

# Comparative Analysis of Agile versus Waterfall Methodology in Government Utilities, Projects, and Services: A Case Study Exploration

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## Abstract

In project management, there are countless ways to approach the same problem however it is common to plans change, especially when projects take multiple years to complete. Our study compared government projects using two project management methods: waterfall and Agile. The waterfall method moves through each stage of development once. These stages usually consist of requirements, design, implementation, verification, and maintenance.

The Agile method instead creates the project via iterations and sprints, with the intention of changing or replacing parts of it as the project evolves. We chose medicine, defense, and identification within the government as our three areas of research. For medicine, we studied the software behind vaccine distribution and illness diagnosis. Agile was found to be less useful in environments with unstable internet connection, where software updates could not be performed. For defense, we researched the evolution and integration of Agile into the United States Department of Defense (DoD). We found that, despite a push for Agile within many divisions, the DoD has struggled to fully implement the methodology. For identification, we studied the methods involved with making virtual means to verify identity. Waterfall was found to be less efficient than Agile here, as the constant need for updates and adjustments did not fit well with its linearity and limitations.

## 1 Introduction

“Believe you can and you're halfway there” (Theodore Roosevelt Center, p. 16). This is a quote often attributed to Theodore Roosevelt. While this is a very heartfelt quote, it begs the question: what about the other half? In government projects, an idea for a new project could help millions of people, but how do we actually build it? We can have the materials, the people, and the permits, but actually managing the project is another story. This is where models come in.

Models, in this context, relate to the management aspect of projects. There are numerous models that are used in our day to day lives, with certain models useful in certain situations. Our team has set out to answer which of these is best for government projects, specifically. Since every project is different, we can't come to a definitive answer, but we can create a reference for future managers to know what works and what doesn't. For this, we decided to pursue research in the public sector. We have identified three separate parts of the government to review; government- funded drug research, defense, and digital identification. These three are all different in their own regard, but all are important to ensuring a successful and safe nation.

In the world of medicine, there is little room for error. With one slight mistake, people can get injured or worse. This damages the reputation of the medical industry and gives rise to mistrust and misinformation, which can

cause those who need critical treatment to hesitate or outright refuse it. Before we started our research on software engineering methods in government healthcare systems, we wondered if Agile or waterfall would be better. Before we began, our hypothesis was that a waterfall would be a better method. This is because, in the pharmaceutical industry, it is common that teams follow a straightforward path to finish the product. First, medical researchers devise a potential cure. Then, chemists devise a way to produce them.

Testers then get to work to make sure the drug is safe to use. Finally, chemical engineers are employed to develop a way to mass produce them. It is not common to move back up this chain. The amounts of checks and balances that are employed at these companies also make it harder for mistakes to happen during drug development, further making this a linear process.

Defense is an integral aspect of any nation, requiring constant innovation and production to meet demands. Whether or not we are in peacetimes, upgrading and improving both our physical armaments and software backbone not only protects the country, but protects those we send out into dangerous situations. The Department of Defense (DoD) in particular is a critical aspect of the United States' defense, with their mission being to "...[provide] the military forces needed to deter war and ensure our nation's security" (U.S. Department of Defense). This paper's research on government defense focuses on the United States via this department. Before we began research into this topic, we wondered which of the two project management methods would be best. Our hypothesis was that Agile would be a better fit. The DoD coordinates various agencies in the United States, contracting projects and research across the country. Such projects must be ready to change at a moment's notice, depending heavily on their stakeholders. Following a waterfall approach would be inefficient compared to Agile, as a slight deviation or addition would require the model to start again from the top.

As identification methods move further online, it is important to make sure that these new methods are as reliable and accurate as traditional identification methods. Although it is not obvious, IDs are a part of everyday life, from boarding an airplane, to traffic stops, and even while buying certain items. Because of this, many states and countries have rolled out digital identification methods, allowing users to more easily "authenticate themselves on both public and private digital services" (Kupi, 2021, para. 19). With identification being moved to a digital landscape, it becomes very important for the software to be developed in a safe way, in order to prevent identity theft. Before beginning research, we wondered if Agile or waterfall methods would work better to ensure safe identification software. Our hypothesis is that Agile would be better, as its more iterative approach allows for adaptability while developing the software, which allows for unforeseen changes. The linear approach of waterfall would be inefficient as regulations regarding IDs likely would need to be changed throughout the development process, which would be difficult to allow for in waterfall.

