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Design and development of a developer Kit for the realization of a SIM-based app: the case of Telecom Italia

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Design and Development of a Developer Kit for the realization of a SIM-based App: the case of Telecom Italia

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Sommario

Il presente lavoro di tesi è il risultato di un progetto condotto per conto di Telecom Italia, con l'obiettivo di realizzare un kit di supporto allo sviluppatore di "SIM-based App".

Le "SIM-based App" sono un particolare tipo di App che memorizzano dati sensibili su SIM con la possibilità di renderli disponibili mediante la tecnologia NFC (Near Field Communication). Nel progetto sono state condotte valutazioni tecnologiche e di business, analizzando i fattori dell'ambiente interno ed esterno che hanno condotto alla nascita del progetto, studiando gli e-wallet, i developer kit e servizi SIM-based e applicando il processo di Quality Function Deployment (QFD). A valle di tali attività, è stato possibile definire la soluzione concettuale del developer kit: una App che emula il "secure element" presente sulla SIM, una App che testa il funzionamento dell'emulatore e un sito web di supporto allo sviluppatore. In seguito, ogni singolo componente è stato progettato dapprima a livello architetturale e, successivamente, nel dettaglio. Infine, i componenti sono stati sviluppati e testati, inglobando le proposte di miglioramento emerse nel corso di tale ultima fase.

Abstract

The following thesis work is the result of a project developed on behalf of Telecom Italia and aimed at the realization of a developer kit to support the development of a SIM-based App. A "SIM-based App" is a special App able to store sensitive data on a SIM card making them available through NFC (Near Field Communication) technology. The project started from technological and business assessments in which internal and external environment factors were analysed, including the study of e-wallet, developer kits and SIM-based services with the application of the Quality Function Deployment (QFD) process. At the end of these activities, it was possible to define a conceptual solution of the developer kit: an app emulating the "secure element" contained in a SIM card, a Service App testing the emulator and a website to support the developer. The last step was the architectural design, followed by a detailed characterization. Finally, each component was developed and tested taking into account suggestions for improvement emerged during this last phase.

1. Context and goal

This thesis is the result of a five-month educational program called “Junior Consulting” carried out from November 2014 to April 2015 by Elis Corporate School (ECS) and the companies of the “Consorzio ELIS”. The project assigned to the candidate, called “Mobile Wallet developer kit”, was commissioned by the Strategy and Innovation function of Telecom Italia, one of the main telecommunication companies in Italy operating in the field of fixed telephony, Internet access and mobile telephony under the brand TIM. TIM is very committed to NFC related services including Retail/Digital Market Areas; TIM is also working with all relevant stakeholders to build an ecosystem suitable for the rollout of mobile services designed to support retailers’ digital commerce activities. Great effort is also spent in participating in the main SDOs (Standard Development Organizations) such as ETSI, 3GPP, Global Platform and GSMA. The project was born from the company’s need to take advantage, as a mobile operator, of the steady growth in the smartphones market and the spread of NFC technology. So, Telecom Italia intends to take advantage of this business opportunity using its own assets, optimizing this new technology integration ability on its own SIM. In detail, Telecom Italia wants to support the development of the SIM-based App (apps that store sensitive data on the SIM Card and make them available through NFC technology).

2. Project structure

The project management was based on the goals to be achieved, the resources and available time. The project followed the macro-level activities and milestones are shown in the Gantt chart (Figure 1).

