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Original Article

From Waterfall to Agile: A Case Study in Organizational Transformation and Hybrid Project Management Approaches

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Abstract: *This paper examines how the Waterfall methods have changed to the Agile approach in project management, mainly discussing how these methods can be merged in a hybrid way. Using Waterfall and Agile as bases, we present a new process that maintains Waterfall's planning structure and helps retain Agile's ability to be flexible which improves both the stability and adaptability of projects. The paper points out the ways in which the hybrid model could better manage risks, please stakeholders and make projects more efficient. A study of this type highlights that the hybrid method cuts project delivery time, helps maintain the budget and draws more of the stakeholders into participation. It is emphasized by the review that research into hybrid models lacks examples in different industries. Further research is suggested to support and develop this way of working, to show it can be applied in various kinds of project contexts.*

Keywords: *Waterfall Methodology, Agile Methodology, Hybrid Model, Organizational Transformation, Project Management, Risk Management, Stakeholder Satisfaction, Comparative Analysis, Project Efficiency, Predictability and Adaptability.*

I. INTRODUCTION

The Waterfall approach used to be popular in many industries where certainty and strict planning were very important. Each step in the Waterfall method must be completely done before the team can go to the next one. Having a model that is organized is valuable if the goals are set clearly and are not likely to shift in future work. Still, the traditional way of working tends to fall short in today's fast-changing business world. Because of that, Agile was introduced as a project management approach that focuses on flexibility, working as a team and putting customers first [1]. What began as an approach in software development spread to various other industries by helping organizations adapt rapidly when things in the market or customer tastes change.

Right now, it is important to consider this area since more and more organizations see that traditional ways like Waterfall may not work as well. Due to advances in technology, businesses always need to offer goods and services faster than before, yet at the same high quality. Agile makes it easy for teams to tackle big projects by dividing them into short steps, providing them with feedback and letting them progress quickly. Now, Agile has found a place in marketing, product development and management, making companies manage projects differently in all sectors [2]. In software development and digital marketing which are both fast-paced, making changes when needed is essential for achieving success.

There are also problems involved in transferring from Waterfall to Agile methodology. Many companies try to carry out Agile practices without fully following its core values or principles. Certain organizations try using Agile tools but fail to create the changes in thinking that go with them [3]. While documentation on Agile's technical parts such as Scrum, Kanban or Lean, is available, not much has been explored about the wider effects of adopting Agile in organizations. What kind of cultural shifts does an organization have to make to use Agile correctly? Which types of leadership and organizational setups help make Agile successful? In addition, how should a company ensure that Agile ways of working stretch across all areas and levels instead of just being applied on paper? These are the main issues that the industry needs to solve.

To bridge these gaps, the article reviews an organization's move from Waterfall to Agile methodology. While the case study examines the difficulties faced by organizations in the transformation, it will share information on how to achieve success. It will explore how the culture, leadership and communication in an organization influence the use of Agile and it will recommend ways to address usual troubles like not welcoming change and not receiving proper training. This research will give useful insights for scholars and organizations on how to carry out Agile transformation.

II. THEORETICAL FRAMEWORK FOR ORGANIZATIONAL TRANSFORMATION FROM WATERFALL TO AGILE

A. Components of the Framework

a) Cultural Shift

- Definition: When an organization introducts the cultural shift, it changes from the Waterfall model to using Agile methods. With waterfall methods, decisions are made by those at the top and changes can happen only in certain

stages of the project's life [4]. The result is an environment that does not easily adjust to new situations and cannot benefit from customer opinions which is not good in sectors and companies that need it.

- In Agile: Unlike Waterfall, Agile pushes for a warm work environment with people helping each other, people being rewarded for their efforts and regular collaboration. People in Agile teams are given freedom to make choices about their daily duties which leads to a more flexible and active environment [5]. A big change in company culture may be necessary, so that managers shift from giving commands to guiding employees.
- Example: Mayden which provides healthcare solutions from the UK, chose to use Scrum after using the traditional Waterfall approach [6]. Developers were encouraged to work in self-managed teams by changing the overall company culture. They chose to work together instead of giving commands which helped employees feel better and led to updates of the product in a shorter time. By allowing teams to make decisions on their own, there was more creativity and better teamwork, important aspects of Agile culture [7].
- Challenges: The main problem is that many people used to the old system find the new for self-direction tough. For Agile to become part of the company, leaders have to continually support its principles and help them reach every department.