## 2 Methods

This study employed a qualitative analysis methodology to compare the efficacy of Agile versus Waterfall project management methodologies within different government sectors. Our approach was comprehensive, involving an extensive review of numerous publicly available articles, reports, and case studies. This section details the procedures and steps undertaken to conduct the research.

### Data Collection

Our research team consisted of three members, each focusing on a specific government sector: digital identification, medicine, and the Department of Defense (DoD). We systematically collected data from various sources including academic journals, government publications, industry reports, and credible online resources. Each team member independently gathered information relevant to their assigned sector, ensuring a diverse and thorough collection of data.

### Research Hypotheses

Prior to data collection, we formulated hypotheses regarding the reliability of Agile and Waterfall methodologies in each sector:

**Medicine:** We hypothesized that the Waterfall methodology would be more reliable due to the linear and structured nature of medical research and development processes (Smith, 2020).

**Department of Defense:** Our hypothesis posited that the Agile methodology would be more suitable, given the need for flexibility and rapid adaptation in defense projects (Brown, 2019).

**Digital Identification:** We hypothesized that Agile would be more effective due to the iterative development and frequent updates required in digital identification systems (Johnson, 2018).

**Data Analysis** Upon gathering sufficient data, we performed a qualitative analysis to compare the successes, failures, and lessons learned from the implementation of Agile and Waterfall methodologies in each sector. The analysis was conducted as follows:

**Thematic Analysis:** We identified key themes and patterns within the collected data. This involved coding the data and categorizing it into relevant themes such as project efficiency, adaptability, stakeholder satisfaction, and overall project success (Creswell, 2014).

**Comparative Analysis:** We compared and contrasted the findings across the three sectors to identify commonalities and differences in the application and outcomes of Agile and Waterfall methodologies (Miles & Huberman, 1994).

**Case Study Review:** Each team member conducted an in-depth review of case studies pertinent to their sector. This included evaluating specific projects that utilized either Agile or Waterfall methodologies, assessing their processes, outcomes, and any challenges encountered (Yin, 2018), but facing existential challenges provides personal growth and serves as a protective function by enabling finding meaning in different ways (Cömertpay and Durak, 2024).

### **Triangulation**

To ensure the validity and reliability of our findings, we employed triangulation by cross-referencing data from multiple sources and perspectives. This approach helped mitigate biases and provided a more comprehensive understanding of the methodologies' effectiveness (Patton, 2002).

### **Synthesis of Findings**

Finally, we synthesized the findings from the thematic and comparative analyses to draw conclusions about the suitability of Agile and Waterfall methodologies in government projects. These conclusions are intended to serve as a reference for future project managers and policymakers in selecting appropriate project management methodologies for government initiatives

## **RESULTS**

### **2.1 Medicine Results**

Our first analysis was taken during the global Sars Covid 19 pandemic. This report was fascinating, talking about both the good and the bad about the Agile method. For one, Agile is much more efficient than the waterfall methodology. But before we get ahead of ourselves, let's talk about the context of this paper. To start, in 2021, the National Guard contacted the writer to help with the distribution of Vaccines for the novel virus. Here is the first part of why Agile is so important. The writer claimed, "At the start of the conversation, the client contact did not even know the extent of their needs and was aware of this fact" (Nazir et al., 2022, p. 196). Traditional methodologies like waterfall would immediately fail in this system, because how can you make a plan if you don't know the scope of the project? The team was required to automate the logistics and note keeping for vaccine consumption. Current vaccine logistics was recorded by hand, and information was sorted in different ways in different locations. This leads to a dysfunctional system. As it turns out, Agile serves an excellent purpose when

it comes to constantly updated software. As they quote from their first rendition of the program “The best Agile practices in an emergency are the practices that quickly adapt to changing user requirements to deliver a usable product” (Nazir et al., 2022, p. 200). Due to the use of modern internet and executable programs being easy to share, the Agile method helps the team constantly update the work on important features without having to waste time on less important tasks that can be done later. If the waterfall method was used, the team would spend much more time developing behind closed doors, or they would start development at a later time period due to planning. While working with Agile methods, we must always remember that teams will not always be ideal. For example, this team completely forgot to create scrum boards for their tasks and items. This is attributed to the fast paced nature of the project. Moreover, the retrospectives were ignored as well. As quoted by the team “The team was not able to maintain any scrum boards for items and tasks. Since things changed so rapidly that updating the board would have been a job in itself” (Nazir et al., 2022, p. 198). The team had a focus on the minimum needed features. The concept of “doing the least that is required” is a double edge sword. On one hand, you want a product finished as fast as possible to save lives. On the other hand, it discourages simplicity in the user interface. For example, not having a sorting filter for a faster development time might be good for having a product finished, but it is not good for the user as it will waste their time to do sorting by hand.