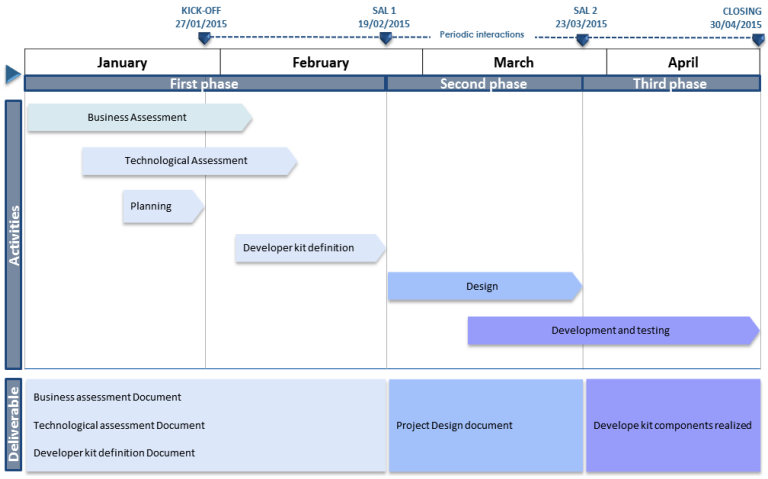

Figure 1 - Project Gantt chart

Each phase produced a specific output that was delivered to the client during the planned meetings, also shown in Figure 1. The first phase was characterized by a technological and

business assessment to get a better understanding of the context in which the product is a part. At the same time, a macro-level "planning" activity was carried out to define a plan for the deployment of the entire project. The results of previous activities and the insight into the market and technologies led us to define the configuration that best meets the requirements (i.e. developer kit definition). This was followed by a macro-level design activity to outline the essential operational lines of each component and their initial development. In the third phase, the development of all components was completed and the developer kit prototype was released during the closing meeting.

3. Activities, objectives and methodology

Table 1 and Table 2 report information about the first phase and the second and third phase respectively, which may help the reader to better understand the deployment of macro-level activities, objectives and methodology.

FIRST PHASE			
Macro activity	**Sub-activity (Thesis Paragraph)**	**Objective**	**Methodology**
Technological and business assessment	Analysis of project context (§ 1.3)	To understand the reasons why the consulting project was born and as-is state of main correlated elements	Through interviews with referents, by Telecom Italia and other main sector websites and through business reports, the assets and vision of the company were investigated, as well as its external market correlated to the project goal. Then, an insight into the main elements involved (SIM-based App, developer kit and e-wallet) was reached through scientific contributions about these topics using websites such as Google Scholar, Global Platform., GSMA, Gemalto, IDC, Dupress
	Quality function deployment (§ 3.1)	To assure a unique perspective, to find the best product features and finally, to integrate the assessment documents	To start with the product's main stakeholders were identified through brainstorming and then their expectations were collected and listed through interviews, surveys, focus groups and brainstorming. Then, the required needs were translated into measurable product characteristics. Subsequently, the perceptions of competitive performance were estimated according to the previously identified customer requirements and characteristics. Finally, the HOQ (House of quality) was built as the conceptual map of the collected data.
Planning	Project setting (§ 1.2)	To share a project plan with the client and to obtain their validation	Through brainstorming based on the project definition document, some examples of projects, the total timescale work plan and team member skills, the project management tools were used to show the background, goals, governance, macro-level activities, milestones and deliverables of the project.
	Work breakdown (§ 2)	To simplify the work execution with a shared plan between team members	At first, through brainstorming based on Kick-off power point presentation and on project context SWOT matrix, the deployment of macro activities has been defined. Then, the project evolution has been illustrated on timescale based on the planned deadlines, giving information about activities interconnections (PERT logic) and about input and output of each activity.
Developer kit definition	Definition of product concept (§ 3.2.1)	To define the best product concept based on technological and business drivers	Brainstorming based on repeated cross checks between the rooms of HOQ (Figure 6) and on technological and business assessment documents allowed the identification of some possible product concepts. Then, they were evaluated and finally, a unique product concept was chosen though a qualitative assessment based on trade-off considerations of all the stakeholders involved.
	Definition of component requirements (§ 3.2.2, § 3.2.2)	To draw the guide lines for the design of each component	Specific studies on the market and technologies made it possible to detail the concept chosen and to obtain the final product concept and the design requirements of its components, validated by Telecom Italia during the first project review meeting.

