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Product development models in the IT sector-From Waterfall to Agile Project Management Model s in the case of AVIRA SOFT S.R.L

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Abstract. *The digitalization process of the business activities has increased tremendously in the last fifty years, revolutionizing several fields of activity, such as communication, medicine, production, transport, as well as all aspects of the daily social, economic and political processes. Furthermore, the IT field has developed new ways of innovating, including new management models in the production field, that allow management of IT companies to become more customer-oriented in a dynamic competitive field. As technological progress is becoming present in every aspect of everyday life, the pressure for innovation and customer involvement represent the two main challenges of producing successful prototypes and final products for the IT market. The purpose of the present paper is to analyze two of the main product development business model trends in the IT field, namely Waterfall model and Agile model, the latest being an adapting strategy to increased customer requirements and the changing business environment. In order to ensure a practical approach the case study was based on the analysis of their implementation within the company Avira Soft S.R.L. The results of the study emphasized the benefits of using the Agile model at Avira Soft S.R.L starting with 2011 in comparison to the previous model of Waterfall product development. The relevance of the paper consists in the fact that the two models indicate how the IT product development business models are evolving depending on environmental factors and the need for continuous adaptation and innovation due to increased competition. The Agile model brought improvements of the Waterfall model, but also new challenges regarding the organizational culture, communication between members of the company and more pressure for continuous improvement. However these two models are an example of how the IT product development business models are evolving and they form a basis for future product development strategies.*

Keywords: Waterfall, Agile, software development, project management, technology.

Introduction

For the last two decades the business environment has adopted a more strategic view, involving technological innovations as methods to diversify revenue sources, enhance productivity and obtaining insights in different fields of activity. According to Comptia (2017) the global IT industry had a value of over 3,4 trillion US Dollars in 2016, while the US market represented 28% of the total IT market globally, followed by the Asia Pacific region with China, Japan, Australia, India and other surrounding countries and Europe accounted for approximately 23% of the global IT market.

The expansion of the IT sector, especially due to the increased software products demand, has led to the development of more software development models, such as Waterfall, Agile and the Spiral model, the first two models being analyzed in the present paper. Each of these models have provided strategic approaches to project management of product development in the case of software, that have adjusted depending on the size and complexity of the project, changes in customer preferences, increased competition in terms

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of innovation and a dynamic pace of technological progress. While the Waterfall model represents the classical type of software development model, focusing on an extended documentation and planning of the project before its actual creation, the Agile model ensures a permanent focus on changing customer needs (Ajam, 2018), as well as on integration of customer improvement priorities on a frequent basis during the work year. Thus, the Agile model changes the perspective from a more strict, inner based planned model focused on documentation to a people's perspective, where more stakeholders are involved in order to create successfully improved products. The Agile model is mainly concerned with bringing the stakeholders', especially customers' or direct interest groups' , feedback suggestions continuously during a year in the form of frequent product releases, that can be evaluated and improved again by the users. The fast changes in customer needs and preferences in terms of speed, quality, design, characteristics and abilities of the software used have made the Agile model replace in numerous companies the Waterfall model due to its increased adaptability chances. Several authors have emphasized the differences in management of software development for both Waterfall and Agile, such as, however in practice there are specific characteristics of these models, that are implemented depending on the individual objectives and projects of the companies.

The present study focuses on analyzing the process of transformation within the anti-spam products developing company, Avira Soft S.R.L, that encountered the change from Waterfall model to the Agile model in 2011. Avira is one of the most well-known IT companies, offering security solutions as software products, employing internationally in over 500 people and being present in Europe, America and Asia (Avira, 2018).

The hypothesis of the study were as follows:

H1: The Agile model will facilitate integration of customer improvement suggestions in product releases. Due to the expanded use of the Agile software development model, this hypothesis was established, in order to analyze whether the interviews would reveal relevant integration of customer feedback in the product releases of the company and how often.

H2: The Agile model will cause a change in the organizational culture, in terms of adding pressure to the employees' deadlines and work justification, increasing the risk of personnel fluctuations. As the change from Waterfall to Agile occurred, several cultural values, principles, norms and other elements of the organizational culture were expected to be adapted and bring change in the management of projects, working style of the employees, increased expectations of finalizing product releases and possible employees' fluctuations due to resistance to this type of changes.

Literature review

New product development represents one of the main factors for generating economic growth, as it is a main source of revenue and profit in the economy. New product development is also the core source of technological progress and revenue streams in the IT field. The IT field is being present in most daily social and business activities and more frequently in the education field, which can contribute to changing the way of teaching and learning, a higher integration of students on the labour market (Dima & Ghinea, 2016; Dima et al., 2017, Ghinea et al., 2017), as well as to provide a balance of social needs with corporate requirements on a long term (Dima & Vasilache, 2013). Thus, the IT field is one of

the main fields producing innovations and becoming a necessity for the business, social and environmental sectors.

