ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΙΡΑΙΩΣ

UNIVERSITY OF PIRAEUS

MANAGING PRODUCT DEVELOPMENT

AS A PROJECT: BUSINESS PROCESS

MODELING

Master: Project Management and Product Development

Fani Parlani

November 2017

"If you can't describe what you are doing as a process,

You don't know what you are doing"

W. Edwards Deming

Dedicated to my mother, who always support me!

Contents

Chapter 1

1.1 Introduction

Business process management (BPM) is an increasingly important topic for every organization and especially for large organizations. There is a variety of methodologies that companies usually adopt for their processes, using them both for their projects or daily work. The most common of them are the traditional methodology of project management which is waterfall and agile/scrum management which started to be applied the last decades, mainly in software organizations. Another one is spiral model but as it used usually in Information technology (IT) field, in the following thesis we will be more specific and detailed about waterfall and scrum models as our goal is to represent how important and useful is the transaction from the traditional model (waterfall) to more flexible one such as scrum model.

A lot of theories regarding these methodologies have been said. The only thing which is sure about these two methodologies is that both of them have advantages and disadvantages and if they would be used properly could have successful results. There are supporters of waterfall project management which believe that this is the appropriate methodology to handle a strict project such as a construction of a bridge and other more flexible methodologies are more adequate for project which are connected with technology like software projects. On the other hand, opinions that Scrum methodology could be used in every project and all the advantages

of this methodology are increasing rapidly. All these contradictions are one of the incentive of the following research, as well as the confrontation of product development as a project through processes. Thus, in this paper an executive presentation of these methodologies would be presented, analyzing them using product development as a project, and provides a foundation of modeling it using Business Process Modeling Notation (BPMN) model.

1.2 Scope & Challenges

The scope of this thesis is to represent all the "basic" methodologies which are used in order to execute a project either it is referred as a product or a service or result. Then, a more extensive analysis regarding product development will be presented, as well as the confrontation of product development as a project. Analyzing all the product development processes and designed them by using BPMN model. Organization's point of view about how they handle a project has been significantly changed. Nowadays, every single organization pays a lot of attention on feedback, which is implemented in the whole duration of a project, as well as in the continuous and direct communication with the customer. Continuous development attracts also organizations' attention as it has proved results that help them to adapt the changes during a project. All the above consist important factors that companies have been turning on using more flexible methodologies so that handle both their projects individually and their portfolio of projects. The fast technology growing constitutes one more factor which affect to a large extent company's' performance, which means that they are leaded to need to be adaptable more than ever. Finally, not only the continuous increasing requirements by customers, but also the oversupply of competitors are factors which

contributes significantly in strategic business choice of every organization, one of which is the appropriate business process model they are going to use in every case in order to acquire the competitive advantage in market.

The opportunity of having feedback during the whole processes of a project has as a result to prevent actions, which could be characterized as corrective actions, in order to complete the project as much as possible following the initial and planned specifications. In the traditional methodology of waterfall project management, feedback is something which comes after the completion of the project, thus changes are too hard to be implemented. However, in other more flexible methodologies such as Scrum project management in every stage (sprint) of execution feedback is given, fact which not only helps in the continuation of the project by better decision-making, but also contributes in a successful completion of a project.

The scope of this thesis is to represent the product development as a project, all the processes which are needed during this project, which will be designed by Business Process Modeling Notation (BPMN) using both traditional methodology (waterfall) and scrum project management. Through this, not only all the differences, but also the similarities between the two methodologies would be represented graphically.

1.3 Goals

As it mentioned above, traditionally, product development follows waterfall methodology, however nowadays more flexible methodologies has been applied successfully mainly in the

fields which are quite related with technology such as software product development. Through these methodologies companies have been benefited by feedback which could be given in every project's process of product development. The goal of this thesis is to examine how product development could be confronted as a project, how much feedback could affect the successful completion of product development, as well as to represent a process model of product development.

The processes of product development would be represented graphically both with waterfall and scrum project management methodologies, so that everyone could locate in which phase of the project there similarities and differences of them. Moreover, through an example would be easily understood the advantages of each methodology. It is highly important to be pointed out that organizations traditional used waterfall methodologies and the implementation of more flexible methodologies such as scrum project management is a challenge for every organization. Furthermore, every methodology could be very positive effective and useful, as well as could contribute in successful completion of project, under the condition of well understanding and application of it, as well as using the appropriate one in any case.

1.4 Approach

Business process modeling is used by organizations as a way to depict their business process either current or forthcoming processes. In every approach from every model a business process consist of activities, events and a connection among them, as well as a typical control of them.