Table 1 - Project Approach during the first phase

SECOND and THIRD PHASES			
Macro activity	Sub-activities (Thesis Paragraph)	Objective	Methodology
Design	Architectural design (§ 4.1, § 4.4.1,§ 4.4.2)	To obtain a general structure of the product	Starting from the product specification (summarized in Figure 7) the architectural design was carried out using a mockup to represent the website structure and its sections, thanks to the utilization of use case diagrams and flowcharts to underline respectively the tasks and the sequence of operations performed by the two applications.
	Detailed design (§ 4.2, § 4.3, § 4.4.3)	To obtain a specific and detailed design for each module	The detailed design of each component is obtained, starting from the decision taken during the architectural design, mainly thanks to tools offered by UML (unified modelling language) for a synthetic and comprehensible representation and for its collection of best engineering practices.
Development and test	Development of each component (§ 5)	To realize the components according to the selected technologies, the logics fixed and improvements notes	Based on the design document and according to the principles of an agile development, the components were developed including notices of bugs or improvements from the testing activity. The two apps are developed using the Eclipse IDE (integrated development environment) with the Android development plugin. The website is developed through WordPress CSM (content management system) and the installation and customization of its plugins to implement specific functionalities.
	Testing (§ 5)	To obtain improvement notes or suggestions linked to the right and effective working of every single component	Through regular feedbacks, a test was conducted of every single module. Then, a system test was performed to verify that the Service App and Emulator, that work alone, are able to work together. Afterwards, an integration test was carried out to confirm the correct working of website when each module and other downloadable elements have been loaded into the website server. These tests are supported through a form provided by referents to keep alignments on bugs or notes. Finally, a user acceptance test (UAT) was carried out by potential end-users and by referents to test all the functionalities of the "developer kit".

Table 2 - Project Approach during the second and third phase

4. Results

The data are reported in §§ 4.1 to 4.6 and give the reader the key for interpreting the actions carried out to achieve the objectives described in Table 1 and 2, the outputs, the results and the role of the candidate for each action.

4.1 Analysis of project context

Sub- activity	Actions	Role of the candidate	Output
Analysis of project context	Study of internal environment	R	• SWOT matrix (Figure 2) • TOWS matrix (Figure 3)
	Study of external environment	R	
	Insight into the project key elements: • SIM-based services • Developer kit • E-wallet	R	• Business assessment document (Draft v.0.1) • Technological assessment document (Draft v.0.1)

Table 3 - Analysis of project context: Output ("R" means for responsible)

The schematic analysis of the project context was an essential task, because initially the Client did not express a definite idea about the components that had to be realized for the developer kit and also because many topics were linked with the project purpose. The SWOT matrix in Figure 2 provides a brief summary of the data collected about the project competitiveness context highlighting internal strengths and weaknesses as well as,

opportunities and threats of the external environment correlated to the project purpose: development of a kit supporting SIM-based app developer.