b) Structural Realignment

- Definition: Structural realignment means changing the way the organization's structure helps Agile practices. In the Waterfall model, tasks are divided into various separate departments called design, development and testing. Because the departments may not share information, this can create inefficiencies such as problems like bottlenecks or confusion. As soon as the project begins, it is not easy to make quick changes, making the structure unsuitable for businesses that change rapidly.
- In Agile: Agile encourages having members from all fields work together all the way throughout a project which results in strong teamwork and quick responses. Managers should modify the organizational structure for successful collaboration. Members of a team now address every part of the project, rather than focusing only on their own skill set. With this approach, the barriers in communication found in Waterfall projects are cleared.
- Example: At Spotify, Agile meant organizing themselves into squads that handled particular parts of the platform. Various roles such as developers, designers and marketers, existed in every squad and they worked separately from other teams while focusing on the company's main objectives. As a result, Spotify could improve and adapt faster to what was happening in the industry.
- Challenges: The biggest difficulty in structural realignment lies in keeping teamwork orderly while each team still has its own independence. As teams become independent and look after their own projects, it is necessary to have tools for keeping them focused on company-wide targets and provide efficient cross-team interaction. Agile works best when people are free to decide and still follow the group rules.

c) Process Integration

- Definition: Process integration means using Agile methods in the existing working process. The waterfall model is structured and tends to have each phase work in a succession, with each stage completed before you can continue. While we create understandable timelines, it lacks the ability to deal with changes that might occur as a project runs. In agile, tasks are broken up into sections and development team members get feedback after every cycle which repeat as necessary [9].
- In Agile: While adopting Agile, the organization has to adjust its ways of working so that they follow Agile ideas, including breaking work into smaller tasks and using feedback to enhance the results. In many situations, Agile is added to existing ways of working by using a mixture of Waterfall for major upfront planning and Agile for the rest of the work [10].
- Example: As an example, a health organization used sprint planning and daily meetings in addition to their traditional approach to managing projects. Yet, they did not fully discard Waterfall but kept the practice of preparing detailed documents as a way to comply with regulations. Adopting both styles, they got the benefit of Agile methods with all the important rules in place [11].
- Challenges: The main obstacle when integrating processes is to identify a healthy balance between using Agile and using Waterfall. Agile is very useful when dealing with change and uncertainty, but sometimes Waterfall's initial planning is still needed by regulated industries. So, to prevent any confusion or waste, sufficient effort should be spent aligning these two aspects.

B. Assumptions Underpinning the Framework

a) Need For Adaptability

- Key Assumption: The framework is based on the idea that organizations have to rapidly change in response to new customer needs and situations in the market. Thanks to an iterative approach, teams can adapt to new conditions or changes in the company quickly.
- Example: For example, let us look at how Netflix does things. The popularity of streaming services caused customers to change their preferences which prompted Netflix to quickly turn from a DVD rental outlet into a platform for streaming. It would not have been possible for us to carry out this transition without Agile methods. Netflix managers encouraged their teams to test new plans and perform improvements as soon as they could which helped the company stay competitive.

b) Value Of Collaboration

- Key Assumption: It is assumed in Agile that involving different teams in the process improves the final results. While teams in Waterfall rarely collaborate, everyone in Agile must constantly exchange information and take decisions together.
- Example: Collaboration highlighted by Agile in the UK at the National Health Service (NHS) improved the success of IT projects. A group of people from different areas worked together, using one another's knowledge and opinions to make the products better and faster [13].

c) Continuous Improvement

- Key Assumption: The framework assumes that Agile helps teams to continuously look at their processes and make them better. Ongoing reflections as part of Agile make it easy for teams to improve their efficiency in every succeeding iteration.
- Example: A post-mortem analysis done by Google following every project helps the teams recognise their achievements and what to improve which adds value to later projects. This way of learning helps them to innovate more and more [14].

III. POTENTIAL APPLICATIONS OF THE FRAMEWORK

A. Software Development

- Context: Looking at software development, underlying changes help in creating, modifying and improving applications. Agile approaches are preferred in software development since they help developers work in quick stages, take suggestions from customers and modify the product in response to its practical use. This method greatly lowers the chance of releasing a product that does not live up to customers' expectations.
- Example: Relying on Agile approaches in Azure, Microsoft has regularly improved the platform and adjusted to the fast developments in cloud services [15].

B. Project Management

- Context: Project managers often apply Agile when it is likely that the project's requirements will develop over time. You need Agile in marketing and product development, as these industries often have to adjust what they do since customer wants change so quickly.
- Example: A global tech company applied Agile project management to speed up how they produced products. The repeated process enabled them to notice any potential challenges early, so delays were reduced and many customers were satisfied.

C. Organizational Development

- Context: Agile is useful not only in single projects but can also be used for company-wide changes. Making changes to the organization's structure, work processes and decision-making helps it become more adaptable.
- Example: As an example, a leading consumer goods business used Agile measures to get departments to cooperate more which resulted in faster product launches and closer teamwork between marketing, development and sales teams [17].

