

A Hybrid Framework HWF-PR in Software Engineering: MySpot-PR an Application

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Abstract— *In software engineering there are many models to develop a completely functional application. Many of them have been sufficiently reported in the current literature, which include traditional, agile methodologies and some hybrids. The main objective of this work is to implement the Hybrid Work Framework HWF-PR in a specific case study, with the participation of two development groups, one control group using the extreme programming XP and, another experimental group using HWF-PR, in order to establish differences that allow to determine the benefits of the framework. The groups are composed of students of the computer engineering program of the UAGM of Puerto Rico. The foundation of this method is to apply the Shewhart principle, agile methods, agile practices and usability. Developing software through this methodology would represent a saving of time and effort. The flexibility to make corrections at any time can represent the improvement of ideas and the development of a better product.*

Keywords—HWF-PR, Software Engineering, Agile Methods, Waterfall, Usability

I. INTRODUCTION

There are many reasons why a person decides to travel abroad, whether for work or tourism, leaving the country of origin can represent a completely new experience. However, when a person visits a place for the first time, there are only a few tools with update information that they can use to find out what places are around them. This situation often occurs in Puerto Rico, when tourists decide to visit the island and arrive in the city of San Juan, capital of the country. The main objective of this work is to design a mobile application (called MySpot) that helps users to get to know San Juan, Puerto Rico, and get a better experience of their visit.

This work will be based on the techniques studied in the discipline of software engineering. According to Somerville [1], software engineering is the of a study that deals with all aspects of software production from initial conception to operation and maintenance. Specifically, this field focuses on some essential attributes that include: acceptability, reliability, safety, efficiency and maintainability. In software engineering there are many models to develop a fully functional software.

Specifically, for this work a Hybrid Work Framework will be implemented, conceived from the perspective of software design and development in Puerto Rico; it is still in the experimental phase, known as Hybrid Work Frame (HWF-PR). The basis of this method is to apply the principles of the traditional Waterfall methodology, especially its formalism

in the initial phase of the project, as well as the Shewhart cycle, agile methods, agile practices and usability [2].

II. METHODOLOGY

For this project the methodology used is a hybrid called HWF-PR which combines various practices and techniques. A project has more probability of success when a plan of development is chosen beforehand [3]. Developers tend to prefer the use of agile method for the development of a software [4]. The HWF-PR model is flexible and allows developers to go back in the processes, improve them and adapt them to the needs of the user.

There have been several researchers who have dabbled in hybrid methods for software development, studies such as that of [5] seeks to evaluate, synthesize and present results on the use of Capacity Maturity Model Integration (CMMI) in combination with the agile software development, offering an overview of the topics investigated, which includes a discussion of its benefits and limitations, the strength of the findings and the implications for research and practice. Companies can use agile methodologies to reduce efforts to reach levels 2 and 3 of CMMI, there are even reports on the application of agile practices that led to reach level 5. However, agile methodologies alone, according to the studies, were not enough to obtain a qualification at a given level, being necessary to resort to additional practices to do so.

Another investigation [6] suggests whether it is feasible or not, for an organization that develops web systems, to achieve a certain level of maturity of the CMMI-DEV model using agile methods and end up concluding that although the definition of an agile approach to comply with the different objectives of CMMI maturity levels could be possible for an organization that develops web systems, still lack studies and detailed analyzes in this field.

