# A Software Development Methodology to Extend E-Services to M-Services (eM$^2$ethodology)

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*Abstract*— **Nowadays smart phones play an important roll between business and users. Therefore, businesses decided to go mobile. Municipalities and organizations that provide services to the public through E-Services will benefit from utilizing mobile features along with choosing the appropriate development approach. Services will be more users friendly and will reach more citizens.**

**Developing in house M-Services that mirror E-Services need to be handled systematically through a software development methodology. As a step forward in this direction, we propose eM$^2$ethodology (Electronic to Mobile methodology) to extend E-Services to M-Services. The methodology is based on existing methodologies in two fields' web development and mobile development. The reason behind choosing these fields is that the methodology should be able to transfer and extend the E-Services of an application to M-Services. The methodology concentrates on minimizing the risk of failure and delivering the project in an efficient time.**

**We validated the methodology by transforming E-Services of Omani public authority of consumer protection website into M-Services as a mobile web application. Validation is on progress as this is ongoing research. Moreover in the future we are going to validate the methodology against other development approaches.**

*Index Terms*— **E-Service, M-Service, Software Development Methodology, Web application, Mobile application**

## I. INTRODUCTION

Recently, the high adoption of mobile computing toward creating M-Governments, M-Marketing, M-Commerce and M-Learning [1, 2, 3] raises the attention of extending E-Services to M-Services. E-Services are the services offered over the internet. M-Services are defined as the type of service that can be accessed via mobile device and which is delivered by the interactions between organization and customer [2]. The ubiquity and mobility that are provided by different technologies such as wireless in the highly influential adoption of mobile phones [4, 5] made governments, organizations and companies "transform their activities according to this demand of convenience and efficiency of interactions for all parties" [4]. This is done by enhancing their produced web-based services (E-Services) [4] to M-Services. The goals of the extension are to increase revenue, reduce costs, enhance performance [6], be proactive, reach a wide range of users and provide effective and up-to-date services [1, 4]. Moreover, organizations and companies which are interested in extending their E-Services to M-Services must have some guidelines in the development process of such applications in order to achieve the previously mentioned extension benefits.

The guidelines are used to structure, plan and control the process of developing the application, which is known as a software development methodology [7]. The traditional approaches come under software development life cycle (SDLC) which focuses on process and quality of software. Nowadays, an agile software process is being widely used although "agile process follows software development cycle" [8]. It is a combination of iterative and incremental approaches where requirement can be changed according to customer need [8]. It is enough to say that "each of the available methodology framework is best suited to a specific kind of project" [7]. Web development projects methodologies differ from software development methodologies, because they are designed to fit the nature of the web. Extending web-based services to a mobile phone as M-Services is achievable through several existing methodologies. They need some adjustments to solve the adaptability problem of viewing services within websites in different mobile screen's size [5] and provide user friendly services through the development of mobile web applications.

The goal of the apparition of mobile application is to provide facility for the users through accessibility of services (marketing, commercial, technical etc) everywhere and anytime. But, the quality of the mobile application must be at the same level of web application because the final aim is to guarantee the comfort to users. So we must not just transmits the web application to a web mobile application but also ensure the same level of quality.

To ensure the quality, we don't need to look far. As the M-Service was inspired from web application the guaranty of quality is inspired too from the guaranty of web application, although the quality factors may be different.

The quality of the web application is based on methods and methodologies of the application construction. But we must look at the incremental and iterative one because the mobile phone application is a set of small functionalities so is already divided in services. Requirements of users change and grow rapidly so we

must adopt an agile methodology and adapt it to the mobile application.

In this paper, we propose a software development methodology to extend E-Service to M-Service which is a combination of existing methodologies that provide benefits for both businesses and users. To businesses, the proposed methodology provides a cost effective solution, reduce risk of failure and deliver the product in an efficient time. The objective of the methodology along with using mobile web application development approach is to help companies and any other organizations to make their services reachable to more audience by making the service user friendly and adaptable with different screen devices. The major advantage over implementing M-Services by developing mobile web application is that you are developing a cross-platform application which will suit all different platforms [9]. Hence, this will support the intended extension goals, which are previously mentioned. The main features of this methodology are: (1) it is based on a combination of approaches of web and mobile methodologies; (2) the input of the methodology is the E-Services provided by the official website. (3) the development process is iterative and incremental to increase the speed of the development, (4) the product of this methodology is a mobile web application. The methodology is validated via extending Omani Public Authority for Consumer Protection (PACP) website services into mobile web application and further validation is in progress.