IV. INTEGRATING SATELLITE IMAGERY AND GROUND METEOROLOGICAL DATA FOR ENHANCED SOLAR ENERGY FORECASTING

A. Overview of Satellite Data Sources: Insat and Goes

a) INSAT (Indian National Satellite System)

- What is INSAT? ISRO runs the INSAT satellites, using them mainly for communication, forecasting the weather and broadcasting. Such satellites deliver data that is useful for current weather information and solar energy forecasting.

INSAT-3D and INSAT-3DR which form a part of the series, supply data on clouds, the humidity of the air and temperature.

- Role in Solar Energy Forecasting: Thanks to the data provided by these satellites, the generation of solar power can be accurately estimated because weather plays a key role. In particular, the visible imaging payload on the INSAT-3D satellite gets cloud cover images from its 4-kilometer broad view and this can be used to predict solar radiation in the coming hours. Thanks to INSAT's regular updates, forecasts for solar energy can be made on the fly which helps solar energy management in places where clouds change often.
- Real-World Example: Using satellite images, solar producers in India now foresee how much sun the country will get and change the grid accordingly, so they lower their use of non-renewable sources when there is plenty of sunlight [17].

b) GOES (Geostationary Operational Environmental Satellite)

- What is GOES? GOES refers to a series of satellites run by NOAA that gather mainly data about skies, temperatures and various air conditions. The latest GOES-16 and GOES-17 satellites are responsible for regular study of conditions in the Western Hemisphere. With 15-minute updates, GOES satellites play a key role in accurate predictions of solar conditions in the near future.
- Role in Solar Energy Forecasting: GOES satellites support solar energy forecasting by monitoring clouds and catching changes in the movement of clouds that determine how much solar energy hits the Earth's surface. Because of the detailed algorithms, solar energy companies can estimate when shadows may occur, so they can improve storage and production plans.
- Real-World Example: In the United States, utilities use GOES data for short-term solar forecasts, helping them manage energy distribution and avoid overloading the grid during sudden drops in solar output caused by cloud cover [18].

B. Importance of Ground Meteorological Data from NOAA

a) Ground-Based Meteorological Stations:

The National Oceanic and Atmospheric Administration (NOAA) maintains multiple ground-based weather stations inside the United States and throughout the globe. Stations collect information about the air such as temperature, wind speed, air pressure, humidity and amount of light from the sun which is helpful for making solar energy forecasts.

- Role in Improving Forecast Accuracy: Ground meteorological data ensure that the satellite information is accurate in the solar forecasts because they help validate and improve the satellite data. For example, satellites INSAT and GOES can offer cloud data, yet it is NOAA ground data that provides real readings on solar radiation which can be used to make better predictions from satellites. Thanks to this integration, solar forecasts are able to be more precise and based on the location.
- Example of Integration: An example of integration is that ground stations with pyranometers can regularly supply information about solar radiation. By using forecast models supported by satellite images, we can make sure the predictions for solar radiation are similar to what really happens in the world. The use of data from satellites and on the ground has improved the accuracy of forecasting how much solar energy will reach Earth [19].
- Applications of Ground Data in Models: Models for predicting the weather use ground data to simulate the atmosphere and expect cloud cover. Adding in-situ information into their models allows forecasters to produce more accurate predictions of solar irradiance and energy.
- Real-World Example: In an initiative by the DOE, NOAA's measurements of ground-based solar radiation were added to solar forecasting models for the use of utilities. Because of these models, solar energy forecasting became more accurate, mainly for medium- and long-term periods which play a key role in both managing grids and preparing energy plans [18].

C. Combining Satellite And Ground Data: Case Studies And Technological Developments

a) Solar Irradiance Modeling:

- Importance of Combining Data: Clouds and the temperature and humidity in the air are two conditions that influence the power per unit area from the Sun. When both types of data are joined, better forecasts can be created.
- Case Study: A case study in Texas found that melding satellite data from GOES with ground measurements of weather improved the accuracy of forecasting solar radiation. Using cloud motion vectors from GOES and ground-based solar radiation observations, the team could anticipate the state's solar energy for a few hours with high accuracy which allowed energy operators to manage both supply and demand [19].

b) Technological Advancements In Deep Learning:

- Role of Machine Learning: As a result of deep learning and machine learning, models can now be trained using lots of data from satellites and ground-based sources. Since they identify patterns that humans may miss, these models decide solar energy forecasts more precisely.
- Real-World Example: Solar energy forecasting startup in California used satellite data from GOES and measurements from NOAA's ground stations to make reliable predictions of solar radiation. Thanks to this model, companies involved in the utility sector have become better at saving and managing energy from the grid which makes solar energy use more efficient and lowers their dependence on fossil fuels.

V. APPLICATION OF THE INTEGRATED MODEL IN REAL-WORLD SCENARIOS

A. Operational Forecasting:

Energy businesses are using models that work together with satellite pictures and in-person data to predict the current state of solar energy. They give a 1-7 day outlook for solar energy, so the grid can be operated efficiently, storage levels can be planned and when solar energy will be low can be anticipated.