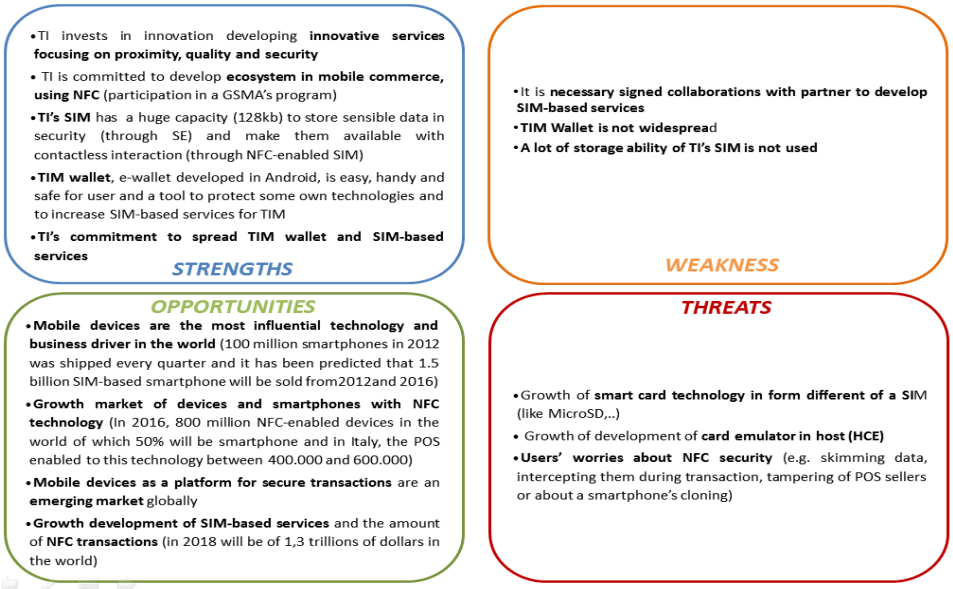

Figure 2 - SWOT Matrix ("TI" stands for Telecom Italia and "SE" stands for Secure

The TOWS matrix in Figure 3 helps to streamline the decision-making process that led to setting the final project goal: the realization of developer kit to encourage and to facilitate the development of SIM-based services, at first, independently from an operator mobile without any commercial agreement between Telecom Italia and a third party.

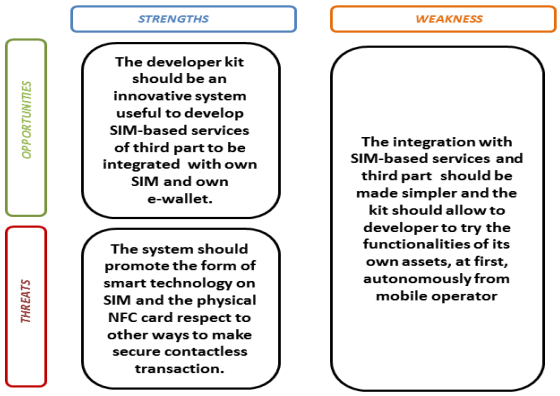

Figure 3 - TOWS Matrix

4.2 Planning

Sub-activity	Actions	Role of the candidate	Output
Project setting	Definition of project goals	R	• Kick-off power point presentation: ▪ Project Gantt Chart (Figure 1) ▪ Project RACI Matrix ▪ Collaboration areas with Client (Table 5) • Project poster
	Definition of governance	R	
	Development of project work plan	R	
Work breakdown	Static deployment	R	• Project WBS (Figure 4) • Team member responsibility allocation • Activities Diagram (PERT logic) for each phase • Activities Diagram (I/O information) for each phase
	Definition of responsibilities	R	
	Dynamic deployment	R	

Table 4 – Planning: Output ("R" means responsible, "C" means collaborator, "I" means informed)

The Gantt chart shown in Figure 1 and validated by the referent during the Kick-off meeting was one of the main results of the project setting sub-activity. For each macro-level activity shown in the Gantt correlated to the project "execution", the areas of collaboration with Client were defined as shown in Table 5.

Project key moment	Phase	Macro activity	Area of collaboration with the client
Execution	First phase	Business and technological assessment	Sharing of know-how
		Definition of developer kit	Sharing of technical documentation, alignment on requirements and validation of the output documents
	Second phase	Design	Alignment on design and advice on the strategy to be adopted in the development
	Third phase	Development and test	Support with a test environment and prototype validation

Table 5 – Collaboration areas with client

Through a brainstorming based on kick-off power point presentation and on SWOT (Figure 2) and TOWS (Figure 3) matrices the macro-level activities of the Gantt chart were deployed first into sub-activities and then into actions. The responsibilities were assigned for each action. The static deployment of workload is condensed in the project WBS (Work breakdown structure) Diagram in Figure 4.