The rest of the paper is organized as follows: Section II provides the literature review. Section III represents the used approaches to create the methodology. Section IV illustrates the developed methodology to extend E-Services to M-Services by developing a mobile web application. Section V shows the case study which validates the methodology steps. Section VI explains related work and finally Section VII provides conclusion and future work.

## II. LITERATURE REVIEW

### A. Existing Methodologies

Methodologies are variants depending on the development field. Agile methodologies become the new approach to software development [10]. They are often used in modern web 2.0 applications, but others argue that it could be suitable for any other field [11]. They were developed to overcome the traditional methodologies drawbacks and to provide fast, cheap and flexible development process [12]. The main development features of agile methods are simple design principles, a large number of releases in a short time frame, extensive use of refactoring, pair programming, test-driven development, and seeing change as an advantage [10]. Agile focuses on dividing the work into small portions and process them iteratively [13]. As a result, using a mixture of agile methodologies with other plan-based methods will be able to provide us with best development practice for any field [10].

We believe that like any other development field, extending from E-Services to M-Services requires a

specific development methodology. There exist development methodologies for services in both the web and mobile fields. Regarding the web development fields, FDD and the developed methodology by Debra Howcroft and John Carroll are ones which were used to develop services for the web applications [14, 15]. Basically, FDD is one of the agile methodologies that depends on a short iterative process. Effectively, it is used for the development of one feature at a time. It plans, designs and builds the feature and moves to the next one iteratively [14]. The developed methodology by Debra Howcroft and John Carroll exists too as a supporter to the iterative feature development [15]. This methodology was developed based on various web based development methodology. It depends on author's experience in the websites development field [15]. Furthermore, methodologies that are used for mobile development field use agile characteristics too. These methodologies include: Mobile-D methodology [10] and lead mobile enterprises methodologies [16, 17]. With these methodologies we feel the extension from web-based services to mobile-based services still requires a specific development methodology that is able to gather the features of both fields.

### B. Development Field

The development filed of extending E-Services to M-Services depends on the used mobile development approach. Specifically, there are three main mobile development approaches which are mobile native applications, mobile web applications and hybrid applications [9]. Native mobile application is an application for a specific device and precisely for a specific platform (iOS, Android, Windows Phone, and BlackBerry) [18, 19]. Mobile web applicationis accessible through the mobile browser [9, 18] and hybrid applications are mobile web applications, which are embedded inside a thin native container [9]. We can notice that each approach has different characteristics than the other which illustrate the need of having different development methodology for each one of them.

In this case, we preferred to focus on the mobile web application or HTML5 mobile application approach, since its product is a cross-platform application which will suit all different platforms [9]. Today, there are many things enhanced the development of such applications. For example, there are great frameworks which support developing mobile web applications with amazing features such as, iScroll, JQuery and Sencha Touch [9]. Hence, user will have the best practice since applications will be having a more native look. Moreover, World Wide Web consortium (W3C), the primary Web standards organization is dealing with many browser vendors, mobile phone manufactures and operators to provide devices features accessibilities via browsers [20]. In addition, security concern is quite little, and it could be handled by cashing files on the device or by encryption of the database [9]. As a result, from our point of view, the development of HTML5 applications has a great chance to spread out the ability to reach many users definitely. After illustrating the purpose of the chosen mobile web

application among other approaches, we can now describe the approach that we used to develop the eM²ethodology to transfer E-Services to M-Services.

### III. eM²ETHODOLOGY APPROACH

The approach contributes to the area of E-Service requirements analysis by taking a consumer and process centric perspective. That is, requirement elicitation activities for designing E-Services need to broaden their scope and also consider the E-Services' impact on the consumers' business processes. E-Service needed within a service interaction in order to use a specific E-Service.

Additionally services which place extraordinary requirements to the mobile networks are identified, and an overview is provided of the predicted requirements set by the new services. The majority of mobile data services that are in use today require some sort of infrastructure; for the SMS service, this infrastructure is provided by the SMS Centers (SMSC) owned and operated by the mobile carriers.

The advanced mobile data services, based on a much more open architecture, are more likely candidates for witnessing the emergence of non-operator competition.

Therefore, in order to develop web application or mobile application, requirement are gathered as first step. Fig. 1 shows that E-Requirements are end user requirements to develop web application. M-Requirements are end user requirements to create mobile application. Since the development for each area is different, non-functional requirements can differ in timing, performance, reliability, security, cost and possibly other defined constraints as described above.

