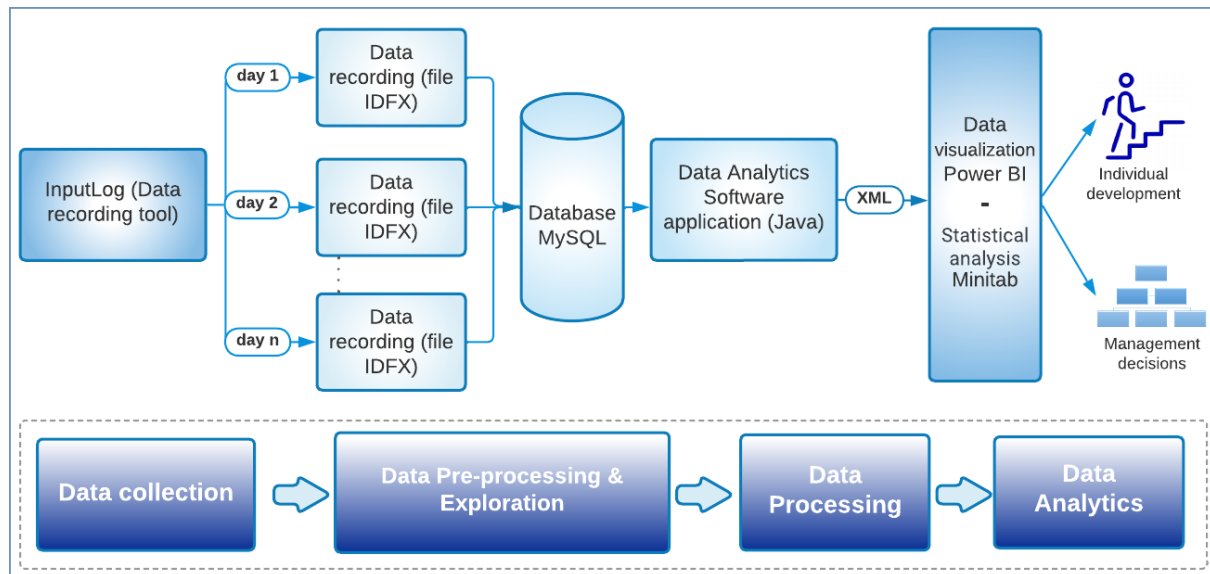

Figure 1. Model for human resources analysis (Claudiu Vasile Kifor et al., 2021)

Analysis of employee activity and performance in traditional work systems and teleworking. Comparative study for two companies with different fields of activity.

Structure, purpose of research and research questions

In essence, the aim of studies on teleworking is to help organisations and society as a whole to better understand this constantly evolving way of working, develop better practices and adapt to ongoing changes. These studies provide data and information to make more informed decisions regarding teleworking and human resource management.

In this second stage of the study carried out, called the deepening stage, the **proposed purpose** is to come up with new elements to help outline the image of the working days carried out by employees who perform their work tasks in telework, through a comprehensive analysis of possible links between the employee's recorded daily activity, on the one hand, and other variables extracted from applying questionnaires to both the employee and to the direct superior. Also, in order to fulfill the purpose set, we analyzed the activity registered by a company that carries out the activity from the office.

In order to achieve the proposed purpose, three research questions (RQs) were formulated as follows:

RQ1: Is there a relationship between the employee's activity/habits and the employee's profile?

RQ2: Is there a relationship between employee activity/results (as assessed by the supervisor) and self-assessment?

RQ3: Are work routines different between the 2 companies in which the study was conducted?

Proposed research model

The research model proposed in this second stage, the deepening one, mostly follows the structure of the model proposed in the first stage of the study, the one we considered the pilot stage. In addition, new elements have been added to this model to achieve the formulated purpose.