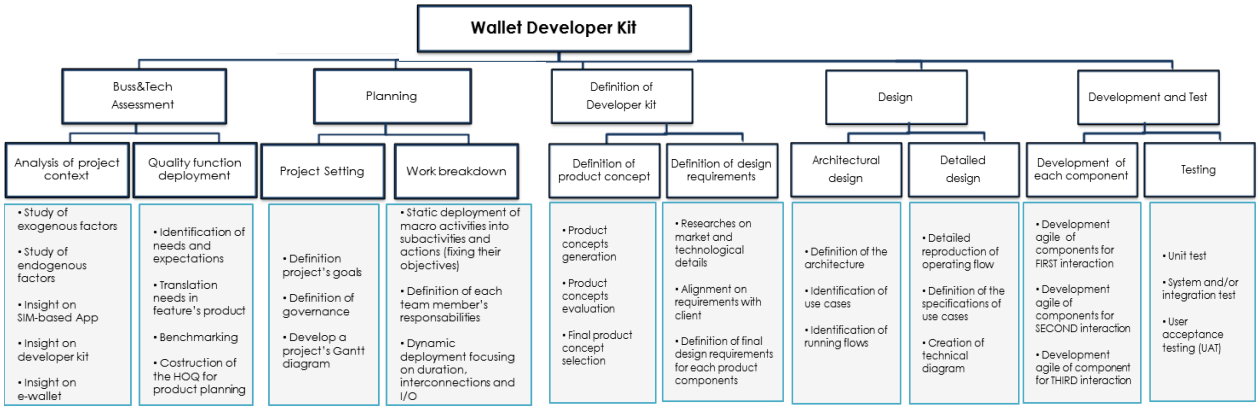

Figure 4 – Project WBS Diagram

Afterwards, dynamic deployment of these activities was carried out, considering the time limits and focusing on inputs and outputs of each activity and interconnections between the activities described in the paragraphs of this summary, especially in Paragraph 3.

4.3 Quality function deployment (QFD)

Sub- activity	Actions	Role of the candidate	Output
Quality function deployment (QFD)	Identification of needs and expectations	R	• Product stakeholders • Customer requirements
	Translation of needs into product features	C	• Product features (and their test) • Relation Matrix
	Benchmarking and needs ranking	R	• Competitor product • Relative Importance of Needs • Rate of satisfaction of existing products based on needs • Rate of satisfaction of existing products based on product features
	The creation of House of Quality	R	• HOQ - House of Quality (Figure 6) • Business assessment document (Draft v.0.2) • Technological assessment document (Draft v.0.2)

Table 6 – Quality function deployment: Output ("R" means responsible, "C" means collaborator, "I" means Informed)

The QFD process was used because it allowed a favourable approach to creative activities, to reduce the need to make changes and corrections in the advanced stages of development, to minimize the time of interaction with the Client and to have automatic documentation of the project during its evolution automatically producing a unique reference document for the Client and for the team. It also allowed non-coded and unshared ideas to be cut down, thus assuring that all people involved in the project would look at the product from the same single prospective. According to the QFD process, the data collected have to be summarized in the HOQ (House of Quality). The creation of the HOQ was based on the scheme shown in Figure 5. The QFD process made it possible to capture customer requirements and prioritize them (the WHATs, collected in Room 1 and weight of each need) and to translate them into specific and measurable characteristics (the HOWs, collected in Room 2). Then, these characteristics were prioritized (Room 7) thanks to the graph check, thus assigning the values in Room 3. These values inside the central matrix represent the correlation intensity of the relationship between design decisions and customer needs, so they give a vision of how much the product feature influences the expected quality of the customers for their satisfaction. Then, the QFD process continued with benchmarking to have perceptions of competitive performance based on needs (Room 4) and on product features (Room 5). The key activities of the QFD process (described above) have been applied to our specific project and are summarized into the HOQ (House of Quality) of Figure 6.

