Annals of "Dunarea de Jos" University of Galati
Fascicle I. Economics and Applied Informatics
Years XXX – nº3/2024
ISSN-L 1584-0409 ISSN-Online 2344-441X
www.eia.feaa.ugal.ro

DOI https://doi.org/10.35219/eai15840409426

How COVID-19 Pandemic Shifted IT Software Development from Waterfall to Agile

Andreea Teodora Iacob*

ARTICLE INFO

Article history:
Accepted September 2024
Available online September 2024
JEL Classification
J010, I000, O350, O390, Z130

Keywords:
COVID-19, Pandemy, Social distance, Software Development, Waterfall Methodology, Agile Methodology, Human Capital

ABSTRACT

Human capital has encountered many challenges and changes during the COVID-19 Pandemic. This adaptability that we needed to embrace, to face the many challenges of the Pandemic context, have also increased the human capital capabilities in the labour market. Many companies have significantly transformed their business operations. Both workers and companies had to adopt new practices and ways of working while facing various challenges. One of the most notable changes is the shift towards remote work, which has led to a surge in the use of Agile Methodology, particularly in software development. Agile Methodology is a dynamic and flexible approach that fosters an empowering work environment, encouraging creativity, autonomy, continuous feedback, effective communication, and iterative progress. This paper aims to explore the positive correlation between the increased adoption of Agile Methodology during the pandemic, driven by social distancing measures, and its impact on Human Capital, especially within the IT development workforce.

1. Introduction

The COVID-19 pandemic has fundamentally altered the way businesses operate, compelling both employees and companies to embrace new work methods and business practices while confronting various challenges. One of the most significant changes has been the shift to remote work, which has led to a heightened adoption of Agile Methodology. This dynamic and flexible approach fosters a work environment that empowers employees, encourages creativity, autonomy, ongoing feedback, effective communication, and iterative progress.

Before the pandemic, IT delivery projects commonly relied on either Waterfall or Agile methodologies. However, during and after the pandemic, the use of Agile methodology has seen a significant rise. The specifics of this shift, along with its impact on human capital, will be explored in detail in this article.

Agile Methodology emphasizes iterative progress, proactive and reactive responses to challenges, and adaptability to changes as they arise. In a global market characterized by fluctuations in traditional processes, Agile has proven to be a working method that facilitates quick fixes and rapid adjustments to unforeseen shifts, all while maintaining effective communication and feedback within companies and in relation to market demands.

This article aims to demonstrate, particularly in the IT sector, how the increased adoption of Agile Methodology has naturally expanded among development teams and organizations. Concurrently, this growth has also bolstered the human capital of workers. By fostering an environment of continuous flexibility, adaptability, and learning, Agile methodology has enabled employees to develop new skills and enhance their abilities. The Agile framework consistently strengthens teamwork and communication, thereby activating new skill sets and capabilities within the workforce.

2. Agile Methodology. Description and advantages in usage during COVID-19 Pandemic

Agile methodology is a project management approach characterized by incremental and iterative progress. Unlike linear methods, it involves phases that overlap and interconnect, enabling continuous integration and allowing the project to evolve flexibly and collaboratively. This approach emphasizes adaptability, regular feedback, and responsiveness to ongoing work, with the flexibility to adjust both requirements and priorities as needed.

Agile methodology encompasses various frameworks, including Scrum, Kanban, and Extreme Programming. Each framework defines specific processes and ceremonies designed to foster ongoing

*Bucharest University of of Economic Studies, Romania. E-mail address: tia.iacob@gmail.com

collaboration and communication. Together, these elements create a model that matures over time, naturally guiding the team toward collaboration, flexibility, and the evolution of work ideas to meet objectives.

Regardless of the framework used, Agile methodology is rooted in the Agile Manifesto, which outlines the core values and principles of the approach. The Agile Manifesto prioritizes: Individuals and interactions over processes and tools, Working software over comprehensive documentation, Customer collaboration over contract negotiations, and Responding to change over following a plan. In addition, Agile methodology is supported by 12 principles that underpin the practices of each Agile framework.

Among the key advantages of using Agile in software development are its flexibility, adaptability, continuous collaboration, and the structured ceremonies and communication frameworks that facilitate iterative and evolving work.