The set of stages of the study being a complex one, in order to facilitate the understanding of the proposed model, it was chosen to create it from two perspectives, namely:

- a representation that highlights the route of study data, starting from recording the daily activity of employees with the help of keyloggers tools (computer application that records any user interaction with the computer) to the final stage of the study, namely outlining conclusions and establishing the limitations appeared. Thus, in Figure 2 are represented the two companies in which employees record the activity carried out at the computer, the recorded information is saved in a NoSQL database, subsequently the data is exported in json format (JavaScript Object Notation) and imported for processing, in a MySQL database, with the help of the application developed in Java in the previous stage of the study, Pilot stage. Extensible Markup Language (xml) files necessary for data analysis and interpretation are exported from the data processing application.
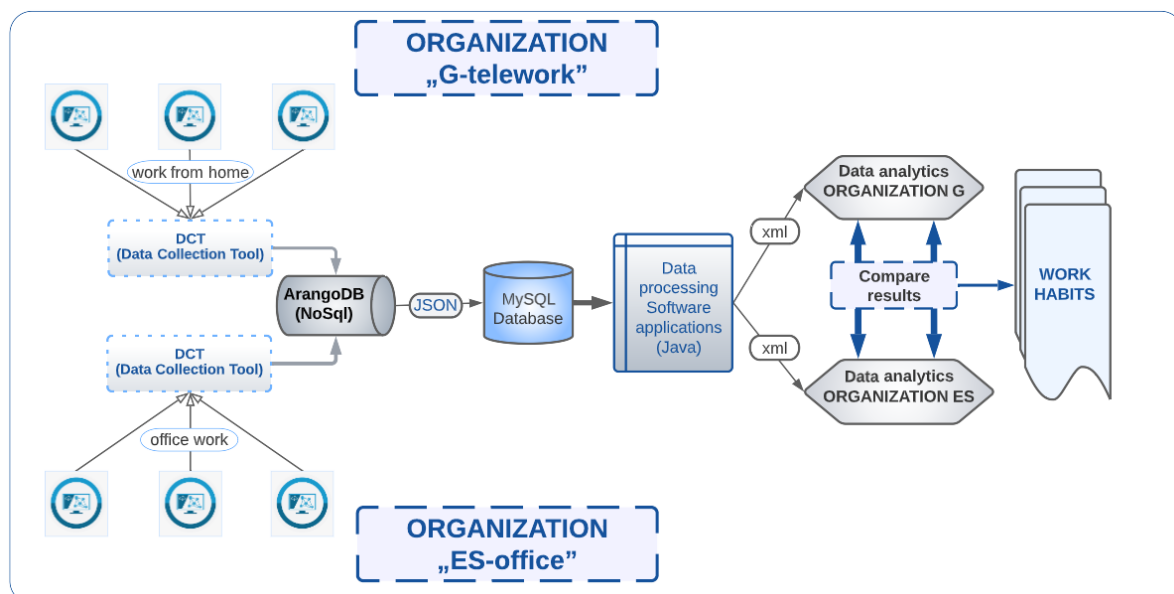

Figure 2. Proposed model -both companies

-the second graphic (Figure 3) focuses on only one of the companies, namely, the company "G-telework". In this company, knowledge generation for the study was achieved both by recording data from employee interaction with computers and by applying questionnaires. The questionnaires were applied to the study participants and their direct superior, and the extracted data will be analyzed together with the data collected from the daily record of working days.
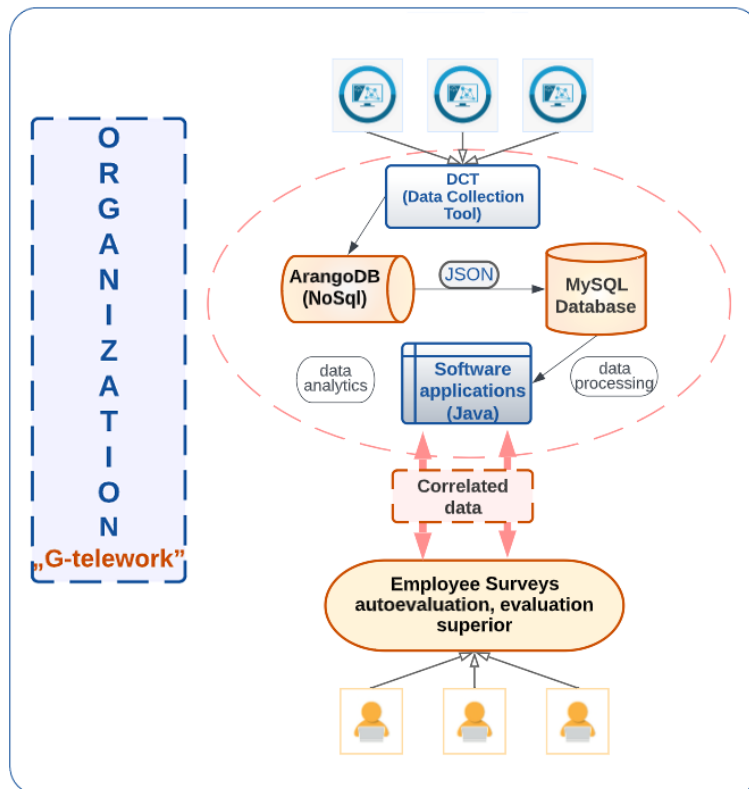
Figure 3. Proposed model – company "G-telework"