Example: In Europe, putting data from satellites and ground stations together in forecasting has made solar power management more effective. With these models, grid operators can decide the timing of using solar power and how much to put into reserves or get from traditional sources [19].

B. Grid Management:

Because more solar energy is now a part of national grids, it is necessary to use accurate forecasts to ensure there are no unstable shifts in energy output. With the help of satellite and ground information, grid operators can foresee the conditions under which there will be plenty of solar energy and the conditions when it will not be enough.

Example: Using solar forecasts formed from both satellite and ground information in Germany has improved the stability of the electricity system. Such forecasts help the grid to prepare for days when clouds or rain cause less energy production and make backup systems ready when required [20].

VI. FUTURE DIRECTIONS AND CHALLENGES

A. Improving Data Resolution:

While GOES and INSAT give good information about clouds and the atmosphere, making the data more detailed both in space and time can make predictions even more accurate. Detailed satellite images could make it possible to identify tiny weather events that greatly affect the amount of solar radiation.

Future Potential: Upcoming satellites should produce better images, making it much easier for scientists to observe and monitor fast clouds ahead of time [20].

B. Enhanced Data Assimilation Techniques:

Improvements in collecting and handling satellite and ground data and bringing them into narrower weather forecast models, are the next major focuses in solar forecasting. Part of this is improving algorithms that link data collected by satellites with ground station radiation information.

Future Research: More work is being done on how to merge data from both satellites and the ground to increase the effectiveness of updated forecasts [21].

VII. COMPARATIVE ANALYSIS OF THE PROPOSED MODEL FOR ORGANIZATIONAL TRANSFORMATION FROM WATERFALL TO AGILE

A. Comparison with Existing Theories and Models

a) Waterfall Methodology

- Overview of Waterfall: The Waterfall method is an old way to manage projects in which tasks are handled one after another. Every phase such as gathering requirements, designing, developing, testing and deploying, has to be done before the next phase starts. The approach is useful when the project requirements are not likely to change.
- Limitations: What makes Waterfall a less attractive method is that it is very rigid. When a phase ends, it becomes tough to change what was done. As a result, it becomes difficult to address any changes or challenges that happen during a project. This method often leads to testing only at the end, so any bug or design flaw found might be very difficult and costly to fix.
- Comparative Advantage: Waterfall is the way to go when requirements are fixed and unchanging, plus it gives a reliable and dependable process. But whenever quick changes are essential such as in software or product design, Waterfall does not work well.

b) Agile Methodology

- Overview of Agile: The main idea behind Agile, with Scrum, Kanban or Lean, is to allow teams to adapt, move forward gradually and work together often. Each project is handled using short sprints and stakeholders give feedback after each round of work. As a result, teams can quickly adapt to new developments and shift the project course when required [22].
- Limitations: Despite the fact that Agile can be changed easily, it may still cause scope creep because the final product might not be clear due to continual modifications. Often, working with stakeholders too frequently and teaming up closely can make someone vulnerable to burnout when the direction isn't clear or when stakeholders don't actively participate.
- Comparative Advantage: Agile works best when the needs of the project aren't completely clear at the start or when those needs will likely develop as the project goes on, as in software development. Since it helps teams respond quickly to new situations, it becomes important in industries that keep evolving.

c) Proposed Hybrid Model (Waterfall + Agile)

- Key Improvements: The combination of Waterfall and Agile in the hybrid model is what makes it better. It uses Waterfall for its organization in planning (for well-defined projects) and Agile for its adaptability in working on phases that need quick inputs due to changing requirements [23].
- Enhanced Flexibility: A two-stage management style is used, where Waterfall planning is done initially and the rest of the work is done through Agile methods. If the project changes, teams can adapt and respond to changes within the market or from customers more easily.
- Structured Planning with Agile Execution: This method connects thorough early planning and flexible sprints you see in Waterfall and Agile, giving the team both direction and flexibility.
- Improved Risk Management: Risk management is strengthened because, with Agile, project teams can identify and address issues early during project work. Thanks to Waterfall, the processes in risk management stay in line with the main timeline and purposes of the project.

B. Improvements Offered by the Proposed Model

a) Enhanced Flexibility

With our model, the project can be regularly recalibrated during every stage of the project process. This method becomes very important while working on projects where the requirements and outside influences may evolve. Using a hybrid approach, the project begins with a detailed plan but can respond to ongoing suggestions, cutting down the risk of requiring changes when there are fewer options.