One of the most relevant studies in this field of software development is that of [7], the study indicates that organizations are adopting agile methods through an upward combination from the point of view of adoption and a descending strategy from the point of view of change. The truth is that many changes have taken place since the original

Digital Object Identifier (DOI):

<http://dx.doi.org/10.18687/LACCEI2019.1.1.36>

ISBN: 978-0-9993443-6-1 ISSN: 2414-6390

ideas proposed by the Agile Manifesto, now several organizations have opted for a scheme similar to what West calls Water-Scrum-Fall. This model is not bad, but if you do not make the right decisions about the dividing lines between Scrum and Scrum-Fall, you are unlikely to realize the benefits of the agile. From 2001 to the present it has been observed that the agile approach is practiced by many organizations, gaining much popularity; in fact, a survey conducted by Forrester (Editor of the article by West) in 2010 found that approximately 39% of 1,023 IT professionals said they follow an agile method. But the reality is that the approach followed by many organizations is limited both by organizational culture and by government requirements. The result is that the adoption of the agile is a challenge for the work team and does not necessarily materialize in the commercial benefits such as: time saving of commercialization, added value for the business, greater flexibility or a better response capacity.

As part of the methodological process in this work, two groups were created: the control group and the experimental group, both groups were made up of three people and developed the same project: MySpot-PR; the control group used the XP methodology, while the experimental group used HWF-PR. It is important to note that the control group had previous experience (approximately 2 years) in development using the XP methodology and other agile development methodologies, while the experimental group was trained for a week in the new framework, this group also had experience previous in software development with agile methodologies.

A. First Foundation: Shewhart Cycle

The Plan-Do-Check-Act cycle (PDCA) has been held onto as an incredible establishment for, and invasion into, quality enhancement for general wellbeing offices, as it is both basic and ground-breaking. Its effortlessness originates from the methodical, direct and adaptable methodology that it offers. Its capacity is gotten from its dependence on the logical technique, i.e., it includes creating, testing, and breaking down speculations. This establishment offers a way to wind up alright with a large group of value enhancement strategies and procedures, and to continuously advance into tending to progressively complex issues, utilizing extra QI instruments, and relocating to framework wide ways to deal with QI. PDCA depends on the “Shewhart cycle”, and was made well known by Dr. W. Edwards Deming, considered by numerous individuals to be the dad of present-day quality control [8].

B. Second Foundation: Agile Methods

Disappointment with these heavyweight ways to deal with programming building drove a few programming

engineers during the 1990s to propose new lithe strategies [9]. These permitted the advancement group to concentrate on the product itself instead of on its structure and documentation. Coordinated techniques all around depend on a steady way to deal with programming detail, improvement, and conveyance. They are most appropriate to application improvement where the framework prerequisites as a rule change quickly amid the advancement procedure. They are expected to convey working programming rapidly to clients, who would then be able to propose new and changed prerequisites to be incorporated into later cycles of the framework. They plan to eliminate process organization by staying away from work that has questionable long-haul esteem and wiping out documentation that will presumably never be utilized [10]. According to [2], the second ground HWF-PR are agile methods because as it emerged as alternative solutions to problems with traditional methods. In this case, agile methods help to improve the work of the developers and prioritize the role of the client in the development of the software.

C. Third Foundation: Agile Practices

Light-footed practices, utilized in the support procedure itself, are probably going to be successful, regardless of whether a deft methodology has been utilized for framework advancement. Steady conveyance, plan for change and keeping up straightforwardness all bode well when programming is being changed [11].

Formal documentation is frequently not stayed up with the latest thus does not precisely mirror the program code. Consequently, deft techniques lovers contend that it is an exercise in futility to compose this documentation and that the way to executing viable programming is to create high caliber, intelligible code. Spry practices in this manner underscore the significance of composing very much organized code and putting exertion in code enhancement. In this manner, the absence of documentation ought not be an issue in keeping up frameworks created utilizing a dexterous methodology [9]. In the HWF-PR when talking about agile practices as a third foundation, it does not refer to developers moving from the traditional to the agile, but without subscribing to a methodology, the process can be made more flexible and the developers have a framework of work faster and more efficiently [2].

D. Fourth Foundation: Usability

Usability contributes directly to increasing software quality. HWF-PR proposes to include usability throughout the entire software development cycle. This property reflects how easy it is to use the system. It depends on

the technical system components, its operators, and its operating environment. The HWF-PR, also, proposes to include usability throughout the entire software development cycle.