In this paper there are approaches of management processes from two sides, theoretically and practically. Thus, in the beginning there is an extensive analysis of the methodologies that organizations usually adopt. Waterfall, Spiral and Scrum project management are used in order to organize their processes in every project. A deeply description about waterfall and scrum has been done, as the first one consist of the traditional model and the other one the model that organizations try to switch nowadays more than ever. Afterwards, there is the practical approach using both models (waterfall and scrum). There are diagrams using BPMN, which depicts the whole procedure of the processes in the same project for both methodologies. Thus, there is an example for better understanding how both of them work in practice.

1.5 Structure

Introduction is the first part in this paper; the topic is generally described, so that it could be analyzed deeper in the next chapters. Everything included in this thesis is a representation of the project methodologies based on books, papers and articles. This would be the theoretical part which would try to explain deeply every methodology in order to make easier understandable the graphical part would be represented afterwards. Traditional project management (waterfall) and Scrum project management methodologies would help the depiction of the processes of product development project.

Waterfall management and Scrum management would be the two methodologies which have been analyzed more deeply. As, the description of the methodologies are about every kind of

project and not specifically about product development projects, following there is the definition of product development and how companies use it. The connection among all the above - waterfall management, scrum management and product development, is the subject of this paper. Thus, through the graphical representation would be understandable the usage of every methodology, its advantages and disadvantages.

Chapter 2

2.1 Product development

Over the time, companies have been benefited by the use of products. Products and services is what companies sell to their customer and through them try to attract more and more customers with the purpose to increase their financial state and gain more portion in the market. Thus, the definition of a product is that it is something, which is sold by enterprise to its customers, but the existence of products is because of solving customer needs. The fact that customers' needs are high demanding is proved all over the world, thus, the product development has paramount importance for every organization. Product development is defined as a set of activities beginning with the prescription of a market opportunity and ending in the production, sale, and delivery of a product. The importance of product development is as high as it could provide benefits to everyone who comes into contact with them, as successful developments projects are critical to success in many industries. Some of the proven benefits are that products can improve the quality of life for a user provides them with status, give an improved performance over previous models, as well as create a new or better aesthetic. Moreover, not only increase company profits and create a new market or expand an existing one, but also minimize manufacturing costs and use existing resources more economically.

A great percentage of companies give a lot of emphasis to product development process, which is a creative effort for them and is a process of design-related activities, which can be documented, studied and improved .According to Karl T. Ulrich and Steven D. Eppinger, Product development process is the sequence of steps or activities which an enterprise employs to conceive, design, and commercialize a product. There are a lot of reasons why it is highly important to define product development process well and some of them are the following:

- Quality assurance
- Coordination
- Planning
- Management
- Improvement

Nowadays, the new product development process is more complex than ever before due to many reasons. The intensive pressure that companies receive both by their competitors and the limitation of their cost is one of them. Another one important factor is the time launch in market in which contributes the complex global supply network. The continuous demand, the fast acceleration of technology development and the abound resource constraints affect significantly. At the end, important factors are the shortened component and product lifecycles. Speaking more deeply for product development processes, the Generic Development Process consists of six phases: Planning, Concept Development, System-Level Design, Detail Design, Testing and Refinement, Production Ramp-Up. Thus, the activities

which would take place are variable and really important for the products. In the next diagram a generic concept development process is presented.

A project's development process describes the flows of work among developments phases and the completion of development tasks within each phase. The characteristics of a development process describe the relative difficulty of development activities, concurrence relations among activities delays within processes such as defect discovery and iteration within and between phases.

Developing products faster, better and cheaper than competitors has become critical to success in many markets whether the product is an office building, software package, or computer chip. This has made the performance of product development projects an increasingly important area of competitive advantages. In response to these pressures many industries have shifted from sequential, functional development paradigm to concurrent, team based paradigm. Moreover, the understanding and the immediately adaptation to changes are factors which organizations have to think about, as the resulting of them have contributed to the frequently cited poor management of development projects.