In the last two decades the development of new types of software products has been increasing due to an expanded use of technological gadgets and devices in most of the daily activities, creating a dynamic field of competition for software producing companies. This digitalization has led to new product development business models within IT companies in order to adapt to the changing technology environment, requiring continuous innovations.

According to Münch and Vierimaa(2006) a software development process contains two phases, namely: process definition model or the definition management of the software development process and project execution model, that deals with the actual software development process definition instance. In the IT field there are three main business models for software development, namely the Waterfall model, the Agile model and the Spiral model. In the present study the Waterfall model and the Agile model will be discussed.

The first type of software development model is the Waterfall model, that emphasizes the requirement for documentation before starting with the software design and all activities follow one after the other in a sequential manner as illustrated in Figure 1 below:

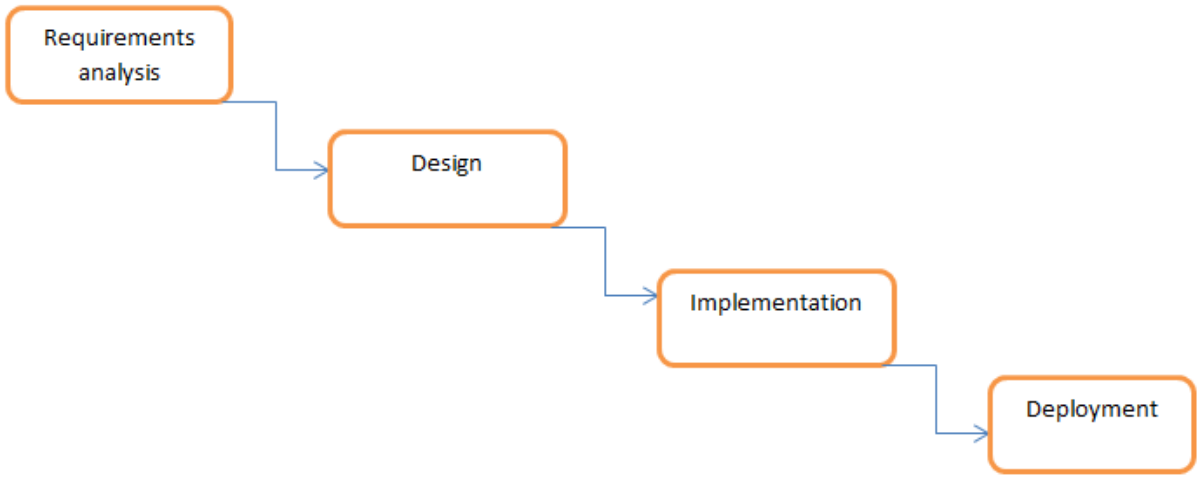

Figure 1. Phases of the Waterfall model

Source: Christensen, 2010.

As Stober and Hansmann (2010) describe, the Waterfall model is the traditional type of model adopted in smaller or larger projects in the past decade, containing the following steps:

a) requirement analysis, namely the collection, analysis and discussion of the stakeholders' (such as team, sponsors, interest groups) requirements;
b) design phase, where the whole system and individual parts of the system are designed, so that they can be coded further in the implementation phase;
c) implementation, that represents the coding phase of the project parts after design has been established. The integration is done usually afterwards, unless errors are encountered, that have to be repaired;

d) testing is another sub-phase or the design code unit testing, where different units of the software are integrated and tested in order to review possible flaws of the coding.

The software product is taken further to the deployment phase. A major issue of the waterfall model is time consumption and transmission of errors from one phase to the other. Errors discovered in the implementation and testing phases, implying the returning to design phase, which can consume time, resources and delay the project.

In comparison to the Waterfall project management model the Agile method brings a new type of approach to developing the product, as in focusing on providing a solution through the cooperation of people instead of focusing on planning of the project, thus:

a) stakeholders' cooperation instead of focus on tools,
b) customer cooperation over contract negotiation,
c) adapting to changes of the environment over following a plan (Christensen, 2010; Imran et al., 2016).