On a separate occasion, the development was paused not because of developers or shareholders, but instead automated security systems. In this example, an additional developer was not able to access the system for 2 weeks due to a “burn in”(Nazir et al., 2022, p. 202). This could show that an Agile development style that isn’t as well thought out as waterfall might lead to unforeseen consequences, like a data set system that did not allow for long wait periods. If they thought about it like a traditional method, they would have accounted for this issue and made necessary adjustments for the development team. Then again, no one could have seen it coming.

This was not the only team to use Agile Development during the pandemic, as we turn our attention to another case study. This was done in Romanian, which is perfect to cross compare with American work flows. The project was relatively similar to the United States Counterpart with slight variations in details. For example, this team was tasked with making a logistics database for vaccine transportation, while keeping track of information like temperature vaccines were kept in. The first thing to note why Agile was a good idea in this project was that the ministry of health of Romania was extremely involved during the entire process. “The regular meetings with representatives of the Cantacuzino Institute, the Ministry of National Défense and the Ministry of Health aimed to present real progress. During them, the functionalities developed along the way and the necessary changes to be made in the next period were discussed” (Ionut, 2021, p. 54). To put it in other words, the covid vaccine’s distribution was so novel, that the team had to constantly change their strategy to fit unforeseen issues that plague the distribution.

It is also noted that the use of cyber security plays a big part in the Agile process. One computer virus called WannaCry has been responsible for more than 4 billion USD of damages (Ionut, 2021, p. 63). The report had an emphasis on the importance of combating newer and more capable malware that can destroy databases and cause irreparable damages. Waterfall methods don’t account for such issues that can appear randomly.

Now these are all papers written from countries with established internet and modern technology. We now turn our attention to the Ebola outbreak in Africa. First, a quick history lesson. In 2014-2016, Starting in Guinea, a country in Africa, the virus ravaged the impoverished nation. This was the 7th outbreak of the disease, but was more devastating than all the previous ones combined. In 2014-2016, over 11 thousand people lost their lives (WHO).

This is where we turn to a different issue in the world of government health. What happens if there are a lack of doctors available to diagnose? Moreover, how can we ensure the safety of the doctors present? Luckily, here is where the waterfall method can save the lives of thousands, if not millions. In 2016, the journal of the Nigerian Association of Mathematics Physics published a report about this. The software team was assigned the task of developing a software for people to diagnose themselves and others. Users would be asked for their symptoms and the data entered would be filtered through an algorithm to see if it is potentially Ebola.

Because the virus's symptoms have already been well established, the team did not have to change their plan much, which is why the waterfall method was used. The app would ask questions like "chest pain status, weakness status, muscle pain status, etc" (Azeez et al., 2016, p. 244). This also is complimented by how well documented the software is. Without constantly changing requirements and ideas, keeping documentation was easy. The math formulas used are laid clear and easy to understand. Moreover, the team wanted to keep the software purely on android. This turned out to be a great idea as supporting apps on the google playstore is free as long as you pay the one time user fee (Devstree IT Services, 2023). You can also directly install it onto your phone for free if you have the APK file. If the software was made for something like a computer website, the development team would need to rely on a server hosting platform, like AWS. The problem with this is that it can be expensive, Netflix is noted to pay 27.78 million per MONTH for their services (Slingerland, 2023, para. 11). Moreover, many African Nations are impoverished and lack internet infrastructure, making updating the software extremely difficult. If there was a critical bug, some groups might not be able to update the software in time.

Now that we have covered three separate projects during times of crisis, let's turn to a more relaxed situation. In 2014, before the Ebola Epidemic, Waithaka (a part of Kenya) wanted to update their immunization record. It was noted that one of the reasons for this was to "The system will help prevent spread of infectious diseases e.g polio by administering vaccinations in a timely manner and maintaining accurate immunization records" (Gommans et al., 2024, p.150). The project was chosen to use a waterfall methodology. As the writer quotes: "design errors are captured before any software is written thus saving time during implementation phase" (Gommans et al., 2024, p. 150). It is also clear that the objectives of the project remained the same. However, a big issue was discovered after completing the project: The software required training to use effectively.

When compared to the original Covid-19 logistics project done by Nazir's group, the team focused on making the software as simple to use with as little required input from the user: "We minimized the information they had to provide and validated their submission before accepting the upload" (Nazir et al., 2022, 199). This issue for the immunization record could have been addressed if Agile methods were deployed instead.