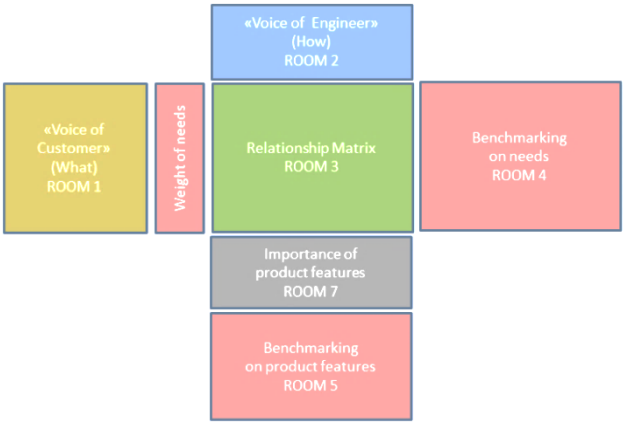

Figure 5 – Scheme of HOQ used: rooms vs activities

Figure 6 – HOQ (House of Quality) for the developer kit of "Mobile Wallet Developer kit" project

The main product stakeholders that were considered necessary to be involved in the needs identification are: Telecom Italia, App developer and Service provider. The competitor products chosen are: Devkit Sierra Wireless, IzyNFC, BBva Open4U, Seek for android and Mobile Connect.

4.4 Definition of developer kit

Sub- activity	Actions		Role of the candidate	Output
Definition of product concept	Product concepts generation		R	Graph of possible scenarios for the developer kit
	Product concepts evaluation and selection		R	• Concepts Evaluation for the developer kit • Service definition document (Draft)
Definition of product requirements	Researches on technical details		I	• Technological assessment document (Final)
	Researches on market details		R	• Business assessment document (Final)
	Alignment with Client on requirements	Service App	R	Service definition document (Final)
		Emulator App	I	
		Website	R	
	Definition of design final requirements for each component		R	• First project review meeting power point presentation • Developer kit configuration (Figure 7)

Table 7 – Definition of developer kit: Output ("R" means responsible, "C" meanscollaborator, "I" means Informed)

Through the analysis of the House of Quality and the other information collected in the previous studies, different scenarios emerged for the configuration of the developer kit. After evaluating the product concepts through a qualitative assessment, the selected concept was a set of elements: a SE (Secure Element) Emulator, a Testing App and a Website.

Then, the product concept chosen was detailed based on the considerations emerged from researches on market (i.e. mobile wallet market, mobile commerce market, some case studies on MNOs with a look to the world and to the Europe) and on technologies (i.e. Telecom Italia SIM Secure Storage). The final product concept with its component design requirements is shown in Figure 7. Requirements Lists are shown in paragraph 3.2.3.