III. HWF-PR LIFE CYCLE

Figure 1, shows the general structure of the HWF-PR, as can be seen the circles with the capital letters between A and D, indicate the process of continuous improvement of the Shewhart cycle and, the circles marked with the numbers from 1 to 3 indicate the moments in which the members of the development group must implement each of the phases of the HWF-PR, the members of the group can move through these phases in an indistinct way, that is, it is not a rigid and orderly form that must be followed until arriving at the time of a deliverable. In addition to this, the location of usability can also be observed, this to indicate that it is one of the important components, since it behaves as a transversal line throughout the software development cycle.

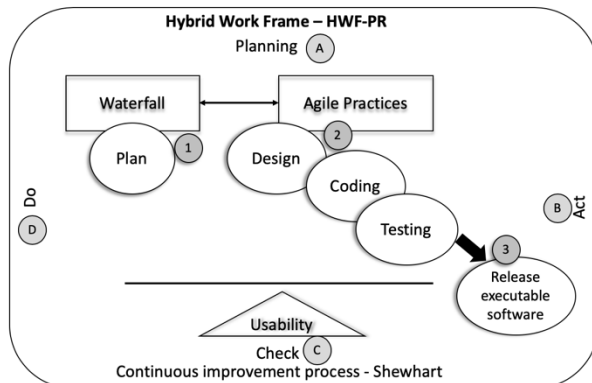


Figure 1. General structure of the Hybrid Work Framework

The purpose of this work is the implementation of the HWF-PR framework for the design and development of a product called: MySpot-PR; This work was done as a class project with undergraduate students of the fourth year of the Computer Engineering program at the Ana G. Méndez University, Gurabo Campus, the students involved in this project were three per group.

MySpot Application description

MySpot is a software product that includes usability practices and user-centered design and serves as a tool for travelers who want to know the island of Puerto Rico. It allows users to use it in a desktop environment, as well as in a mobile environment, users can download the application to their mobile phone and begin to interact with it through an easy to understand and manage interface allowing to obtain the best experience of a tour of the island, showing the most relevant places and attractions according to their geographical position.

A. Plan

In this stage, the measurement parameters that are to be used to control and follow the process are determined. From the perspective of the HWF-PR, the traditional WaterFall formalism will be used, to plan all the activities of the process. WaterFall is the most classic of all models and has served as a structure for the construction of other paradigms of software life cycle. This model is one of the oldest models used in software engineering and is widely many major companies. As this model emphasizes planning in early stages, it ensures design flaws before they develop [12]. In the HWF-PR the WaterFall model is transformed into a dynamic planning system, where in each round or iteration, the system is fed with more refined approaches, with more technical details, which are refined thanks to the timely intervention of the client.

The first step to follow in this part of the model is the planning of the design. Determination of specifications and system requirements will be carried out. A timetable for completing tasks will also be prepared. Once the previous steps are carried out, it will be continued to the next step, where the tests will be designed. It is during the design of tests that it is determined whether the software does what it is supposed to do and if it does not do what it is supposed to do.

In this project the software must show the user about tourist sites, recreation and entertainment, and gastronomy. As well as providing a brief descriptive and / or historical information about the place. Also, the software will have information about San Juan, Puerto Rico. A mobile application will be designed for Android devices and a Web version. All the information of the places will be stored in a database so that it can be updated, and the application can offer recent information.

B. Do

In the cycle of continuous improvement, build consists of the implementation of the changes or actions necessary to achieve the improvements proposed. In order to gain efficiency and be able to easily correct possible errors in execution, tests are usually applied to the process. In this stage the start of the development of the software product will begin. HWF-PR [2] is based on agile practices so activity names can change; but they can be the same action. Some universal agile practices are: quality control, practice of validation, review of results and monitoring of progress. This allows the easily correction for possible errors in the execution of the software. The results of these tests will be the necessary input to visualize the aspects in which the system must

improve and therefore constitutes one more activity in the process of quality control.