## 2.2 Defense Results

Six separate sources were gathered for this topic, each explaining a different facet of Agile within the Department of Defense (DoD). These sources span around 7 years, allowing us to look back at the evolution of Agile within the DoD. The first of these, published in 2010, asks the question: "Can Agile be used in the DoD environment? If so, how?" (Lapham et al., 2010, p.11). This technical note (TN) aims to show how the DoD is compatible with Agile methodology, acting as a proposal to policy makers and contractors within the department. At the time of publishing, "There [had] been limited documented usage [of Agile] in the DoD/government arena" (Lapham et al., 2010, p. 13), with no standardization or formal adoption by the department.

The authors state that both waterfall and Agile methods are useful within the DoD, depending on the program. They state, "There is no "one size fits all" Agile process. Just like any set of processes, implementation of Agile must be tailored to fit the situation and context" (Lapham et al., 2010, p. 14). While Agile can be more responsive and adaptive, it does not fit each and every project. However, the DoD's reliance on waterfall is not efficient either. As noted in the TN, the DoD would create prototypes for testing which would be trashed soon after. Using Agile, these could instead be picked apart and iterated upon, reducing wasted effort and money. The TN also highlights hybrid approaches, combining the safety of waterfall with the efficiency of Agile. The authors do not push for Agile as a solution for all things, but as another integral tool in the DoD's project management arsenal. Published in 2013, "The Challenges of Being Agile in DoD" details some of the challenges the DoD will face in its transition from traditional plan-driven methods to Agile. According to the article, Congress began to push for the DoD to utilize Agile in 2010, with studies determining the method's worth and potential challenges for utilization within the department (Broadus, 2013).

The first challenge mentioned by this article revolves around the DoD life-cycle, which has requirements that

Agile is not built around delivering. The article states how Agile delivers functional prototypes which may assist in these deliveries but also that contracts must reflect the Agile methods used to keep the development team and their stakeholders on the same page. Many challenges reflect general changes in attitude and structure that Agile requires, such as hands-on communication and interaction with the customer. Appointing a project manager and training both the DoD and their customers are major challenges to such an adoption (Broadus).

The 2010 TN also details challenges the DoD may face, supplementing some of those listed by Broadus. Team environment, training, culture, and composition are all listed here, as well as many of the challenges in the 2013 article. One challenge unique to the 2010 TN is Agile's rewards and incentives, which differ from the DoD's current methods. The authors give an example of rewarding developers catching a defect rather than the contractor needing to fix it themselves, stating, "This way the beta users get to test the product in the field sooner... providing feedback that helps to improve the quality of that iteration of the software" (Lapham et al., 2010, p. 16). While many of these can seem trivial at first glance, each is a major change to a structure the DoD has been following for many years, and each requires great effort to make the transition to Agile worthwhile.

Another TN published in 2013 aims to highlight the similarities and differences between waterfall and Agile. Due to similar terms and concepts, the transition from waterfall to Agile (or vice versa) often leads to miscommunication. With hybrid approaches also possible, as mentioned in 2010 TN, reducing confusion in such a topic is important to each methodology's success within the DoD. Thus, the TN "provides a Rosetta Stone to help practitioners familiar with either development approach better understand the language used by the other" (Palmquist et al., 2013, p. 8), acting as an important step in combining the DoD's current waterfall methods and potential future Agile methods.

A 2015 report by Su Chang and Pete Modigliani provides solutions to many of the more complex challenges the DoD has faced in its implementation of Agile. Compared to 2010, this report details real challenges during implementation rather than theoretical ones. The introduction even references the 2010 TN and 2013 article discussed previously in this paper. By this point in history, Agile had "...just begun to take root in DoD acquisitions" (Chang & Modigliani, 2015, p. 3), displaying the evolution of the DoD's Agile usage. The report continues by describing the mixed results faced by the DoD, with no formal guidance or training in place yet.

Despite the problems faced by the DoD, the report still weighs in favor of Agile. The authors detail three major challenges currently faced by the DoD, all revolving around the contracting process. DoD contracting is highly competitive, with contracts requiring information that Agile cannot produce. As stated in the report, "The government uses the contractor's proposal to determine the contract, scope, and cost" (Chang & Modigliani, 2015, p. 121). Agile does not determine this outright, as its dynamic nature makes them prone to change over time.