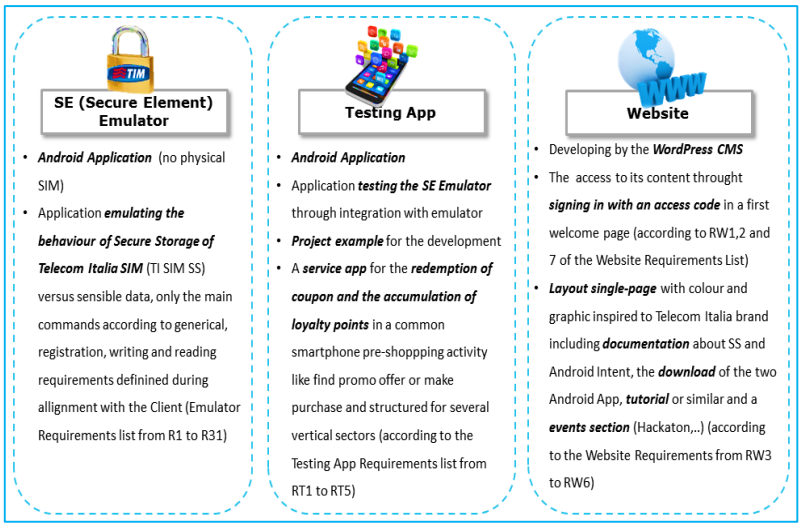

Figure 7– The developer kit configuration

4.5 Design

Sub- activity	Actions		Role of the candidate	Output	
Architectural Design	Definition of the architecture for…	Service app and Emulator	I	Architecture of applications	Design document (Draft)
		Website	R	Architecture of website (Figures 8 and 9)	
	Identification of use cases		R	Use case diagram of the Emulator-service app system	
	Identification of execution flow		R	• Flowcharts for “Gift choosing”, “Coupon redeeming” and “App registration” processes • Scheme of the website use	
Detailed Design	Detailed reproduction of operating flow	Service app	C	Service App Mockup for the processes of coupon redeeming and gift choosing	• Design document (Final) • Second project review meeting power point ppt
		Emulator		Emulator Mock-up for the “interactions visualization and selection” functions	
		Website	R	Mock-up for the website contents	
	Definition of the use case specifications		R	Specification for each function of use case diagram	
	Creation of technical diagrams		I	Technical diagrams	

Table 8 – Design: Output (* R means responsible, ** C means collaborator, * I means Informed)**

4.5.1 Android Applications

The business logic designed for the Service App is based on the possibility for an end-user to gain loyalty points using coupons during purchases (coupons pre-loaded from merchants entitled to issue them). The loyalty points acquired can be used for requesting gifts from the merchant (owner of the App) or his partner. In detail, tapping on the Service App (called “GiftForYou”) icon the user will view two options “redeem coupon” or “choose gift” in a welcome page. Then, the user can tap on one option and the Service App will show the

current loyalty points balance. According to the subsequent taps, the balance is increased or decreased by the appropriate amount through communication with the Emulator App. To use the Service App as described above, its first registration to permanent use of the Emulator is an essential task. The Emulator, after a registration check, will allow the reading and writing of sensitive data (used as test) to be processed in the database. Moreover, the Emulator App can display, if a user taps on its icon, the last 10 messages (Intent) exchanged with the Service App and the interaction details by selecting a specific Intent. The Service App and the Emulator are both Android Apps, so their communication is enabled from the Android operative System that drives the message if the two Apps are installed on the Android Smartphone.

4.5.1 Website

The website is designed to allow access through an initial welcome page that will allow authentication by entering an access code (as shown in Figure 8). Moreover, the main page has been designed with five main sections (as shown in Figure 9). The "Home" section will contain an effective way to describe the navigation on the website while, the "SS Emulator" section will contain an effective description of the Emulator functions and the possibility to download it into .apk (Android Package) format. The "References" section will include technical documentation (definition of class, method, etc.) and other generic documentation (i.e. NFC technologies, Android). The "Tutorial" section will include examples of code ready to be imported as Eclipse project, the example code of the Service App and a simple guide about Android Intent. The "Events and Contacts" section will include a form for asking for information and a section to promote a next event using a "Hackathon" as an example.

Figure 8–Website Welcome page coarse design

Figure 9–Website Main page coarse design

4.6 Development and Testing

Sub- activity	Actions		Role of the candidate	Output
Agile development of each component	Emulator App development		I	Emualator.apk (Android Package)
	Service App development		I	GiftForYou.apk (Android Package)
	Website development		R	• www.wdk.elislab.elis.org (fold "web")
Testing	Unit test	Emulator	C	• Improvement notes • Bugs notified
		Service App	C	
		Website	R	
	System test (Service App and Emulator)		C	
	Integration test (website)		R	
	User acceptance test (UAT)		R	

Table 9 – Development and test: Output (* R is for responsible, ** C is for collaborator, * I is for Informed)**

The Service App “GiftForYou” created will be displayed on the Android device with the icon app of Figure 10 as soon as it is downloaded onto the device. Tapping on this icon, the screen in Figure 11 will be displayed to emphasise that the registration to use the Secure Storage Emulator is not authorized automatically. After the registration, launched (by tapping on the only button shown) and authorized by the user, the Service App is enabled to test the Emulator functions and it will display the screen in Figure 12 in which the user will choose an option tapping on a specific button. In each case, the Service App has to communicate with Emulator. The Emulator receives and analyses three main types of requests: register, writing and reading. The created Emulator has also its own icon app shown in Figure13 and works according to its design. The Emulator and Service App developed are loaded onto the single-page website created (Figure 14) into “SS Emulator” and “References &Tutorial” sections respectively, and downloadable as .apk (Android Package). Moreover, into this last section, it is possible to download some guides (.pdf files) and to watch a video that shows how to use the website. The welcome page created (Figure 14) gives an overview of the website contents through the main title, sub-title and the menu bar and allows the authentication via a password or using an existing app developer account in Git HUB, Google or OpenID.