Conclusions and personal contributions

The "dream" of any company manager is to have an instrument that offers in an objective and measurable way the degree of performance and productivity of each of the employees, given that the human resource is a complex resource. Employee satisfaction, motivation, performance or involvement are indicators difficult to evaluate and measure even in office work, under the direct coordination of the boss, but especially when the employee carries out his activity in a telework system.

Therefore, the exposed framework and tools proposed in this research can be considered a solution for monitoring and evaluating the performance of remote employees. The functionality of the framework has been tested and evaluated, for significant periods of time, in a company that develops economic and financial software and in an electrical company, in order

to highlight specific aspects of teleworking compared to office work. Study participants from the two companies were monitored using keyloggers for a total period of about nine months.

The study started, as a pilot stage, with the monitoring of study subjects from the company "G-telework". The promising results of this stage of pre-testing of the proposed model led to the continuation of the research having as novelty the extension of the employee monitoring period, with the addition of new elements, namely performance indicators and profiling of employees who were part of the study, but also the registration of activity in the second company, "ES – office" where office work activities are carried out.

The results of the two approaches to the research, carried out in two stages, highlighted important facets of working from the home office.

In the first stage of the study, conducted in the company that carries out telework, "G-telework", the results showed different habits of the two categories of employees, software developers and implementers, regarding the structure of the work activity, the work schedule and the interaction with the computer. The differences were also identified when we compared the results obtained with previous research that monitored the activity of employees working from the office. Employees who work remotely tend to organize their schedules for longer hours during the day and spend less time in meetings; The scheduling time is also longer for employees who telework. On the other hand, both categories of employees (traditional and teleworking) present a very fragmented work, changing windows after very short periods of activity, with a potential negative impact on productivity, task progress and quality of results.

Analyzing the interaction with the computer, we described what a typical working day looks like, introducing types of activities: actual work, documentation and recreation.

We discovered how employees carry out work-related activities at different time intervals and what types of apps they use. Important conclusions were drawn from the idle time analysis, defined as long breaks and short breaks, because such results can provide important information about employee productivity and burnout risk. While in this study we monitored both programmers and consultants, we concluded that the workday looks different when looking at the start and end times of working hours, types of activities, and their duration.

Another objective of the first phase of research was to find out if the working habits of remote workers are different from the habits of those who work "traditionally", using such indicators as active time/idle time, respectively time with specific work activities. Remote employees extend their working hours over a longer period because they have the flexibility to perform other activities during working hours. Time spent with meetings is much shorter in teleworking, and employees seem to use this time for scheduling and other related activities.

The second stage of the research was carried out in both companies, "G-telework" and "ES – office" and also revealed information worth taking into account in the treatment of the subject of teleworking. Data collection at this stage was achieved by monitoring subjects from the two companies with the help of the computer activity recording application, an application developed especially for this purpose. In addition, in order to answer research questions, in the company operating in telework, questionnaires were applied to employees and their direct superior.

The results revealed links between the activity recorded by the study participants in the company "G-telework" and certain elements of the employee's profile. Thus, employees who live at home seem to work harder than employees who live in an apartment building, employees who work alone in the office recreate less with the help of the computer and manage to work more than those who have "colleagues" in the home office. Subjects who have larger families record more dispersed average values for actual work than subjects with fewer family members. The interpretation of the results shows that the presence of other people teleworking in the same household and the number of children significantly influences the work schedule of the study participants. Children younger than 18 years influence recreation time with the help of computers, so employees with children younger than 18 years old recorded less recreational time than employees without children. We have shown that the level of happiness reported by subjects has effects on their change of context.

The evaluation of the telework employee's performance by the superior and his/her self-evaluation are two different processes, but they are closely related because they concern the same thing, the employee's activity and it would be desirable to be in harmony. In the research carried out, the correlation of information extracted from the application of questionnaires for self-evaluation and evaluation of employee performance by the superior revealed on the one hand the tendency of employees to underestimate themselves and, on the other hand, the lack of pro-activity declared by employees and confirmed by the superior in his evaluation.