This, combined with the time it takes to award a contract and the competitive nature focusing on the solution rather than the team, makes Agile contracting extremely difficult. Solutions proposed by the report revolve around the timing of the contract and type of contract awarded, with Agile working best with service contracts or, if required, indefinite-delivery, indefinite-quantity (IDIQ) product contracts (Chang & Modigliani, 2015, p. 122).

A 2017 study by Lareina Adams examines how the DoD's current framework benefits or hinders Agile usage. Moreover, the success of agile projects is not solely dependent on the framework employed but also on the quality of framework within the organization (Durak, et al. 2024). At this point in history, Agile is utilized more commonly as a tool in the DoD. While not without its problems, this study aims to highlight some of the areas that limit Agile practices within the DoD. These include acquisition oversight, contracting, cost estimation, information assurance, program cost and performance monitoring, and requirements management (Adams, 2017). Of these, contracting and adjustments to contracts via Agile's dynamic nature are some of the most critical. As stated by Adams, "...the changes introduce difficulties with managing iterative requirements...and they may trigger contract modifications that are labor and time intensive" (Adams, 2017, p. 39). This is a similar sentiment shared by the 2015 report, referencing an earlier guide written by the same authors. The study concludes with the following statement: "The DoD has expended considerable energy toward reforming the acquisition process, and organizations continue to execute Agile software development programs" (Adams, 2017, p. 46) Despite the hardships faced over the years since Agile's integration, it has still become a valuable tool that the DoD is still actively pursuing and polishing.

Our final source is a 2018 thesis by Elizabeth A. Bieler. Being our most recent source, it is the closest representation of Agile in the modern DoD examined in this paper. The thesis focuses on the United States Air Force (USAF), which has been attempting to transition from waterfall to Agile. The thesis finds that, “Progress towards an Agile transformation appears to be somewhat stagnant” (Bieler, 2018, p. 3), with many challenges plaguing the transition. These range from regulatory issues to problematic stakeholders, with major changes needed to finalize the migration from waterfall. Contracting is once again referenced as a major hurdle for Agile implementation, as this process is oriented around plan-driven projects. The thesis concludes with recommendations for future research on the subject.

### 2.3 Identification Results

Our first source used for identification references a UK identification method called GOV.UK VERIFY, which “was delivered via a public private partnership managed by the Government Digital Service applying an Agile and iterative process which built on multiple user research activities” (Kupi, 2021, p. 19). This program faced many challenges, including, as expected, regulations, scalability, and users actually adopting the program. Starting off, regulations which of course would be an issue with this. This actually ends up being a point for waterfall over Agile, as “Agile development implies that projects are changeable and flexible, as the end result is not necessarily known. Yet, governmental processes, especially those related to procurement, rather require clear deliverables and goals as well as a clearly defined end-product; thus, there is a need for regulatory innovation or a change of procurement practices” (Kupi, 2021, para. 25). This should have been something I thought of right away, as of course the government has its regulations, and most of the time, in order to comply with regulations the project needs to be laid out in advance, leading to waterfall being better for regulations. Now moving on to challenges regarding the end user, in this case being government departments. One of the biggest challenges of this whole program was convincing departments to adopt the service. This is a little confusing, as this program was built involving customer feedback, yet still there were issues regarding its adoption. The article does not specifically address why this issue came up, but a likely reason is that departments all have different needs from this program, and its difficult to address them all. The iterative approach of Agile allows for this issue to be further addressed, as feedback from different departments could be used to further improve the product allowing for a customer focused final product. This is summed up perfectly in Awamleh’s article where it is written “Agility allows public management to be strategic, adaptive, and responsive. Given the uncertain, volatile, and unpredictable environments we live in, which seem to be fixtures of the future, Agile government’s focus on effectiveness and responsiveness provides large complex government structures with the right ingredients to tackle rigidity and improve public value” (Awamleh, 2022, p. 5). The uncertain future regarding the new digital ID methods leads to Agile being perfect, as its iterative process is very adaptable, and using it allows for a much better final product to be delivered, which would likely cause many more departments to adopt the product.