In the context of remote work and social distancing, coupled with the stress of navigating a life-threatening global crisis, the adoption of Agile methodology in software development increased. This was due to Agile's core principles, which were well-suited to the social and workforce challenges of the pandemic.

The flexibility inherent in Agile methodology proved to be the optimal solution for the rapidly changing environment of the pandemic-era software development labor market. Its adaptability, continuous collaboration, and structured ceremonies and communication frameworks enabled quick solutions in a constantly shifting social and work landscape. With its emphasis on iteration, Agile methodology allowed objectives to be adjusted in real time to align with the ever-evolving market conditions.

3. Waterfall Methodology and it's challenges during COVID-19 Pandemic

The waterfall methodology is a project management approach characterized by a linear and sequential progression. In this model, a project moves through clearly defined phases, with strict guidelines for handling deviations. Each phase must be fully completed before proceeding to the next, requiring synchronization and progressive planning to ensure the project advances in a linear fashion over time.

The most well-known stages of the waterfall methodology include: Analysis and Requirements Specification, Solution Design/Architecture, Implementation, Testing and Acceptance, Solution Installation, and Maintenance.

In the Analysis and Requirements Specification phase, the final product's objectives are outlined. Both business and development workflows are defined, and project resources are identified. This phase involves specifying requirements, work methods, and business processes from technical and non-technical perspectives. The implementation and product reception teams collaborate closely to establish acceptance criteria for the deliverable.

During the Solution Design and Architecture phase, the architecture of the solution is defined and agreed upon. In waterfall methodology, the phases are linear and interdependent, so the second phase builds upon the comprehensive analysis from the first to define the product in detail.

The Implementation phase involves the distribution of technical and functional tasks among resources to ensure the final product aligns with the agreements made in earlier phases. This phase may include several sub-phases to ensure that all deliverables are synchronized into a cohesive final product.

The Testing and Acceptance phase follows implementation, where the final product is tested to confirm it meets the established criteria and is fully functional. Upon successful testing, the project proceeds to the next stage.

In the Solution Installation phase, the product, once accepted by the client, is installed in the production environment, marking the delivery point.

Finally, during the Maintenance phase, the product is live, and end-users begin using it. The delivery team remains available for a specified period to address any issues and support the users as they adapt to the new system.

The waterfall methodology's clear, linear nature offers several advantages, including transparency regarding the product and each phase, as well as detailed, progressively developed documentation. However, it also has notable drawbacks, such as inflexibility and the necessity for a robust risk management strategy, given the dependency of each phase on its predecessor and its impact on subsequent stages. To effectively use the waterfall methodology, it must be carefully chosen, thoroughly documented, and tailored to the specific project needs.

The decline in the use of the waterfall methodology during and after the COVID-19 pandemic can be attributed to several factors:

1. **Inflexibility in Changing Environments:** The linear approach of the waterfall methodology makes it challenging to adapt to rapid changes, which became crucial during the pandemic when swift and high-risk decisions were necessary to keep development projects on track.
2. **Challenges in a Remote Work Context:** The waterfall methodology relies heavily on upfront planning, linear execution, and strong documentation with dependencies and synchronization between phases. These aspects proved difficult to manage in the context of remote work during the pandemic, where communication challenges, risk management, and stress management became more prominent due to the rapid global shifts.

3. **Limited Emphasis on Feedback:** The waterfall model does not inherently encourage iterative work or feedback integration, focusing instead on upfront planning and strict linear development. During the pandemic, the ability to quickly respond to feedback became vital, particularly in Agile environments, making the waterfall methodology less attractive due to its lack of flexibility and responsiveness.
4. **Increased Risk Intensity in IT Projects:** The pandemic introduced new types and intensities of risks in IT development projects. Agile methodology, with its incremental development approach, allowed teams to adapt more easily and efficiently to these short-term risks. In contrast, the rigid and linear structure of the waterfall methodology contributed to its decline in popularity.

4. How Agile Methodology relates to Human Capital

According to established terminology in the specialized literature, human capital refers to the unique capabilities of individuals, which either remain stable or grow in complexity within any social context. These capabilities can be leveraged in the labor market in exchange for various economic resources.