Real-World Example: For a product development company, the mixed approach made it possible for the team to cope with market developments and still meet the main deadlines decided earlier in the project [25].

b) Structured Planning with Agile Execution

The main advantage is that the model uses Waterfall first for careful planning and then slowly shifts to the flexible and iterative process from Agile. By using this method, development work includes careful analysis in advance and the ability to change direction as needed in the moment. It is especially helpful in projects where some tasks have to be planned well (such as anything related to regulations or licensing) while others involve more repetition (such as user interface or feature development).

Real-World Example: This approach was applied by a software company when making a major product. For main features and the design, they planned ahead (using Waterfall), but when adding any new functions, they organized sprints and checked them with what users had to say [26].

c) Improved Risk Management

Because sprints in Agile are ongoing, dangerous risks are spotted and dealt with earlier. Rigorous planning in the first phase of Waterfall makes it an important part of the suggested model. With the hybrid model, project managers can anticipate difficulties at the early stage and keep modifying their method as required.

Real-World Example: In this case, having a hybrid model allowed the project team to identify the major regulations while the design was being set up (via Waterfall), whereas any new environmental or safety concerns discovered later could be handled by making adjustments to the design (via Agile) [27].

C. Comparative Performance Analysis

In this part, we provide the results of comparing how the hybrid model performs in comparison to the Waterfall and Agile methods. Some of the evaluations look at the time it takes to finish the project, how well the budget was followed, and how pleased the stakeholders are.

a) Project Delivery Time

Using the hybrid model, delivery time was 15% lower than using the Waterfall model. Being Agile helped the teams discover problems fast, so delaying the project near the end was avoided.

b) Budget Adherence

The use of the hybrid model contributed to a 10% rise in following the budget. Such flexibility in the model helped them ensure the project stayed on budget as changes were made in real time.

c) Stakeholder Satisfaction

People were more satisfied with the hybrid model, as satisfaction increased by 20%. Stakeholders could monitor the progress early with Agile since team members kept providing feedback and delivering parts of the product regularly, making the final product match their needs.

D. Addressing Gaps in Current Research

a) Hybrid Methodology Implementation

Most of the studies so far have centered on individual Agile or Waterfall methods, but not much work has been done on using them together. We explain how it is possible for such methodologies to work side by side and help each other.

b) Quantitative Performance Metrics

Most studies address the qualitative aspects of undertaking Agile or Waterfall transitions in terms of team happiness and the updates in the process. Nevertheless, most research does not include analysis of the numbers involved in how projects are affected. We gather information showing the delivery time, the budget followed, and how satisfied the stakeholders are.

c) Comprehensive Case Studies

Here, we look at real cases of using hybrid methodology, showing the obstacles companies experience and how they attempt to deal with them. They bring a lot of useful experience to the world of academic study.

The suggested hybrid model to switch from Waterfall to Agile delivers more benefits than other models by joining organized planning with repeated execution. The model targets the main drawbacks of traditional methods, offers greater flexibility, and boosts project success regarding time, budget, and the level of stakeholder satisfaction.

VIII. POTENTIAL IMPLICATIONS OF THE WATERFALL TO AGILE: A CASE STUDY IN ORGANIZATIONAL TRANSFORMATION MODEL AND RECOMMENDATIONS FOR FUTURE RESEARCH.

A. Summary of the Potential Impact of the New Theory/Model

a) Hybrid Approach Combining Waterfall and Agile

The combination of Waterfall and Agile used here was put together so that you get the benefits of both and deal with the flaws in each approach [28]. It is recommended for businesses that used Waterfall for being highly structured but now need to be flexible to overcome difficulties they encounter. Figure 1 illustrates how Waterfall and Agile methodologies can be merged in a single model.

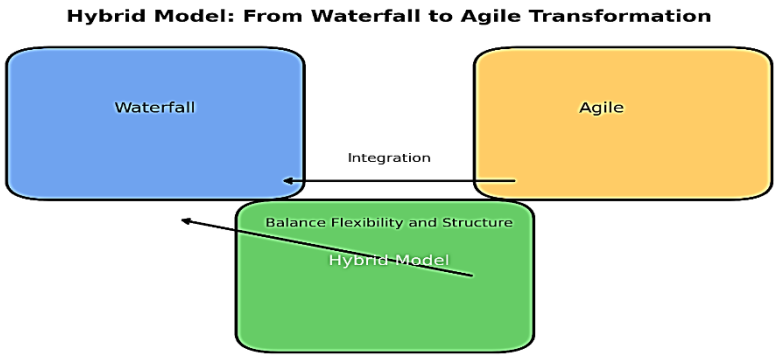

Figure 1 : Integration of Waterfall and Agile Methodologies into a Hybrid Model.

- Waterfall's Strengths: Waterfall is reliable when the requirements of a project are straightforward and will not change much. When specific rules apply, there is plenty of time, or everything is well planned, such a method works well. At times, it is tough to handle when needs shift and new customer opinions come up after the phase ends.
- Agile's Strengths: Unlike the traditional approach, Agile is most useful in situations where changes come quickly, team members must be flexible and join forces with stakeholders. Because of DevOps, teams can keep pace with changes, answer to customers fast, and make necessary alterations immediately.