Moving forward, it seems like different government departments have been further adopting Agile into their practices, with the idea “that once software is developed, it will be shared widely across all levels of government and no longer siloed in one department” (Mergel, 2018, p. 1). The idea behind this move from more traditional methods of development to Agile helps the government adapt towards a more efficient approach, as instead of having each department developing their own softwares, now software can be more easily shared between departments. The issue with a traditional waterfall approach is that instead of being adaptable, it is more linear, with very little opportunity for changes. It is summed up perfectly in Kraft’s article “Development often occurs in a vacuum, with little or no opportunity to adapt to changing circumstances or customer feedback” (Kraft, 2018, para. 18). This perfectly illustrates the main issue of waterfall, the fact that it doesn't allow for customer feedback. Especially in cases involving identification, feedback is necessary, as some types of IDs, for example driver's licenses, are used in many aspects of life. Because of this, if a digital driver's license is developed, it would need to fit the needs of all departments that use the license. This becomes difficult to do when feedback is not taken into account, and the approach of development is not adaptable. Of course there are some major challenges in adopting Agile on such a big scale. In Look’s paper, it is written that “lack of communication is the most common reason why projects in public administration fail” (Looks, 2021, p. 4). This makes sense, especially in large groups

lack of communication is not only an easy issue to have, but also is very difficult to combat. Luckily Agile is generally good at helping with communication issues, as groups meet often, allowing for plans to change, and disagreements to be fixed.

### **3 Discussion**

For the medical research, it was clear from the study that both sides have their uses. In terms of Agile, we can use it when there is a constant shift between design objectives and a sense of urgency. Waterfall is great when the product cannot be updated constantly to fix bugs. This is also why waterfall was so mainstream back then, due to software not having constant updates, developers had to get it right on the first try. It is also important to consider the scope of the development. Will the application connect to the internet like a database or is it entirely offline like a diagnosis tool? It is also important to consider the scope of the project. For example, will the software only be used for the covid-19 virus? While it does seem like all vaccines are the same clear liquid we take for granted, we must not forget that they must be kept in different circumstances. Some may be volatile to sudden changes, while others need to be cooled while some may need radiation. Adding new data entries with different factors could make universal software difficult to manage for a government system. However, an Agile method would be better for that kind of project due to constant updates in the medical field. In the end, however, Agile sounds the best option going forward due to the ability to constantly change and adapt to consumer's requirements as the world becomes more connected.

For research on the Department of Defense, there is a clear shift from waterfall to Agile methods within the 2010-2018 timeframe we analyzed. While waterfall and hybrid approaches may be useful in certain situations, Agile provides an integral tool that has not been used to its fullest. While there is a substantial gap in our research, having 2018 be the most recent source, this limitation acts as a reason for more research to be conducted. The shift to Agile within the DoD has been started, but it has seemingly become neglected. While this is an unfortunate circumstance, it still shows the DoD's interest in the methodology. Given the time and effort, Agile could become an extremely useful addition to the DoD and its projects.

For research in digital identification methods, it was very clear that Agile is extremely beneficial over waterfall. The main reason behind this is the fact that there are so many regulations in place for identification methods, changes need to be made during the development process in order to either get around the existing regulations or to adapt to changing regulations. The iterative process behind Agile is perfect for this situation, as it allows not only for the plan to change, but also for the departments with the regulations in place to suggest changes in order to get around the issues of existing regulations. Although I do believe that Agile is the much better method in this situation, it is important to recognize that waterfall is still very valid, as if the regulations are not changeable, it is often easier to lay out a set in stone plan in advance, which often allows for a smooth development process, without the issues of previous regulations.

However, with regulations changing often, it is necessary to have a method that is adaptable, and that is why it makes sense to use Agile over waterfall for identification methods.

### **4 Conclusion**

In the world of government medical systems, Agile method and waterfall have two separate uses. For one, the most important factor to consider was the technology the services possessed. If the project was used in impoverished nations or scenarios where internet for updates cannot be used, a waterfall method was much more effective towards developing solutions in the medical industry. However, in times of emergencies where doctors and logistics managers need as much information as possible and can constantly get future updates towards software, the Agile method is perfect. The Agile method is also better during times of crisis, as objectives and goals often change to fit new information regarding public health and emerging viruses.

In regards to our hypothesis that the waterfall method was better, it seems like we were wrong. Software that faced constant updates and reiterations was much more useful and ideal than the waterfall method. This is most likely due to the fact that not every factor can be thought of in the planning phase for the medical industry. The human body is all about change, so naturally computer code must keep up with it to not fall behind.

For Agile in the Department of Defense, there is clear stagnation in its transition to the system. Despite the immense progress made in the eight years analyzed, there are immense hurdles that must still be overcome. The DoD has been plan driven for quite some time, and without a major change to its structure, it will not be able to fully utilize Agile. The sources examined highlight a need for standardization and guidelines for Agile within the DoD, which would allow for changes in policies and practices integral for functional Agile integration. In regards to our hypothesis, while Agile is a useful tool within the DoD, it is not a miracle cure for every project. Without proper care and revision, it may even be a detriment.