For simplicity the methodologies used to develop web application are referred to as E-Methodologies. However, Methodologies used to develop mobile application are referred to M-Methodologies. Some of the methodologies are mentioned in the literature review (see Section II). We can see that to develop E-Services as web application can be done directly using the E-Methodologies, the same for developing M-Services. Using eM²ethodology we have a new approach, ready E-Service (website) can be transferred to M-Service without the need to collect requirements again from users.

This methodology is designed for in-house projects to transfer and extend their web based services into M-Services. It takes as inputs E-Service (website), which goes through systematic steps to finally produce M-Service through a mobile web application. Consequently, in order to enhance reachability and usability of the service, eM²ethodology combines methodologies from two fields' web and mobile to produce as M-Service a mobile web application. Specifically these methodologies are mentioned in the literature review (see Section II).
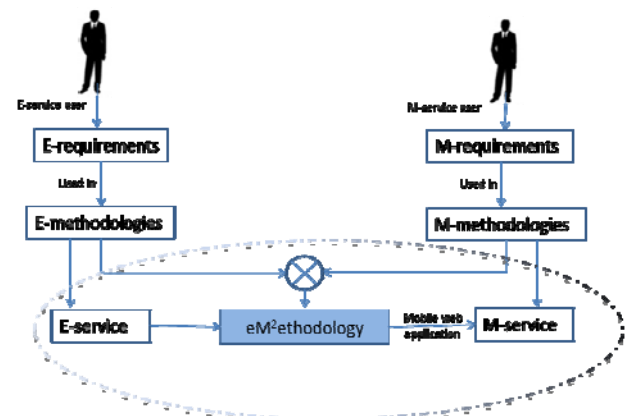
Fig. 1: eM²ethodology approach

Using such approach allows us to combine the best practices of both application types and utilize maximum benefits as possible. The need for methodologies from web and mobile fields comes from using mobile web application development approach, which relies on the web and has some access to mobile features. Therefore, the proposed software development methodology can be used to transform E-Services to M-Services by developing mobile web application.

### IV. eM²ETHODOLOGY FOR WEB APPLICATION

The eM²ethodology as mentioned previously is composed of methodologies from both fields: mobile and web based application. The methodology inherited the characteristic of agile development methodologies. The methodology helped in reducing cost of testing, producing quality product and speeding up the delivery process of the products. Using the incremental approach, the website is divided into smaller services to be implemented. A unit testing is preformed along with continues integration. Fig. 2 shows the methodology with its phases. The phases of the methodology are described as following:

#### A. Feasibility Study Phase

It is a short period phase, where a website is ready to be extended to a mobile web application. Requirements are gathered directly from the website. Tasks associated in this phase are: project planning, requirements collection and resources collection. The language to be used to develop the application is decided in this phase too. Finally, we study the nature of the service that is needed to be extended. Whether it suites mobile web application or not? If yes we can go to the next phase, if no then try to select other approaches such as the development of native or hybrid apps.

#### B. Analysis Phase

A study is taken in this phase. This study will show how the application will improve the provided services. Moreover, this study will try to reduce risk of not being aligned with the business plan. It should clearly be mentioned how this extension will help in reaching where the organization, company or enterprise wants to be. After doing the study the services that are to be mapped

are to clearly be documented from high priority to low. This will help in identifying the good services that will be extended to the mobile web application and knowing the companies that can benefit from the usage of these services. A use of certain modeling techniques like use cases will help to summarize the services of the application and will provide a clear idea how the system should be designed and implemented. A list of functions or use cases will be as an input to the next phase (Service Generation phase).

To accomplish this phase the following questions must be answered:
- What are the objectives of your application and how they will be aligned with the business plan?
- What are your application functions and their scenarios?
- Who are your targeted users and what is their technology status?

*C. Services Generation Phase*

Services generation phase is a crucial phase. It is the core of the methodology that shows the agility features. The idea of this phase is to handle the development of each application service in iteration. The iteration process will go through several steps which are service design, service implementation, service testing, service integration and validation. The generation phase consists of two sub phases which are initialization and iteration process. The iterations will handle the services therefore, we say that the iteration process will end after N iterations. N is the maximum number of services could be implemented in the mobile web application. In the initialization phase, the template of the mobile web application is prepared. Services are then integrated together in it one by one facet in an incremental way. Iterations will continue until all services are integrated with each other. Before an iteration process starts we set up couple of things in the initialization sub phase as following:

**Initialization Phase** is an initialization step (iteration 0) that has to be done before we start iteration process. In this sub phase we choose the implementation tool or framework and develop the main template that will work as a container for the service. Test plan is generated in this sub phase. This test plan will be applied to test the services after implementation in different environments and different technologies. Then we create the Domain for the web application to be stored in a web server to do all the integration together with the validation. At the end of this phase, we will choose a service to start with. Services are organized by priority. Therefore, we will first select the highest priority.