In the following diagram is depicted the process of product development from the generation of an idea to create a product until its modeling:
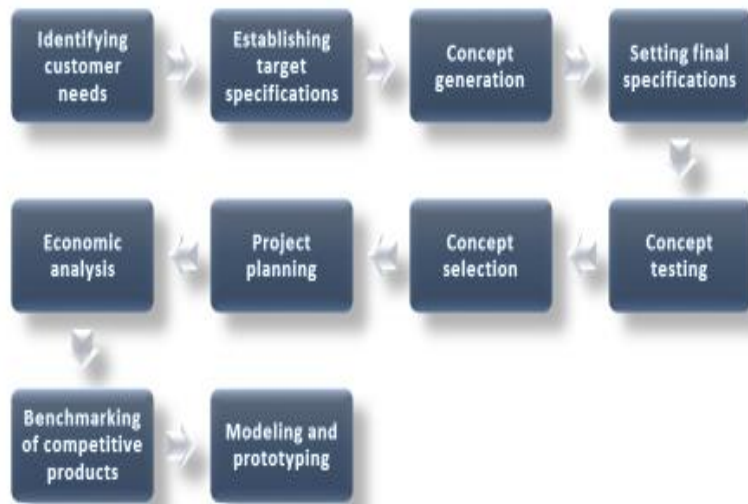
Organizations have to face the complexity of product development, which the biggest challenge for them. The complexity in product development could come from many sources such as the development process, the product design, the requirements have been set, as well as by the organization itself. Both the organization structure and the tools and technologies applied could contribute in product development complexity. That's why product development is considered as management task so every decision would be carefully taken after gathering and analyzing the best information about the project. Another fact that increases product development complexity is that usually organizations keep in hold their potential customers. Thus, they take the risk to spend time and money in a project without preparing them introducing them a new product or an improvement in a product. As Susumu

Ogawa and Frank T. Piller has said "To avoid costly product failures, companies can integrate customers into the innovation process and ask for their commitment to purchase early on."

Chapter 3

3.1 Project management

Through the years it is proved that both organization results and society has been influenced positively by project management. A project is defined as a temporary endeavor undertaken to create a unique product, service or result, which means that it has define start and end, however the outcome of any project could be ongoing, as well as tangible or intangible. The temporary nature of projects stands in contrast with business as usual (or operations), which are repetitive, permanent, or semi-permanent functional activities to produce products or services. Another potentially contradictory fact is that some of the project activities could be represented by repetitive elements, which certainly does not change the structure of a project and the fundamental, unique characteristics of it. An important information regarding all kinds of projects is that they have an various and increased uncertainties in relation to the ongoing work of an organization. One of the organization's' ways to deal with projects is project management. Project management is "the application of knowledge, tools and techniques to project activities to meet the project requirements". The primary challenge of project management is to achieve all of the project goals within the given constraints. The secondary - and more ambitious- challenge is to optimize the allocation of necessary inputs and integrate them to meet pre-defined objectives. On purpose of better management of it, it

is accomplished through 47 processes, a process is " a systematic series of activities directed towards causing an end result such that one or more inputs will be acted upon to create one or more outputs - using tools and techniques". All these processes according to PMBOK could be logically grouped in the following 5 process groups:

- ○ Initiating
- ○ Planning
- ○ Executing
- ○ Monitoring and Controlling
- ○ Closing
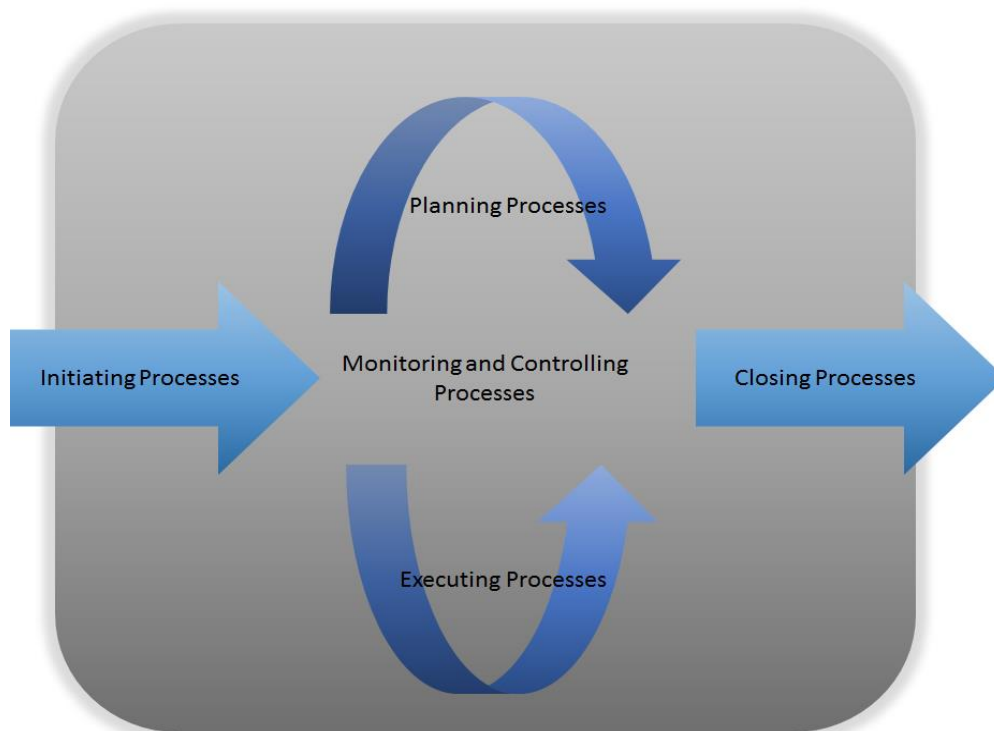
Initiating process group is the first group, as it is composed with those processes performed to define a new project or a new phase of an existing project by obtaining authorization to start the project or phase. In this phase the initial scope will be defined, financial resources will be committed, stakeholders will be identified. A significant fact for this process group is that a lot of times these processes are not under the project's control (project selection, budget allocation, deadlines etc.), as top management may choose them or could be chosen as part of portfolio management.