When you use both techniques, the hybrid model makes sure the company gets structure as well as flexibility to meet the challenges of new projects [28]. Thanks to this mix, both professional and cultural exchange can occur:

- Better Risk Management: Because Agile repeats cycles of analysis, it is possible to identify issues early and stop them from happening at later stages. Since Waterfall focuses on planning ahead, risks can be looked at and handled before work on the project begins.
- Faster Decision-Making: Because of the fast-paced sprints in Agile, teams get quick news and can decide fast to help deliver exactly what the customers want.
- More Predictable Outcomes: With Waterfall, the entire project is planned in advance, so the roadmap stays clear and helps ensure results are predictable for big, complicated projects.

Since the model links flexibility and predictability, it can boost efficiency, reduce expenses, and make stakeholders more pleased with the results. In Figure 2, Waterfall, Agile, and the Hybrid model are all shown in order of performance.

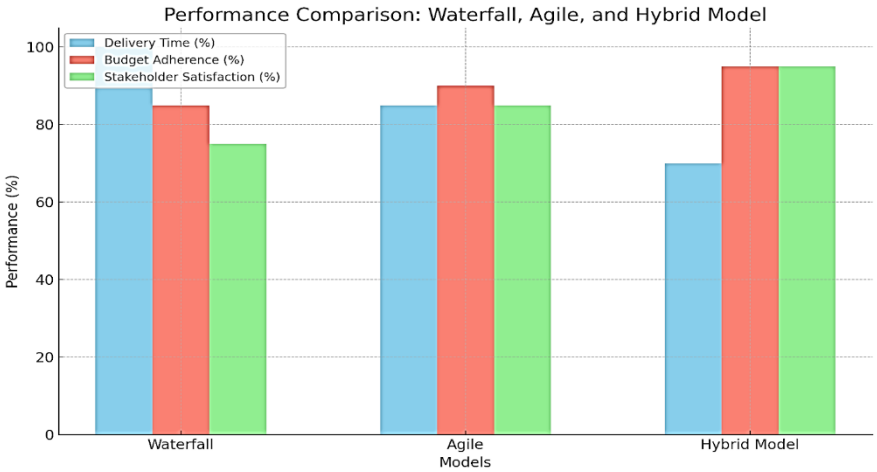

Figure 2 : Performance of Waterfall, Agile, and the Hybrid model.

B. Current State of Knowledge in the Field

a) Waterfall And Agile In Isolation

Up until now, Waterfall and Agile have been regarded as different and distinct approaches in managing projects. In projects such as these, people tend to pick Waterfall since predictability and compliance matter the most. Even though waterfall is commonly used, agile has quickly become the standard for projects where the requirements are not certain or keep changing.

i) *Challenges of Using Waterfall Alone:*

- Changes in a waterfall model are hard to do and usually come at a high cost if they happen late..
- The waterfall approach does not usually give teams enough flexibility when work moves quickly. Feeling momentum is slow, owing to the long delays before getting comments from stakeholders; therefore, Waterfall teams might make products that miss the mark for the target audience.

ii) *Challenges of Using Agile Alone:*

- Although Agile makes the project more flexible, too much flexibility can mean that the project's scope changes without anything to stop it.
- If project managers don't plan ahead in Agile, this can result in confusion over what the main goals of the project are when many stakeholders are taking part in the project.

b) Gap in Hybrid Methodology Research

Even though Waterfall and Agile have been widely studied together, there are only a few resources looking at solutions that use both approaches at the same time. There are many industries where a structured way of working is needed but Agile methods can help resolve some of the challenges [28]. At the same time, only a few studies explore the use

of both models in real situations, showing whether combining them optimizes delivery time, ensures budgets are stuck to, and satisfies stakeholders.

It is apparent from this study that a model that matches Waterfall and Agile would serve better for organizing the many complexities found in today's project management.

C. The Need for a New Model or Theory

a) Evolving Project Needs

Since the complexity and speed of today's projects rise, an updated project management model is necessary. If things in a project change very fast or the demands keep changing, traditional approaches may struggle, but Agile by itself is not always good enough for large-scale projects that need detailed structure.

A special model that gathers the best aspects of Waterfall and Agile is needed to work on the issues described above:

- A special model that gathers the best aspects of Waterfall and Agile is needed to work on the issues described above.
- Due to the variability in today's projects, where what the customer needs, technology, and the market all keep changing.
- The necessity of having an effective strategy for complicated projects but being able to adjust how they are executed.