Thus, Agile method emphasizes a people's perspective over a fixed plan perspective. The Agile model comprises for each project module the phases of the waterfall model adding also customer feedback, as follows:

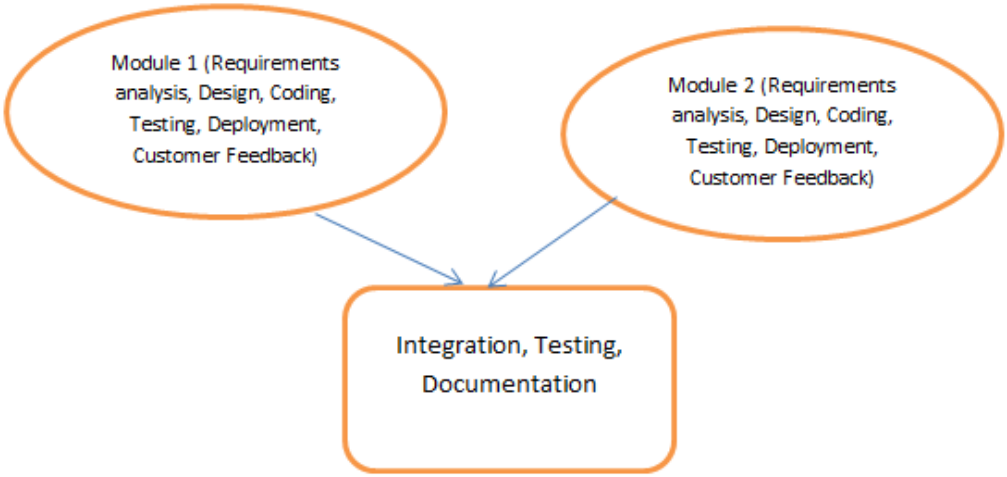

Figure 2. Example of Agile project modules phases and integration

Source: Adapted after SDLC, 2017.

As shown in Figure 2 the Agile model implies that the project is divided into modules, that follow the phases of Requirement analysis, Design, Coding, Testing, Deployment, but also benefit from frequent customer feedback at several periods of time. The customer feedback suggestions are then further integrated in a short period of time in the product development in order to improve it and adapt it to customer changes. Therefore, the Agile model is bringing the concept of people's perspective and cooperation over tools and planning. Small product releases are done, whereas the product is working, but not fully functionally improved in order to have a broader understanding of it and better discussion point with the customers and stakeholders for future product improvements (Christensen, 2010; Layton and Ostermiller, 2017).

The Agile model has some versions, as well, namely: scrum, extreme programming and test driven development. While the main concept of the agile model of integrating customer improvement priorities in frequent releases remain, these versions were designed to adapt depending on the organization and project size and complexity, so that depending on the case one or more could be used within a company. The extreme programming version of the Agile model has a specific characteristic, namely that two developers work together on a computer, one writing the code and the other checking the written code (Marchessi & Succi, 2003).

In the case of the scrum model the customer priorities are divided into so called sprint objectives and during two to four weeks these should be implemented in the product, whereas the team should meet daily to discuss and solve progress and obstacles in the software development (Stober and Hansmann, 2010). The scrum model has a scrum master as the project manager usually, the team and product owners or end users as main roles.

The test driven development version, as the name mentions, supposes that unit tests are done first before the actual software development, meaning the first version of the software is tested, that does not have the new feature yet and will fail the test, being followed by coding of the software to insert the feature ability, so that it passes the test (Hazzan, Dubinsky, 2008).

Although several authors have inquired the two mentioned software development models their practical implementation within companies produces specific effects in terms of management for product development, organizational culture, organizational structure of the working activity and the relationship between managers and employees, as well as among several departments in certain cases.

Methodology

In the present paper the objective is to analyze the Waterfall vs. Agile model implementations in a practical approach based on the strategy of Avira SOFT S.R.L in 2011, that represented the transformation of the strategic business model for software development in order to face increased customer requirements and a more dynamic competitive field in the IT industry. Avira Soft S.R.L is a branch of the Avira GmbH company, that produces security solutions, such as antivirus software, Internet security, Privacy, Identity and Performance tools for computers, networks, smartphones since 1986 (Avira, 2018). In order to ensure a practical approach, the study was achieved by interviews and questionnaires for a week time, between 7th and the 15th February 2011, regarding the Anti-spam development team of Avira Soft S.R.L from Bucharest, that offered a broad overview of the implementation methods of Waterfall vs. the newly adopted strategy of Agile.

The interviews and questionnaires referred to issues such as the general process of developing anti-spam software, the Waterfall model implementation for the development of the software and the Agile model, that was adopted in the beginning of 2011 and the followings that were already established by the management of the company.

The interviewing process resulted in a broad overview of the business models for software development, that Avira Soft S.R.L implemented, as well as changes in the organizational cultural and on management and team level, that started to be noticed once the change of the business model was starting. The Agile model was starting to have an

exponential utilization scale internationally with the increasing changes in customer preferences and technological progress.