The next process group is defined as planning because is composed with those processes performed to establish the total scope of the effort, define and refine the objectives, and develop the course of action required to attain those objectives. In this stage the Project Management Plan would be created and project documents needed to carry out the project. This process is the appropriate example of the iterative work which exists on a project as there is continuous new information and experience to the project plan which derives from the feedback. Progressive elaboration is the progressive detailing of the project management plan, indicating that planning and documentation are iterative and ongoing activities.

Executing Process group is characterized this way because it is consisted of those processes performed to complete the work defined in the project management plan to satisfy the project specifications. Fundamental procedures in this stage are the coordination of people and resources, the management of stakeholder expectation and of course the execution of the activities, as the product-related deliverables would be created as well as the work performance data. Two elements which are decisively for this process groups are that it

usually requires the consumption of the biggest portion of the project's budget, as well as it is expected that normal execution variations will cause some replanning.

The most repetitive process are those which belong to Monitoring & Controlling process group, as those processes required to track, review and orchestrate the progress and performance of the project for the beginning to the end of any project. Including the identification of areas in which plan changes are needed the initiation of the corresponding changes and the integration of the change control processes which must be followed. As mentioned above, this process group (PG) could be used for controlling the transition from one project phase to another continuous and consistent monitoring is needed in any project.

The last PG is Closing Process group, those processes performed to conclude all activities across all Project Management Process Groups to formally complete the project, phase or contractual obligations. In this phase of the project the formal acceptance from the customer or sponsor would be obtained and all the documents would be recorded, conducts post-project or phase-end reviews would be created. Documents lessons learned would be kept for upcoming projects either hands-off the completed product or closes a cancelled project and all the project resources would be released. Dealing with project management is not a simple activity as its content is extensive and variable. Some of the activities which must be accomplished are that all the project requirements must be identified, all the needs, concerns and expectations of stakeholders must be addressed via planning and executing the project, as well as communication with stakeholders is required and of course managing the competing project constraints such as: Scope, Schedule, Budget, Risk, Quality, Resources etc.

Project management is accomplished through processes using knowledge skills tools and techniques and the project success should be measured in terms of completing the project within the constraints of scope, time, cost, quality, resources and risk as approved between the project manager and senior management. All these constraints could be presented in the following pictures:
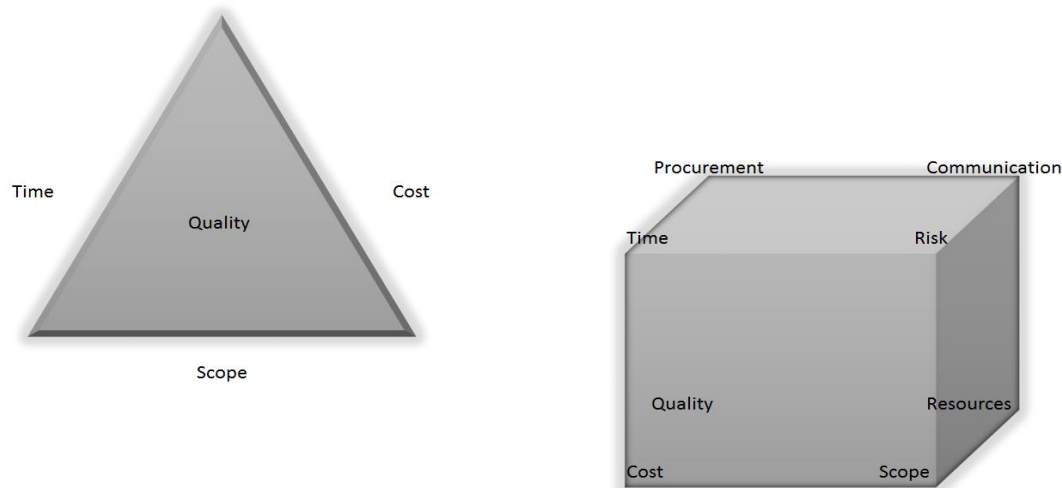
Another, useful information which comes from PMBOK is about the knowledge areas that a project would be divided which are ten: Integration, Scope, Time, Cost, Quality, Procurement, Human Resources, Communications, Risk and Stakeholder. Traditional project management models based on the Critical Path Method and PERT statically describe processes, resources, targets and scope with activity duration estimates and precedence relationships describing the network flow of activities .A description of the process structure in the form of the causal relationships that generate project behavior is needed to investigate how project processes