To make the concept of human capital more quantifiable, it is often broken down into two main components: educational capital (including formal education and related training) and biological capital (inherent biological traits that influence adaptability). By examining these measurable components, we can identify aggregate indicators that represent and measure elements of human capital, either individually or collectively.

Educational capital, a key component of human capital, can be evaluated through various indicators, including preventive health, formal education from mandatory and elective studies, financial literacy (measured by resource allocation across different consumption areas), proactive health practices, ongoing education, social, cognitive, practical, and adaptability skills, corrective health measures, and more.

On the other hand, measuring biological capital, another crucial component of human capital, is challenging but is also influenced by educational capital. Educated individuals typically have better access to quality healthcare services, which enhances their biological capital.

Each of these components includes various relevant indicators at different levels. The impact of human capital on the labor market, and consequently on a country's economic status, is significant, especially today. For instance, consider the aggregate indicator of cognitive ability. In the IT and Telecommunications sector, an employee's ability to acquire and process new information can be critical for professional and financial growth. New technologies continually emerge in response to and anticipation of real-world needs, requiring individuals to stay updated with societal demands and technical tools (such as new programming technologies and tools). This also involves inspiring clients to be more receptive and to enhance their cognitive abilities, thereby ensuring the longevity of their work and maintaining long-term client relationships.

It's clear that cognitive abilities can improve work quality and complexity, benefiting both the company and the individual's professional and financial status. When extrapolated across the entire IT and Telecommunications labor market, the impact of cognitive abilities (and their measurement) will shape the direction and scope of this sector.

This relationship is also relevant when discussing the increased use of Agile methodology during the pandemic and its influence on the human capital within the IT and Telecommunications workforce.

Agile methodology and human capital are closely linked, as Agile practices primarily focus on utilizing workers' skills and resources to create a work mechanism that enhances communication, efficiency, and effectiveness. Agile practices aim to develop, alongside the team, a working mechanism that empowers both the team and individual members, aligning with human behavior and conduct. The success of Agile adoption hinges on the team's adaptability to the new process. A mature and successful team will empower each member, providing the autonomy to be creative, consistent, and organized within the work mechanism. This empowerment leads to increased creativity, job satisfaction, and autonomy, ultimately enhancing human capital.

In Agile methodology, various ceremonies or meetings, such as retrospectives, Sprint Planning, and Sprint Demos, are regularly held within the team. These recurring events encourage continuous learning, challenging workers to deliver, participate, and contribute to the ongoing exchange of ideas, which drives the project forward in each iteration. This constant learning environment fosters the development of new skills and perspectives, promoting growth and acceptance of challenges. The result is a culture of continuous development and growth, deeply connected to both the project and the team, with the benefits first and foremost reflected in human capital. Workers in this environment are consistently asked to step up and demonstrate their achievements during structured and efficient team ceremonies.

A key element in developing and maturing an Agile team is communication among team members and with the broader delivery environment. Agile best practices emphasize frequent collaboration and communication, ensuring that all team members are aware of the full scope of the delivery. The importance of communication is central in Agile methodology, with many methods proposed to facilitate it. Current tools that meet Agile team needs, such as JIRA and Azure DevOps, also enhance the communication skills of workers,

thereby increasing their human capital. Additionally, adapting to these tools helps workers improve their adaptability and continuous learning, further contributing to their overall development.

One of the core principles of Agile methodology is a strong focus on the customer. Agile practices outline processes that maintain constant client engagement, encouraging feedback that is beneficial for the team, allowing them to adjust and improve developments over time. This feedback loop is also advantageous for workers, as it encourages them to grow, upskill, and make necessary adjustments where improvements are needed. Receiving and understanding feedback, coupled with the corrective actions it prompts, are invaluable assets for the worker's human capital.

Agile methodology promotes flexibility, adaptability, and both proactive and reactive responses to change. The qualities nurtured in this flexible, adaptable work environment greatly benefit the worker's human capital.

In essence, Agile methodology is designed to leverage and enhance the human capital of workers to create a work mechanism that boosts delivery efficiency and team performance. Strong collaboration, feedback, proactivity, job satisfaction, consistency, autonomy, and empowerment are just a few of the key areas where Agile methodology aligns with and strengthens human capital.