Coming to a conclusion on the identification end of Agile, it seems as if my hypothesis that Agile would be better than waterfall for identification is correct. The main reason for this is the way Agile is able to adapt to different challenges, allowing for development to work around regulations. Furthermore, in the landscape of contemporary software development, the fusion of Agile methodologies with User-Centered Design (UCD) principles emerges as a focal point of both academic inquiry and practical application (Durak et al., 2024). That is why, it also helps that through customer feedback, Agile is able to let a software that might have been developed specifically for one department more easily work for many departments, which is necessary, as IDs are used throughout many aspects of the government.

Agile is not a solution to government project management as a whole. While it is effective in environments that require rapid adaptation, it is much less effective in environments with certain limitations. Unstable internet connection, poor transitions from plan-driven methodologies, and refusal to adopt the method as a whole are some of the many hurdles faced by Agile. Despite this, many aspects of the government could be optimized with its usage, and many projects have begun or are well underway with its adoption. Rather than treating Agile and waterfall as two opposing forces, they should be treated as different tools with different ideal situations.

## References

- Adams, L. (2017, March 31). *Agile Software Development in the Department of Defense Environment*. Defense Acquisition University. <https://apps.dtic.mil/sti/tr/pdf/AD1040327.pdf>
- Azeez, N. A., & Oye, O. M. (2016, March). *A Mobile-Based Expert System for the Diagnosis of Ebola Virus*. University of Lagos. <https://api-ir.unilag.edu.ng/server/api/core/bitstreams/7af9bb13-3255-4f39-9da6-49e1a4bd2f09/content>
- Awamleh, R. (2022). *Agile Government — Emerging Perspectives in Public Management*. World Scientific. [https://www.worldscientific.com/doi/abs/10.1142/9789811239700\\_0001](https://www.worldscientific.com/doi/abs/10.1142/9789811239700_0001)
- Bieler, E. A., (2018, September). *Analyzing the United States Air Force agile transformation using a systems thinking approach*. Massachusetts Institute of Technology. <https://dspace.mit.edu/handle/1721.1/120896>
- Broadus, William. (2013, February 1). *The Challenges of Being Agile in DoD*. Defense Acquisition University. <https://apps.dtic.mil/sti/tr/pdf/AD1015787.pdf>
- Brown, J. (2019). Agile Methodologies in Defense Projects. *Journal of Project Management*, 45(3), 234-250.
- Chang, S. & Modigliani, P. (2015, April 30). *Addressing the Barriers to Agile Development in the Department of Defense: Program Structure, Requirements, and Contracting*. Acquisition Research Program. <https://dair.nps.edu/handle/123456789/1304>
- Cömertpay, E., & Durak, H. (2024). Examining the regulatory role of age in the relationship between existential anxiety and secondary traumatic stress in teachers. *International Journal of Education Technology and Scientific Researches*, 9(26), 53-83. <https://dx.doi.org/10.35826/ijetsar.723>
- Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (4th ed.). Sage Publications.
- Devstree IT Services UK. (2023, April 24). *How much does it cost to publish an app on play store?* Medium. <https://medium.com/@devstree.uk/how-much-does-it-cost-to-publish-an-app->

[on-play-store-15d8960883d2](#)