These are the questions that might be answered at this point:
- What is your development tool?
- How will the mobile web application look like?
- What is your acceptance test?
- What is the web server you want to use for your website?

- Which service you will select to start with?

**Iteration Processes Phase** in which services are designed, implemented, tested and integrated with each other. The iteration process consists of four steps as following:

**Service Design:** the interface design of the service and all other graphics requirement along with it are done. For example mapping from the formal website the main design requirements such as the colors used, the icons used and the positioning. In addition, the way of template demonstration should be considered. UML design is also provided for the services if there is any connection with database or other complicated scenarios. Documentation of this phase is done.

**Service Implementation:** implementation of the service starts by using HTML5, java scripts and CSS3 for best results. Programmer should apply W3C mobile web best practices for best practices toward successful mobile web application. The guidelines are available freely on the internet.

**Service Testing:** unit testing is carried out by testing the service inside the template alone then apply the testing plan on it. The testing team should ensure that service is functioning correctly against different browsers to address compatibility issues and in available emulators to usability of the service. Bugs and errors if any should be corrected here.

**Service Integration and Validation:** integration is done with all previously implemented services in the template. Therefore we ensure no service can affect other services and integration is done successfully. Upload the service temporary in a webserver to validate it with users and project manager. For better results, it should be validated with more users via an online survey associated with a link to the services.

*D. Application Release Phase*

In this phase it is expected that the product is ready to be released. Since we have the mobile web application as the product of the methodology, we can release the application to the former web server that can then work in parallel with the extended website.
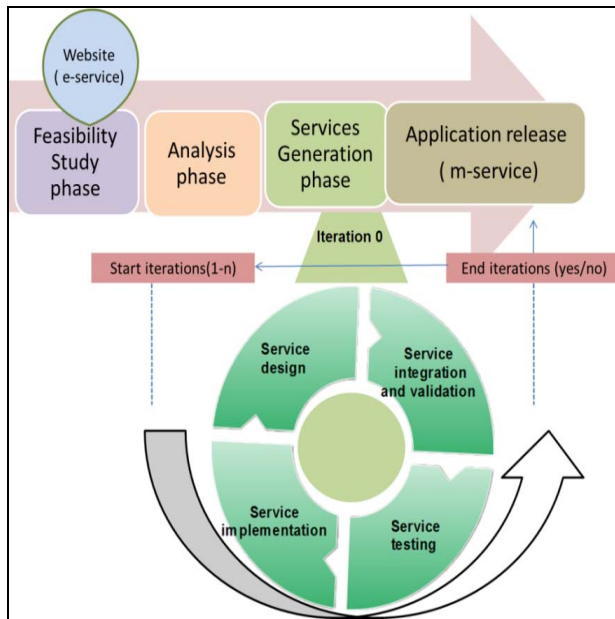
Fig. 2: eM$^2$ethodology

The methodology explained above is characterized by dividing the application to smaller manageable services. Each service is designed, implemented, tested and finally integrated after validation with the rest of applications resulting in reducing the chance of application failure. Documentation is done at each phase. Moreover, a significant increase in productivity of teams causing to reduce the time required to release the quality application. To validate the methodology we have chosen PACP (Public Authority of Consumer Protection) website as a case study. So we can extend its services into a mobile web application.

## V. CASE STUDY: MAPPING PACP WEBSITE SERVICES INTO PACP MOBILE WEB APPLICATION

In order to illustrate the process of the methodology, there must be a clear case which needs the extension process. We could find the need for extending the provided E-Services in PACP website to mobile web application after doing some investigations and analysis. We can illustrate what we have done briefly in each phase.

### A. Feasibility Study Phase:

The PACP website is the official website for the Omani Public Authority for Consumer Protection. The services provided in the website are extension to some manual services, which are provided in the newspapers. For example the index pricing service, which is a list that contains consumable registered prices in many markets across the country. The need to extend the PACP website services to M-Services is valuable due to the benefits that both consumers and the authority will gain. The authority services will be more reachable and usable by consumers. As a result, we decided to take the website as our case study and started the development process of their mobile web application.

### B. Analysis Phase:

In this phase, we planned to examine the current state of Omanis using smartphones and the state of the current provided services. Therefore, we used a questionnaire. The questionnaire is distributed to a sample of 131 people who were selected randomly from different Omani regions. The participants in the study were 56 males compared to 75 females who were from different age ranges. The questionnaire is composed of two parts. In the first part, we wanted to know whether users in Oman have the well to use M-Services. The other part is to discover whether the provided services by PACP website need to be improved.