Comparing the work routines in the two companies where data were recorded, differences emerged that can be interpreted in two directions, namely: some differences can be considered only specificities of teleworking, while certain differences between the two routines can be considered worrying. Thus, special attention should be paid to the end time of the work schedule of teleworking employees (around 19.00) because it may indicate an imbalance between free time and time intended for work, with possible negative effects in the medium and long term.

We have shown that the average duration of recorded time, but also the average duration recorded for actual work are higher in telework than the time recorded by subjects working from the office, which confirms the reports of previous research. In the same sense, subjects in

teleworking spend more time documenting and recreating themselves with the help of the computer than participants who carry out work activities in the traditional system. We found that there are differences in terms of time spent on breaks, namely that office employees are the ones who recorded longer inactive times, both in duration and number. From the perspective of dynamism in computer interaction, by far telework employees are the ones who have recorded many more mouse, keyboard and focus events.

If the image of working days at the office is not unknown to managers, surely the way in which employees' working days look in the home office is still a mystery to their superiors. By dividing the teleworking and traditional workdays into two-hour intervals, we obtained a projection of the working days. From these representations important information is derived about the most productive periods in the two forms of work, the periods with the most idle time, the periods when employees recreate most intensely with the help of the computer or the periods when they choose to document.

The usefulness of this research could be used in future employee productivity studies seeking answers to a fundamental question for HR analysis – why are some employees more productive than others?

To reduce potential work-family conflict, but also to reduce work overload, leaders should communicate explicit, appropriate policies regarding working time and workload, set expectations about tasks that should be performed. These aspects are particularly important to mitigate the negative effects among workers.

There are more and more signals that teleworking will continue to find its place in the post-pandemic context, thus becoming a viable and profitable alternative for employees to carry out work tasks and responsibilities.

Future research directions

The purpose of the research is not to generalize these results, even at the industry level, studies with more employees involved and monitoring for longer periods would be recommended.

A possible and natural continuation of this research would be the development of a **Software Platform for monitoring and evaluating the performance and satisfaction of employees working both in telework and in traditional work systems.** The platform could offer the possibility to estimate the degree of adaptation of the employee at work, assess the training needs, change the work schedule, reintegrate into another team, estimate the work/life balance. Such a platform could easily find its usefulness, especially during trial periods for new employees in companies. Companies could formulate clear and transparent policies on monitoring employees during the trial period. The data collected during monitoring should be

used objectively to assess the employee's performance during the probationary period. It is important that the evaluation process is transparent and fair, and that employees have the opportunity to express their opinions and concerns.

Relative to the chosen research theme, "Quality improvement in the development of ERP software applications in traditional work systems and teleworking", the Design for Six Sigma—DMADV methodology could be applied in terms of the entire process of improving the quality of work and increasing the satisfaction of employees who carry out work from home activities;

As previously mentioned, Design for Six Sigma consists of 5 distinct phases: Define, Measure, Analyze, Design and Validate. Each phase has its own goal, so that at the end of the last phase the expected result is reached.

1. **Definition.** In the first phase, data and information are collected about employers' requirements (human resources departments, management) regarding their evaluation in the telework system. The criteria for evaluating the activity as well as the criteria for evaluating employee satisfaction are established. More specifically, it is important to mention what problems the employer encounters when some or all employees work remotely and how satisfied the employee is working from home.

2. **Measurement**. During this phase, data relating to the professional activity carried out by employees are automatically collected. Activity is quantified in specific metrics. These represent input metrics within the designed platform.

3. **Analysis**. The key features obtained in the second phase are used to conceive the design of the new platform. Information collected through both qualitative primary research and primary quantitative research will be analyzed. Depending on the results obtained, a mathematical model for evaluating employees in telework regime will be designed, based on establishing statistically significant correlations between employers' requirements and the socio-demographic profile and employees' perception.

4. **Design**. In this phase, all information obtained in previous phases will be taken into account and attempts must be made to comply with it to the maximum. For the design of the evaluation platform, requirements will be taken into account such as: identifying employee performance variations, comparing performance during office work vs teleworking, assessing the level of employee satisfaction at work (physical or virtual), estimating work/social life balance in the 2 environments, physical and virtual.

5. **Validation**. In this last phase, the platform will be tested in a real environment, in several companies, user feedback will also be analyzed in order to correct possible errors and improve the platform's functionalities, so that it can be stated that the employee performance and satisfaction evaluation platform confirms the expected results.