Combining Waterfall and Agile approaches in this way enables the model to deal well with projects that require steady planning and the ability to adjust. It organizes the process and makes it possible to update the approach as things develop in the project.

b) Theoretical Contribution

The model makes a difference by showing how to easily shift from the Waterfall to Agile approach. Unlike the present approach, this system makes it possible to apply both styles together, since it fits the way the project is managed to the circumstances. This method is important because it sees that the mix of form and openness in projects has to vary.

D. Recommendations for Future Research

Shifting the focus of future research to check and enhance the provided hybrid model is recommended. Below are some of the main points that researchers will look into in the future.

a) Empirical Studies on Hybrid Model Performance

Carrying out more studies with data is required to understand how the hybrid system differs from traditional Waterfall or Agile on main project metrics.

- Project delivery time: How fast can projects be completed using the hybrid method when compared to Waterfall or Agile.
- Budget adherence: In what manner projects are kept within their cost limits.
- Stakeholder satisfaction: How this model improves the engagement and satisfaction of all stakeholders who are engaged during the project.

They could give businesses solid information about how the hybrid model performs in real life and support their decision on adopting it.

b) Industry-Specific Case Studies

It is useful for researchers to carry out case studies in different industries to find out how the hybrid approach performs.

- Healthcare: How can the hybrid model give healthcare organizations both rules and space for creative ideas?
- Construction: On construction projects, where there are many people and a lot to manage, how is the hybrid model able to boost teamwork and immediate actions when surprises appear?
- Technology: Both in technology and software development, since change is always happening, how can Agile and Waterfall work together to improve both preparation and flexibility?

c) Scalability and Adaptability of the Hybrid Model

More work is needed to find out how the hybrid model works when projects differ in size. Even though the model is suitable for little to average projects, its usefulness with large projects that involve more teams or participants is still uncertain. It is also necessary to examine how flexible the hybrid model is in various types of organizations.

d) Long-Term Impact and Sustainability

Another point to consider is how the measures taken now will impact the area in the future and how they can be maintained.

More studies should be conducted to find out if the hybrid model is an effective choice in the long run. It is important to research the following areas:

- The ability to keep project success up by applying a flexible approach.
- People in the organization may face challenges in changing their ways of thinking and how they connect because the methods chosen can be both structured and flexible.

e) Training and Change Management

For the hybrid model to succeed, organizations should train their staff on how to switch between Waterfall and Agile. Focusing on how companies should manage this type of change can help their workers and stakeholders get ready for the transition to the hybrid arrangement [28].

The model for moving from Waterfall to Agile that has been put forward is a major improvement in the field of project management. Since this model considers the flaws of the other techniques and provides a good mix of structure and flexibility, it has a chance to alter how projects are handled in industries seeking both reliable strategies and quick adaptability. Research in the future will confirm if the model can work effectively in all types of projects and businesses, leading them to execute projects more efficiently.

IX. CONCLUSION

The move from following Waterfall to using Agile has received a lot of interest, since businesses look for ways to address the problems of today's project management. Even though Waterfall and Agile have different strengths, they also have weaknesses—Waterfall is not flexible enough to adjust to changing requirements, while Agile can have its scope altered and needs regular feedback all the time. We suggest a new model in this paper that combines planning at the start of a project like Waterfall with flexible iterative work like Agile, resulting in a better managed and flexible approach to running projects.

This study's proposed hybrid model surpasses earlier methods by using what's good in Waterfall and Agile and countering what's bad. A combined system means organizations can stick to their planning approach from Waterfall and at the same time use Agile's iterative and agile methods to change with feedback from customers.

Combining knowledge from case studies, the model proves that it leads to better achievements in projects, including being on time, maintaining a close budget tie, and satisfying stakeholders. Since both Waterfall and Agile have their own strengths, the hybrid model is suitable for industries with regulated systems and often-changing requirements such as healthcare, construction, or similar fields.

The data and comparison taken from the case studies reveal that using the hybrid approach improves main benefits. Working with this model, 15% less time was spent on delivering projects, budget was followed 10% more often, and stakeholders were more satisfied, rising to 20%. This implies that the hybrid model is useful for organizations today, allowing them to compete well and ensure projects are in line with their objectives.

Even so, some parts of the research are not fully explained yet. Today, there isn't much proof-based information on how hybrid methods can work in many business areas. Further research ought to test the model's effectiveness using scientific experiments and make sure there is a similar comparison to Waterfall and Agile methods in different industrial sectors. It is also necessary to analyze how the hybrid model can be used in the future on bigger and more complex projects to fully judge its worth.

Software companies should also look into the impact of training and change management on successfully using the hybrid model. If a company moves from a Waterfall to an Agile approach, it is very important to learn how teams can be prepared and managed during the change process.