Since we are using HTML5 in the development of the application, we need to check whether the people have the technology that will support it. We asked the participants about their phone type whether it is smart phone or not. We have found about 77% of them are using smart phones. Hence, the mobile web application will be reachable and usable, since the majority of the participants will be able to install modern mini browsers in their smart phones and access the application. In the second part of the questionnaire, we have examined the improvement needed of PACP services. We have found that around 53% of the participants prefer to improve the authority services by extending them into mobile phones. The rest of the participants preferred using newspapers and computers.

After making sure of the two perspectives which are the people ability of using the mobile web application and the need of improving the authority services, we decided the services that we are going to implement in order to improve the services. The services are as following:

- Pricing index: shows the consumable prices index based on region, month and market.
- Latest news: shows the recent news about the PACP.
- Media center: contains some videos to raise awareness.
- Inform us: submits a direct message to the PACP about any manipulation in the prices or expiry date.

Some other functionalities were added such as connecting with social networks and enhancing searching methods. As a result, we got the services that must be implemented in the application and we ensured about their need ability.

### C. Services Generation Phase:

Generally, in this phase we did two iterations and the initialization phase. The outcomes from initialization phase were as following, the graphical design, which is inspired form of the website was prepared. Then we started to implement the container. The container viewed like a template in which services will be implemented inside. We selected Dreamweaver CS6 as Implementation tool, since it provides many different frameworks to implement like languages JQuery and support languages like HTML5, CSS3 and JavaScript. We then produced the testing plan, which is based on three steps: first, testing the application on desktop browser. Second, test it using emulator and finally test it on real phone. The last

outcome of this phase was to install the code using a free online web host such as 000webhost.com.

The first iteration handled the development of the application home page. This iteration is important since it links all the services together. The implementation of the home page will go through the four main basic steps of the services generation phase which are service design, implementation, testing, and integration and validation. By reaching the last step, we can say that one iteration is finished. The left part of Fig. 3 shows the result of the first iteration. The second iteration went into the previously mentioned steps to implement latest news service and its result can be shown in the right part of Fig. 3. The iteration process is continued until implementing all application services one after the other. By implementing the last service, we could say that we finished the generation phase and the application could be released. In this section, we showed the methodology steps in our chosen case study of the PACP website briefly and we had a closer look to the process of the methodology.



Fig. 3: Interface of service page

## VI. RELATED WORK

The work presented in the paper is based on a development approach which used methodologies that undergoes agile software process from both web and mobile fields. Therefore, we combined the best practices from these methodologies which are as following: Feature-Driven Development (FDD) [14], proposed methodology by Debra Howcroft [15], IndiaNIC enterprise methodology [16], mobile-D [10] and 1-minus-1 company mobile methodology [17].

To extend E-Services to M-Services these methodologies cannot be used as standalone methodologies. We summarized their limitations as following:

- The requirements or services are collected directly from end user as in [10, 16, 17]. We considered this as a limitation since it is not required by the extension process. We do not need to get the requirements from users. They can be gathered directly from the website, since

it is the required input to extend its services into mobile web application.

- Most of the methodologies that are used in the web application field do not apply W3C design standard as has been stressed in the web best practices [21].

- In some of the methodologies, there are many intermediate steps regarding establishment of stakeholder trust and agreements like IndiaNIC [16] and 1-minus-1[17] methodologies.

- The testing procedure is expensive due to the testing of the whole application at once like in [16].

- These methodologies are not specifically used in the development of mobile web application.

The methodologies are effective in their corresponding fields. Therefore, we combined the best practices of all of them and inherited the characteristics of agile methodologies to create one methodology that makes the extension effective, costless and produce quality mobile web application. Consequently, we tried to cover the gaps of the methodologies and provide one methodology which enhances the extension process and makes organizations or companies more proactive in their sector.

## VII. CONCLUSION AND FUTURE WORK

All in all, companies and organizations usually extend their E-Services to M-Services using a third party. Therefore, we propose a methodology for in-house development to extend E-Services to M-Services.

The methodology is a combination of existing methodologies in two fields: mobile and web development. The project of extension is divided into smaller manageable parts. Delivery of the project is efficient and risk of failure is reduced.

The importance of making the service reachable to audience comes from the mobility that smart phones provide. Therefore, choosing to implement the services using mobile web application will imply having user-friendly application.

The methodology is validated by extending PACP services. Further validation is on progress.

In the future we want to test the methodology with other development approach like hybrid approach, which is considered as a next stage after mobile web application.

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