The two hypothesis were:

H1: The Agile model will facilitate integration of customer improvement suggestions in product releases.

H2: The Agile model will cause a change in the organizational culture, in terms of adding pressure to the employees' deadlines and work justification, increasing the risk of personnel fluctuations.

Results and discussions

The first part of the interviewing process was focused on the phases of the product development model in case of the selected department, thus, the process of anti-spam analysis. The general steps of the development process of the anti-spam products at AVIRA SOFT S.R.L were: the initial analysis of the received e-mail, the analysis of the content, applying the Bayes filter of artificial intelligence, final classification of the e-mail as spam or not. In the case of the initial analysis of the received e-mail, some general aspects of the e-mail, such as format (as an example, a red highlighted title), dimension of the characters in the text, dimension of the e-mail or of the attachments, are already inquired. The analysis of the content was mentioned as referring to: separation of the e-mail in logical entities, application of rules on sentences or words, analysis of the links if it is the case through the RBL (real-time black hole list). The RBL contains online databases with lists of URLs, that are usually contained in spams. Points are given to the links that indicate whether there is more possibility of encountering a spam or less.

The last phase of the spam analysis process is the Bayes filter, that uses a certain database with spam words and another one with words, that are contained by normal e-mails. At the same time the Bayer filter is trained, meaning the words contained by the e-mail are added in the database of the Bayes filter. According to all these classifications certain points are granted to the e-mail whether it is spam or not. Thus, the e-mail is categorized as spam if the final score through the addition of these points is high enough to classify it as a spam. During the interviews the process of the anti-spam implementation was presented in order to offer an overview of how further the two product development business models of Waterfall and Agile were applied.

Regarding the Waterfall model that was used until the beginning of 2011 at AVIRA SOFT S.R.L, the main process steps included:

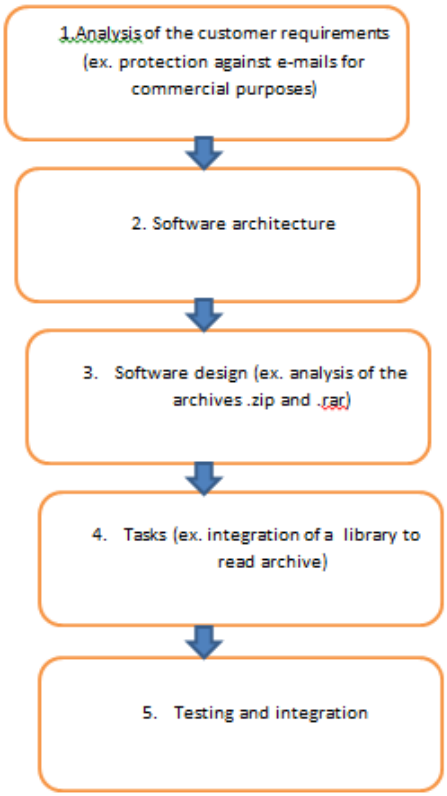

Figure 3. Waterfall software development model at AVIRA SOFT S.R.L 2011
Source: Author's own research based on interview and questionnaire at AVIRA SOFT S.R.L.

As shown in Figure 3 the first step is the analysis of the customer requirements, such as the requirement for protection against unwanted e-mails with commercial material for selling illegal substances or with fake links to fake websites. The second phase of the software architecture is the phase where software developers project the process of reading and analyzing the e-mail until its classification as a spam e-mail or a normal e-mail, that should enter the inbox of the user.

For example, the e-mail will arrive in the inbox of the user and the following sub-phase is that a Parser filter analyses it according to more elements, such as length of the e-mail, length of the text, etc., and then the e-mail parts are analyzed further by the ATA filter, that analyses words, images, links into positive or spam categories. Further, the Bayes, precisely registers the spam words indicated by the ATA filter and will use these also for other analysis of other e-mails. The words of the e-mail that are considered negative are called Spam words, while the positive ones, considered to appear in usual e-mails are named Ham words.

The following phase of the Waterfall model contains the settings needed, such as analysis of archives documents (types .zip or .rar) in the e-mails. The tasks or coding ensures the design can be practically implemented in the process. Testing is the testing of the quality and functionality of the achieved product parts, while integration refers to integrating the different parts of the product development steps to produce a successful

anti-spam product. The documentation is written by the software developers afterwards as well.