C. Check

In this subsection of the doing part all controls and quality tests must be performed (test each task immediately). In addition, the full functions of the software must be displayed. During this phase it is precisely where the tests are developed. A good test should prove the following two aspects: the software does not do what it should do, or the software does what it should not do. The tests in the HWF-PR will [2] be guided by a general protocol that will consist of identify testing techniques, generate data and test cases to run the software, define the procedures to apply the test, run the test, and make a report with the results obtained.

In this design the tests to be carried out must include the following points: that the user can obtain the correct information about the places of interest, that the information of the users is validated, specifically their username and password, that the application is constantly updated and that users can add particular information according to their interests and tastes [2].

The test proposed by the HWF-PR model is the coverage paths, that includes:

- Represent the program in a flow graph.
- Calculate cyclomatic complexity.
- Determine the basic set of independent paths.
- Derive test cases that force execution of each path.

Once the cyclomatic complexity is calculated, the developer can easily determine the basic set of independent paths and at least design a test for each of them. Cyclomatic complexity also allow an assessment of project risk.

D. Act

In the case that the results do not meet expectations, corrections and modifications may be made. On this stage, it is proposed: to place any unfinished artifact or unfinished work at the end of each iteration, check the speed with which a feature of the program has been completed, do a retrospective analysis (to analyze what worked and what needs to be changed for the next iteration); the necessary decisions will be taken that allow to streamline the processes and look for the quality of the final product.

IV. RESULTS

In order to have a balance between the two groups that participated in the project, minimum rules were established

that allowed equal conditions regarding the design and development of the application; these rules are: i) duration of the project, 4 months; ii) average hours of weekly work, 7 hours; iii) generation of minimum diagrams: structural diagram, block diagram, diagram of system architecture, requirements diagram; iv) total of people working in each group, 3 people.

Table 1 shows the most relevant results of the two groups.

Table 1. Comparative results of the experimental group and control group.

Item	Experimental Group	Control Group
Methodology used	HWF-PR	XP
Coding scheme	Processes, practices, people, social and technological dimensions.	Guided by the method
Design	Discovery and creation of products separately. Iterative and incremental design and development.	Guided by the method
Development	Parallel interlocking creation tracks. Continuous participation of the interested parties. Communication mediated by artifacts.	Guided by the method
Results	Deliveries from the third week of work, with intervals every three weeks. Total deliveries made throughout the project: 4. Two reports were generated during the project, both with a good level of detail.	Guides by the method. Total deliveries throughout the project: 5. A single report was delivered, with a low level of detail.

With the use of HWF-PR in this project, the experimental group was able to finish approximately 85% of the product, while the control group reached 90% approximately.

In order to make an equal evaluation to the two groups, a monitoring was established by a general supervisor of the project, which has extensive experience in software development and complete knowledge of the HWF-PR, this monitoring was a relatively simple process and consisted of ocular inspections regarding the performance of each group: communication between the developers; information flow by sprint; solution of problems that arise in the process; use of the appropriate methodology; adjustments in requirements changes, if applicable; use of technological tools to support the process.

As part of the recommendations of the HWF-PR, a block diagram was made, as shown in figure 1. This diagram is part of the planning and organization phase of the project. The figure also shows four stages: i) login, where the user's credentials are verified; ii) main page, where the basic information of the tour is shown and some buttons that allow

navigation and consultation of the different places that you want to visit.

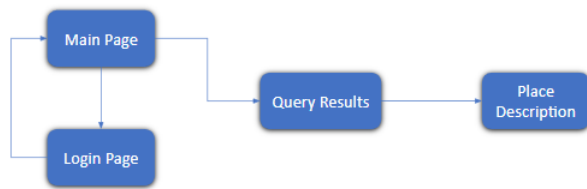


Fig.2: Project Block Diagram

Figure 2 is showing a block diagram for representing the main idea of the project. First, the user is going to see the main page. Then, the user is going to log in, if the entered information is incorrect, automatically the software will return to the main page. But, if the entered information is correct, the software will obtain the query results. Finally, the user will get the description of the wanted places.