5. Reasons why COVID-19 pandemic has increased the usage of Agile methodology in software implementation

The COVID-19 pandemic led to profound changes in work practices, particularly due to the necessity of social distancing. This shift accelerated the adoption of remote work and online collaboration, as well as remote interactions with public institutions. Agile methodology, with its foundational principles, proved highly effective for supporting remote work environments. Its emphasis on adaptability allowed ongoing projects to pivot in response to emerging risks.

The Agile work model's flexibility in reallocating tasks and resources to maximize efficiency became increasingly relevant during the pandemic. As the labor market, working conditions, and product and service markets experienced disruptions and new risks, both demand and supply had to adapt swiftly. The Agile approach, with its focus on incremental progress and short-term adjustments, enabled teams to alter project trajectories while maintaining stability within both the delivery team and the overall project.

Moreover, Agile prioritizes frequent delivery. One key aspect of Agile, particularly within the SCRUM framework, is the emphasis on sequential, regular deliveries. Work is organized into iterations, or sprints, typically lasting two weeks. During each sprint, the team tackles a manageable amount of work, culminating in a demo for the client and subsequent delivery. This process allows for rapid adaptation and quick turnarounds in response to unexpected developments, all while adhering to the project's core principles.

At its heart, the Agile model fosters collaboration, continuous feedback, and constant communication. From the outset, recurring or on-demand ceremonies are established to create a cohesive workflow. Initially, these mechanisms support the team, but as the project progresses, they help sustain momentum, particularly through ongoing feedback and communication. The persistence of remote work during the COVID-19 pandemic highlighted the value of Agile tools for teams already familiar with Agile practices. The structured ceremonies—such as Retrospectives, Backlog Refinement, Sprint Planning, and Daily Standups—helped many Agile teams navigate the challenges of remote work more smoothly.

The iterative nature of Agile work promotes autonomy and builds trust in individuals to manage their tasks. The feedback loops, communication, and collaboration fostered by recurring ceremonies, along with continuous delivery, provided greater transparency and clarity in the work process, benefiting both development teams and clients during the pandemic.

While the choice between Waterfall and Agile methodologies typically depends on the specific project's goals and nature, during the COVID-19 pandemic, Agile methodology proved particularly well-suited, not just for its inherent advantages but also for its responsiveness to the unprecedented challenges of the time.

6. Conclusions

The COVID-19 pandemic accelerated the adoption of Agile methodology over Waterfall in IT development projects, driven by several factors rooted in Agile's core principles, which proved to be exceptionally well-suited to the demands of this period. The pandemic underscored the strengths of the Agile model, prompting workers to adapt and evolve.

The increased reliance on Agile also contributed to the development of human capital, a topic explored in this paper with an emphasis on the fundamental aspects of the Agile model: enhanced flexibility and adaptability, better collaboration and communication, frequent feedback and iterative progress, empowerment and autonomy, and a focus on delivering continuous value. Collectively, Agile's principles and practices foster a long-term work environment that promotes continuous learning and improvement, significantly enhancing human capital growth.

References

1. *Cockburn, Alistair, „Agile Software Development: The Cooperative Game"; Pearson (2nd ed.). Addison-Wesley Professional; 23 October 2018.*
2. *Constanting Marius Profiroiu, Ruxandra Irina Popescu (coordonatori), Economic Sociology, Human Resource Management and Organizational Dynamics, Editura ASE, București, 2015*
3. *Cristian C. Popescu, Ion Pohoață, Capital uman, capital social, creștere economică, Editura Universității Alexandru Ioan Cuza, Iasi, 2007*
4. *Kent, Beck; "Manifesto for Aile Software Development"; Agile Alliance; 14 June 2010*
5. *Larman, Craig; Basili, Victor; "Iterative and Incremental Development: A Brief History" (PDF); June 2013*
6. *Petersen, Kai; The waterfall Model in Large-Scale Development; In Product-Focused Software Process Improvement. Lecture Notes in Business Information Processing. Vol 32; Springer*
7. *Schultz, TW.W., Investments in human capital, American Economic Review, 1961, p. 1-17*
8. *Tom, Gilb.; "Evolutionary Delivery versus the "waterfall model"; ACM SIGSOFT Software Engieer Notes, pp. 49-61*