Figure 10 –Service App Icon

Figure 11 –Service App first screen (NO registered)

Figure 12 –Service App first screen (registered)

Figure 13 – SS Emulator icon

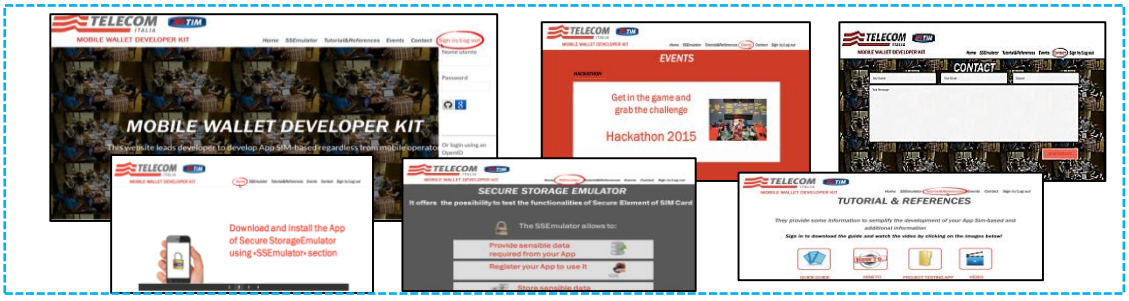

Figure 14 – Welcome page and the sections of single-page website (www.wdk.elislab.elis.org)

5. Conclusion and future development

The developer kit allows Telecom Italia to take advantage of economies of scale through the increasing number of services that can be integrated with its own assets (Telecom Italia’s SIM and TIM Wallet) and it permits a SIM-based app developer to create its own app autonomously from the mobile operator. The final product has been added to a 2-sided Platform: open platform of intermediation and collaboration, focused on the functional reuse and sharing of software developer kit (SDK).

Appendix A

The aim of this Appendix is to give the reader a brief overview of the "Junior consulting" (XXV edition) program. It is a five-month educational program carried out from November 2014 to April 2015 and organized by Elis Corporate School (ECS) and the companies that belong to "Consorzio ELIS". The objective of ECS is to encourage the meeting of university and company realities and, moreover to support companies in the acquisition and development of professional and social skills aimed to train professional figures capable of operating in public or private sectors. The Junior Consulting program offers young master undergraduates the opportunity of a real challenge on a consulting project in which students are required to give a distinctive contribution. The program was composed of four main parts: "Training", "English study", "Personal development" and "Action learning".

The Training included activities to consolidate the professional profile such as Project Management, Personal Leadership, Public Speaking and the alternation of spaces dedicated to discussions with Top Managers such as Luca Bertone (head of TIM WCAP Roma), Massimo Mancini (Chief Enterprise Officer Fastweb), Michele Liberato (EMC Italia's president), Roberto Delli Colli (Managing Director Operation DHL) and Daniela Biscarini (head of the multimedia entertainment division of Telecom Italia) and with companies such as Useit.

The English School was an English course held in Dublin for two weeks to improve writing, listening and speaking skills.

Personal development is a personal development path with a dedicated coach aimed at stimulating self-awareness in participants and inclination to continuous improvement and subsequently, orientation and preparation for employment. In particular, this part included personal development interviews, CV review and interview with companies (Ntt data, Altran, Sky, Soft strategy, etc.).

Action learning concerns the development of a project for a big company led by a Team Leader in nearly 4 months. Its aim is to provide a solution to concrete and real needs expressed by one of the companies of the Consortium. During the project deployment there is the opportunity to work in team and to experience interpersonal skills, to apply and to increase the skills acquired.