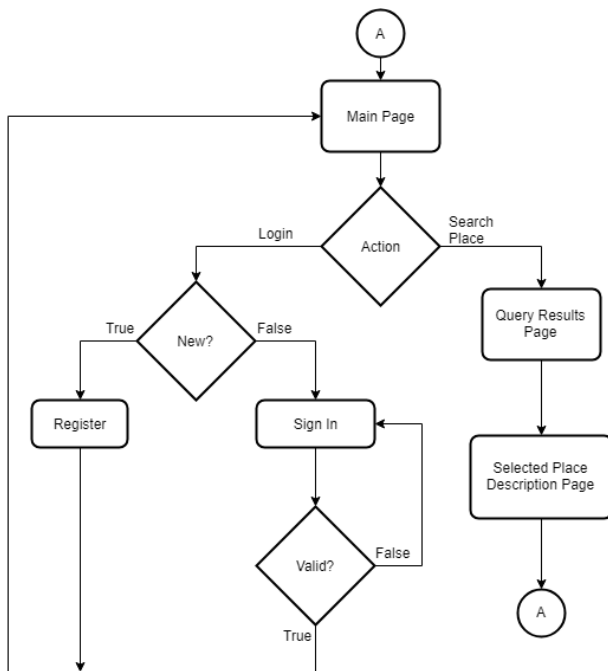


Fig. 3: Project Flowchart

Figure 3 shows in more detail the last three phases mentioned in the previous figure. As can be seen in this figure, the application allows the registration of new users, if these do not exist in the database. As it can be seen, the software is able to do input validations. Also, to users be able to try the program, there is need to make a registration. Once the user is registered, will be able to make a log in. After the log in action, users can search for any place. This type of program is infinite, so that it

cannot have an end.

MySpot-PR is a mobile application that seeks to fill a demand for a platform to help users search, discover, and visit a variety of usually unknown natural resources and tourism spots in Puerto Rico. The application will feature: A smooth graphical user interface; Map-based geolocation and offline maps; Search engine that searches with suggestions; List of Spots (Places of interest); Specific natural resource description with pictures, address, location, difficulty to get there, etc.; Developed with Android Studio & Gradle; Support for JellyBean (Android 4.1) and newer; Material design following Android Design Guidelines; All data about the Spots is stored in a local SQL database (SQL lite); Firebase Cloud Messaging (push notifications); Firebase Analytics; Navigation drawer menu with categories; Favorite Spots; Geolocation; Sort Spots by distance or by alphabet if location is unknown; Interactive map with clickable Spots; Map layers (normal, satellite, hybrid, terrain); Clustering map markers; Static map image; Navigate to the Spot; Current distance to the Spot; Phone call and e-mail intents; Open web link of the Spot (if available); Share Spot; App works in offline mode; Animations and effects; Animated action bar; Animated floating action button; Parallax scrolling effect; Quick return effect; Ripple effect; Responsive design and tablet support (portrait, landscape, handling orientation change); Support for high-resolution displays (xxxhdpi); Deep links.

This tool will help traveler to get to know better the island of Puerto Rico. Smartphones are the best devices for this task due to their nature [13]. It is hard for someone that is new to a place to find what he needs. Many people rely on GPS applications to get to a certain place they already know that exists [14]. However, with this application they will be able to get a better experience from their travel by knowing which places are available and what are those places about.