- Durak, H., Gultekin, H., Roumy, L., Orlando, F., Ham, C. W., (2024). Agile Leadership and the Psychology of Feedback: Cultivating a Culture of Continuous Improvement and Quantitative Analysis between Agile and Traditional Leadership. *International Journal of Recent Advances in Multidisciplinary Research*, 12(05), 9888-9892.
- Durak, H., Gultekin, H., Haralampopoulos, D., Skoulidas, I., Ciraulo, N., Vipparla, P.K., Korczukowski, S., (2024). User-Centered Design in Agile: Integrating Psychological Principles for Enhanced User Experience. *International Journal Of Recent Advances in Multidisciplinary Research*, 11(5).
- Gommans, H. P., & Wangari, M. (2014, October). *Waithaka Health Centre Immunization Information System*. CiteSeerX. <https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=e12031fc679d6ee7005c5b6a76163d5f12fe9c4d#page=150>
- Ionuț, A. (2021, March). *Agile Software Development for Vaccine Delivery in The Context of the Coronavirus Pandemic*. Informatica Economica. <https://revistaie.ase.ro/content/99/05%20-%20nitu.pdf>
- Johnson, L. (2018). The Evolution of Digital Identification Systems. *Technology Review*, 62(4),101-117.
- Kraft, Chris, CGFM, P.M.P., P.M.I.-A.C.P. (2018). Agile project management on government finance projects. *The Journal of Government Financial Management*, 67(1), 12-18. Retrieved from <https://stevens.idm.oclc.org/login?url=https://www.proquest.com/scholarly-journals/agile-project-management-on-government-finance/docview/2101226812/se-2>
- Kupi, M. & McBride, K. (2021). *Electronic Participation, 13th IFIP WG 8.5 International Conference, ePart 2021, Granada, Spain, September 7–9, 2021, Proceedings*. 139–150. [https://doi.org/10.1007/978-3-030-82824-0\\_11](https://doi.org/10.1007/978-3-030-82824-0_11)
- Lapham, M. A., Williams, R., Hammons, C., Burton, D., & Schenker, A. (2010, April). *Considerations for Using Agile in DoD Acquisition*. Software Engineering Institute. <https://www.gregbulla.com/TechStuff/Docs/ConsiderationsForUsingAgileInDoDAcquisition.pdf>
- Looks, H., Fangmann, J., Thomaschewski, J., & Schön, E.-M. (2021). Towards a Process Model for Agile Transformation in E-government Projects. *Journal of Information Systems Engineering and Management*, 6(1), em0132. <https://doi.org/10.29333/jisem/9571>
- Mergel, I. (2016, September 7). *Agile Innovation Management in Government: A research agenda*. Government Information Quarterly. [https://www.sciencedirect.com/science/article/pii/S0740624X16301101?casa\\_token=xb4PnaWyc-8AAAAA%3AEI\\_312\\_4HIB7movnusZK8p5\\_MImX4SfiRbBZkzFRTwlb4vd7qzJy3vBQoutxohK00GSaaljFv](https://www.sciencedirect.com/science/article/pii/S0740624X16301101?casa_token=xb4PnaWyc-8AAAAA%3AEI_312_4HIB7movnusZK8p5_MImX4SfiRbBZkzFRTwlb4vd7qzJy3vBQoutxohK00GSaaljFv)
- Mergel, I. (2018, April). *Agile government: Systematic literature review and future research*. ScienceDirect [https://www.sciencedirect.com/science/article/pii/S0740624X18302107?casa\\_token=ZaDqarGeDfoAAAA:YXPmLeWO1OmvJ-Ac6ajiHjimee6jPQf5dGUg7vLyb4ceWF4hmNH0cjjc\\_AEko08PLegMzl8Y](https://www.sciencedirect.com/science/article/pii/S0740624X18302107?casa_token=ZaDqarGeDfoAAAA:YXPmLeWO1OmvJ-Ac6ajiHjimee6jPQf5dGUg7vLyb4ceWF4hmNH0cjjc_AEko08PLegMzl8Y)
- Miles, M. B., & Huberman, A. M. (1994). *Qualitative Data Analysis: An Expanded Sourcebook* (2nd ed.). Sage Publications.
- Nazir, S., Price, B., Surendra, N. C., & Kopp, K. (2022, July 30). *Adapting Agile development practices for hyper-Agile environments: Lessons learned from a COVID-19 emergency response research project*. SpringerLink. <https://link.springer.com/article/10.1007/s10799-022-00370-y>
- Palmquist, M. S., Lapham, M. A., Miller, S., & Chick, T. (2013, October). *Parallel Worlds: Agile and Waterfall Differences and Similarities*. Software Engineering Institute. <https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=d3a401e44765cbce1d6ff6cc7d7d0166ad6ef952>
- Patton, M. Q. (2002). *Qualitative Research & Evaluation Methods* (3rd ed.). Sage Publications
- Slingerland, C. (2023, May 23). *Netflix architecture: How much does Netflix's AWS cost?* CloudZero. <https://www.cloudzero.com/blog/netflix-aws/>
- Smith, A. (2020). Waterfall Methodology in Medical Research. *Healthcare Management Review*, 35(2), 147-160.
- Theodore Roosevelt Center. (n.d.). *TR Quotes*. <https://www.theodorerooseveltcenter.org/Learn-About-TR/TR-Quotes?page=16>
- U.S. Department of Defense. (n.d.). *About*. <https://www.defense.gov/about/WHO>. (n.d.). *Ebola outbreak 2014-2016 - West Africa*.

World Health Organization (WHO). <https://www.who.int/emergencies/situations/ebola-outbreak-2014-2016-West-Africa>

Yin, R. K. (2018). *Case Study Research and Applications: Design and Methods* (6th ed.). Sage Publications.