In the case of the Waterfall product development model at AVIRA SOFT S.R.L one phase should have been ended before another phase began. In 2011 the adoption of the Agile model, scrum method, has brought the following changes according to the results of the study. The Agile model transformed the working strategies of the management and software developers of the team, by changing the production process, as follows:

Figure 4. Agile model at AVIRA SOFT S.R.L 2011

Source: Author's own research according to interviews.

These process steps changed the whole production process model, as well as the working environment of the department. As shown in Figure.4 each month a final product had to be presented and released. The process starts with analyzing customer requirements, as in the Waterfall model, however the second phase of the Agile model emphasized the priorities of the customer requirements, that should be implemented in the product within a month time.

At the end of the month a product had to be finished and released, while restarting the process meant the following month the first three steps were done again. This model of production development ensured a direct and frequent contact with the customers through the support and sales departments, that analyzed which parts of the products were not satisfactory or not functional according to customer's perspective. In the case of the scrum method the anti-spam department had daily 15 minutes online meetings between the

management in Germany and the software developers in Romania, where software developers had to present their achievements for product creation, obstacles and other details, while further objectives for the following period were established. On the other hand, the communication between project managers intensified, as they started meeting weekly (scrum of scrums meetings) to discuss positive aspects achieved for the product improvement, necessary improvements and further objectives.

According to interviews results the main benefits of the implementation of the Agile model were the stimulation of the employees for improving continuously the product and their abilities in product development, more customer focus through their direct involvement in the monthly improvements of the products, more competitive abilities of the company in comparison to other rivals on the market, as one can observe in Table 1.

Table 1. Process management changes from Waterfall to Agile model in the case of AVIRA SOFT S.R.L in 2011

From ***Waterfall model***	To ***Agile Model***
Finalize each stage before starting another one	Monthly repetitive customer requirement priorities analysis and integration
Product release occurs after all process phases finished	Monthly product release
Process/Product mistakes can be missed and transmitted to the other phase (process	Process/product mistakes can be adjusted anytime throughout the process of monthly releases-higher chance of discovering flaws
Product can already become 'old' according to customer needs by the end of the process	Customer requirements analyzed, communicated and integrated monthly
Communication occurs at certain moments when needed	Frecquent communication between members of team (15 minutes per day) for problem solving, improvement proposals; other departments cooperation-ex. sales
Deadlines can be planned at certain moments	Continuous evaluation of employees' activity results every 2-4 weeks-adding pressure, ''work quick and well'' principle

Source: Author's own research based on interviews and questionnaires.

The introduction of the Agile model brought however, numerous challenges on the level of organizational culture and environment, such as: more pressure on the employees due to necessary monthly releases, leading to personnel fluctuations. This meant management controlling employees' results on a monthly basis, planning time span was reduced, which brought the risk of releasing products, that were not ''designed long enough''. Coordination of the employees and of the process by the direct manager became more difficult. As the process involves the communication between customers, more departments, project managers, employees, this lead to increased pressure in integrating all requirements of all parts and coordinating all members of the process. However, the implementation of the Agile model was described during the interview as a positive strategy and beneficial for maintaining a competitive ability of product development for the company.

Conclusion

As a conclusion of the practical study the first hypothesis of the study was confirmed, namely the Agile model has brought a more customer focused perspective in the case of the anti-spam product development strategy of AVIRA SOFT S.R.L. Comparing to the waterfall model the Agile model involves a more complex organizational culture, that focuses on permanent contact with the customer and communication between different departments in order to set priorities and implement these in the monthly release of final products.

The transformation from Waterfall to Agile model led to an increased dynamic business model, that had less phases of the production process and where the process is repetitive with a main orientation of monthly improvements of the released products in the case of Avira Soft S.R.L. The second hypothesis of the study was also confirmed, as the Agile model indeed added more pressure to the employees working style, causing also personnel fluctuations.

The Waterfall model has the risk of offering a product version, that is already 'old' in terms of what customer expects by the end of all process phases, which is a significant threat in a permanently changing technological environment as other competitors could have already developed better product versions. However, both models should be implemented depending on organizational culture, size and objectives of the company and more important depending on the timing and planning of the company in order to have a well-prepared internal environment for the changes to come. As the IT industry is expected to grow in the next years due to increased demand on technological products for business, social, economic use, the business models and product development models of IT companies will evolve to face the increased dynamic pace of the progress. As new product development models emerge, changing the phases of previous models or bringing new stakeholders in the creation process in order to maintain a direct link for client focused products, new organizational behavioral patterns will emerge in the cases of employees and management.

A future objective of the present study is to analyze the evolution of software development models in the current years in comparison to the situation of the period 2010-2011 given the changed economic and technological context, as well as the effects of possible changes of the product development models on the management and organizational cultures of companies.

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