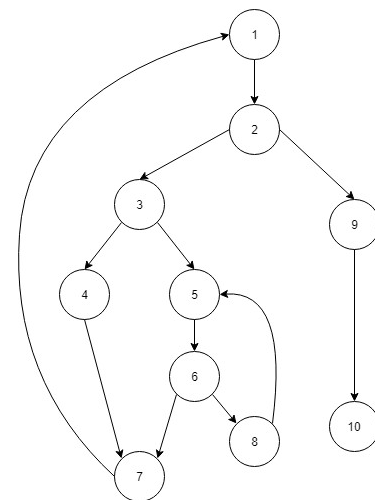


Fig. 4: Cyclomatic Complexity Diagram

The resulting diagram of cyclomatic complexity is shown in Figure 4. As it can be noted, the resulting complexity of the program is 4, which means that is a moderated complex software.

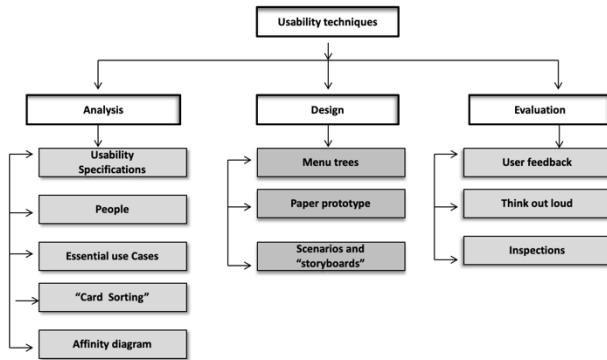


Fig. 5: Usability techniques used throughout the software development cycle

It is important to mention that usability was one of the most important objectives throughout the life cycle of the project development, it was included from the beginning to the end of it. Figure 5 summarizes the usability techniques used in the analysis, design and evaluation phase. These techniques have been widely described by [16].

In order to ensure not only quality in the present study, but also the usability implemented during the entire process of design and development of the application (as a software product), a survey was carried out that was answered by 76 people and consisted of 8 questions: i) Do You enjoy spending time connecting with nature?, ii) How often do you practice tourism inside your own country?, iii) How often do you eat at LOCAL restaurants, food trucks or any other local food service business?, iv) Do You ever get lost while trying to find a beach, river or other natural resource?, v) Will it be helpful to have a platform where you can discover and get information about new and things to do close to where you live?, vi) Do you think that eco-tourism is important for the economy of your country?, vii) As a traveler, do you prefer visiting mainstream tourism spots, or will you rather go where the locals go?, viii) Do you prefer going to the same beach or river all the time? Or will you like to vary and discover new places?

Table 2 shows the results obtained in the survey, you can see for example that 89.9% of the people surveyed, would find it very useful to use a mobile app that shows them and tells them where to find information about the "places" close to their own house, where you could meet and enjoy new things.

Table 2. Summary of the survey and percentage by type of response

Questions	Answer	%
Q1	Always	60.8
	Sometimes	34.2
	Never	5.0
Q2	At least once a month	25.3
	Every 2 or 3 months	29.1
	Once or twice a year	45.6
Q3	At least once a week	50.6
	At least once a month	46.8
	At least once year	2.6
Q4	All the time	17.7
	Sometimes	10.1
	Never	72.2
Q5	Very helpful	89.9
	A little helpful	6.1
	Wouldn't care	5.0
Q6	Definitely	96.2
	Not at all	1.6
	Doesn't make a difference	2.2
Q7	Mainstream tourism	12.7
	Local	13.9
	A little bit of both	73.4
Q8	Same place is fine with me	17.7
	Discover new places	79.7
	I don't enjoy the river/beach	2.6

Although the application is not yet "online", usability tests were done, specifically in the evaluation part. The evaluation was made with 64 people, who used telephones that had previously been installed in the app. The test was done in two phases, the first was a brief explanation by one of the developers of the application making a projection of the cell phone screen, so that people could see each of the screens, buttons, links, maps, etc .; the test consisted of looking for a restaurant, a beach in a specific place or place and sharing the information of the place with a group of friends. The second phase was to observe the process performed by each person and their subsequent feedback.