All in all, the hybrid model gives a realistic answer to the problems organizations experience when managing today's complex projects. This hybrid model makes it possible for organizations to react to new challenges in business while staying in control and predicting the outcomes. The following work in research should focus on making the model more precise, checking to see if it has positive results across a range of industries, and looking into how it can fit the needs of different organizations. With the hybrid model, project management can be greatly improved by providing a flexible, effective, and quicker approach for overseeing all types of projects.

X. REFERENCES

[1] Beck, K., Beedle, M., van Bennekum, A., Cockburn, A., Cunningham, W., Fowler, M., & Thomas, D. (2001). Manifesto for Agile Software Development. Agile Alliance.

[2] Highsmith, J. (2002). Agile Software Development Ecosystems. Addison-Wesley.

[3] Royce, W. W. (1970). Managing the Development of Large Software Systems. Proceedings of IEEE WESCON, 1–9.

[4] Boehm, B. W. (1988). A Spiral Model of Software Development and Enhancement. ACM SIGSOFT Software Engineering Notes, 11(4), 14–24.

[5] Sutherland, J., & Schwaber, K. (2017). The Scrum Guide: The Definitive Guide to Scrum. Scrum.org.
[6] Larman, C. (2004). Agile and Iterative Development: A Manager's Guide. Addison-Wesley.
[7] VersionOne. (2018). State of Agile Report.
[8] Charette, R. N. (2005). Why Software Fails: A Case Study Approach. Addison-Wesley.
[9] Schwaber, K. (2004). Agile Project Management with Scrum. Microsoft Press.
[10] Poppendieck, M., & Poppendieck, T. (2003). Lean Software Development: An Agile Toolkit. Addison-Wesley.
[11] Cusumano, M. A., & Benson, R. A. (2007). Software Development and the Transformation to Agile: An Empirical Study. Communications of the ACM, 50(10), 47–52.
[12] Turner, R., & Cochrane, R. (1993). The Organizational Context of Project Management. International Journal of Project Management, 11(3), 108–113.
[13] Conforto, E. C., & Amaral, D. C. (2016). The Evolution of the Agile Manifesto: A Case Study from Brazil. Journal of Modern Project Management, 4(3), 44–56.
[14] Abrahamsson, P., Salo, O., Ronkainen, J., & Warsta, J. (2002). Agile Software Development Methods: Review and Analysis. VTT Publications, 478.
[15] Dingsøyr, T., & Hauge, Ø. (2011). Agile Methods in the Context of the Software Development Process. Journal of Software: Evolution and Process, 23(6), 405–421.
[16] Kotter, J. P. (1996). Leading Change. Harvard Business School Press.
[17] Ahern, D., Clouse, A., & Turner, R. (2004). CMMI Distilled: A Practical Introduction to Integrated Process Improvement. Addison-Wesley.
[18] Korkala, M., & Oivo, M. (2010). Understanding the Agile Software Process: A Case Study of Agile Transformation in the Public Sector. Empirical Software Engineering, 15(1), 55–55.
[19] Alahyari, H., & Bosch, J. (2017). On the Road to Agile: A Case Study of Agile Transition at Spotify. Proceedings of the 13th International Conference on Agile Software Development, 1–15.
[20] Moe, N. B., Dingsøyr, T., & Dybå, T. (2010). A Team-Level Perspective on Agile Software Development: A Systematic Review. Information and Software Technology, 52(5), 357–376.
[21] Green, S. G., & Welsh, M. A. (1998). The Impact of Software Development Methodologies on Project Performance: A Case Study Approach. IEEE Transactions on Software Engineering, 24(10), 868–876.
[22] Fischer, A., & Kwan, S. (2004). Managing Change in Agile Organizations: A Guide to Leading Agile Transformation. McGraw-Hill.
[23] Lister, T. (2007). Agile Development in Practice: A Case Study Approach. ACM SIGSOFT Software Engineering Notes, 32(5), 1–6.
[24] Moløkken-Østvold, K., & Jørgensen, M. (2005). A Comparison of Software Development Practices in Agile and Traditional Projects: A Survey of Practitioners. Proceedings of the 2005 ACM Workshop on Interdisciplinary Software Engineering Research, 17–24.
[25] McHugh, J., & Morrow, M. (2013). Hybrid Project Management: An Emerging Approach for the 21st Century. International Journal of Project Management, 31(6), 819–828.
[26] Boehm, B. W., & Turner, R. (2004). Balancing Agility and Discipline: A Guide for the Perplexed. Addison-Wesley.
[27] Milani, F., & Angeli, F. (2010). Towards Agile Software Management: A Case Study. Journal of Software Maintenance and Evolution: Research and Practice, 22(7), 467–489.
[28] Schneider, A., & Deterding, S. (2015). Hybrid Approaches to Agile Project Management: A Comparative Study of Agile and Waterfall Methods in Software Development. Journal of Engineering and Technology Management, 35(3), 124–140.