Taking into account that all 64 participants had some experience in the management of a cell phone, it could be observed, for example, that 96.0% could finish the tasks without complications and in an average time of 2.8 minutes. On the other hand, the feedback obtained from the participants 67.0%, point out that in some of the navigation screens of the application, the texts included in the images do not have an adequate color and present some difficulty to read them.

VI. DISCUSSION

The implementation of a hybrid model for the development of applications such as the one proposed in this research may prove to be very convenient. Agile methods are great for small developer teams with good communication with their clients for the decision making [15]. The study showed that it is faster to implement hybrid methodologies. The process of concurrent meetings led to

an improvement in the idea and the phases of development of the project. Another important aspect of the HWF-PR was to emphasize what was expected or not from the software. Many applications focused on tourism do not take into account factors such as: constantly updating the software, hang-out places, tourist sites, parks and theaters, which attracts all types of users who want to explore a place for the first time.

The first foundation of HWF-PR is the Shewhart Cycle, which in turn has three phases (plan, do, check) and the foundations in the Waterfall formalism, the group creates a general coding scheme throughout the development of the project that includes four major areas: processes, practices, people and social and technological dimensions. From this, the other foundations of the HWF-PT were worked on (agile methods, agile practices, usability), see table 1.

Taking into account the agile practices determined by Scrum and XP, the design was made under which the project is seen, this included two areas: Discovery and creation of products separately; and iterative and incremental design and development. This includes a development group to generate value for the product, with a high degree of usability, which can reach the permanent feedback of the users.

The final result shows the following: i) Deliveries from the third week of work, with intervals of every three weeks; ii) Total deliveries made throughout the project: 4; iii) Two reports were generated during the project, both with a good level of detail.

Although the two groups completed the minimum allowed, it is important to note that the experimental group used as a technological tool Visual Paradigm and Jira, while the control group used Sprintometer and Trello, however although the experimental group reached 85% of the total implementation of the project, the prototype of it led to 100%, that is: i) all the diagrams according to the rules; ii) model E-R; iii) flow chart and flow graph; iv) cyclomatic complexity; v) generation of independent roads; vi) design of test cases; vii) use cases; iv) requirements diagram. On the other hand, the control group although it reached 90% of the implementation of the project, the test cases were not 100%, the requirements presented inconsistencies and, in some cases, duplicate requirements, the prototype was not 100% either, this possibly as consequence of inconsistencies in requirements and tests.

For the implementation of the mobile application, if we wouldn't have used this methodology our development would have been greater. In case we would have opted to use an agile method, there still the chance that the resulting application doesn't met the requirement nor the client expectations. Therefore, the combination of agile

methods with agile practices increase the probability for the project to be a successful one.

While it's important to reduce time, we can't ignore the value of usability of the resulting application. In general, with the flexibility of the methodology used, it was possible to save time and have a clearer idea about the quality of the project. In addition, the methodology was useful for a small team like ours made up of two students. By emphasizing the stages of plan, do, check, and act as the life cycle of the project, it can be concluded that the final product of the software will be a complete one and revised from the beginning until the end.

VI. CONCLUSION

In the Hybrid Framework of Work for Puerto Rico (HWF-PR), it proposes to integrate the traditional Waterfall methodology with "agile practices" and usability; this within a framework of collaborative and flexible work, that makes use of open source tools, so that the people involved in the process of developing a software project visualize it as a more facilitating tool, that will serve as a guide, improve its practices, streamline processes and guarantee the achievement of good results. Developing this, time of software through this methodology, would represent a saving of time and efforts. The flexibility to make corrections at any time can represent improving ideas and developing a better product.

VII. FUTURE WORK

The future work that this project will have will be to develop desktop and mobile applications first. In addition, it is being thought that the project is not limited only to the capital of Puerto Rico, San Juan; but that all the towns of the Island can be covered. It is important to give a real tourist experience to the users about Puerto Rico. This would require a larger database and a better GPS range.

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