drive performance. To be complete such a causal dynamic project model must explicitly model and integrate the influence of processes, resources, scope and targets in performance

The most well-known Project Methodologies are the following:
- Scrum / Agile

- Spiral

- Waterfall

The most traditional one is waterfall which has been in practice decades before the new methodologies were introduced. More specific regarding to this model, development lifecycle has fixed phases and linear timelines and it is not capable of addressing the modern software development domain. For this reason, nowadays, agile and Scrum management has been dynamic in our lives. Agile software development methodology is for a project that needs extreme agility in requirements. The continuous development of technology is one of the reasons which lead to the usage of this methodology. The key-features of agile are its short-termed delivery cycles (sprints), agile requirements, dynamic team culture, less restrictive project control and emphasis on real-time communication. Scrum is an agile methodology and the main goal of it is to improve the productivity dramatically by removing every possible burden. As far as it is concerned the Spiral model, also known as the spiral lifecycle model, is a systems development lifecycle (SDLC) model used in information technology (IT). This model of development combines the features of the prototyping model and the waterfall model. The spiral model is favored for large, expensive, and complicated projects.
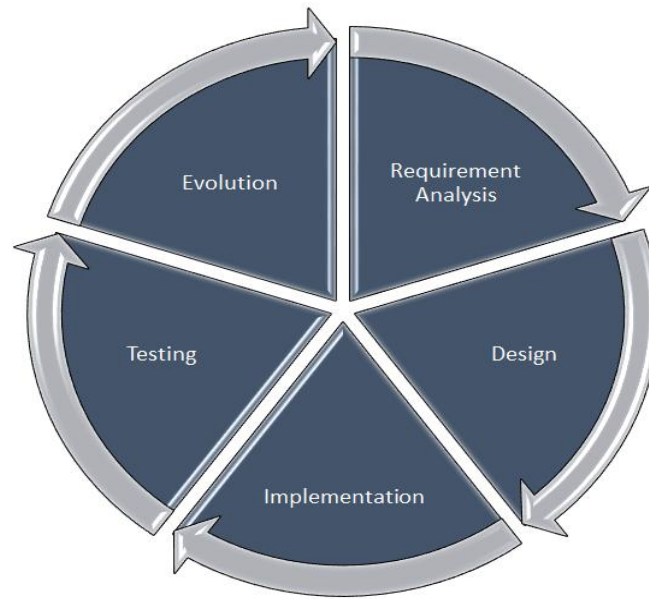
3.2 Waterfall project management

Waterfall methodology was the first approach to describe the processes during a project. The main characteristic of it, it is that is usually used for long term project, as there is a big plan upfront and then a linear execution. In every project in which waterfall methodology is applied, all the activities should be executed in the exact order and one set of activities cannot start before the previous one ends. That is the reason why, the planning is the most important phase in this kind of, as all the activities, their duration and their sequence would be set. In case that a waterfall project is not planned well or just one phase is not planned appropriately, could bring consequences either much significant or less.

There are a lot of reasons to use this methodology as it has many advantages even if nowadays it has considered as an obsolete one, and scum theory gain more and more

supporters. First of all, waterfall it is a simple methodology as everything is linear, every phase is divided and not repeated, that helps also organization to make easier measurements, as they could have progress results from every phase. Another important characteristic is that clients are not co-workers, as they participate only in setting the requirements of the project. Then they do not have any contribution and of course they exactly know what to expect from the deliverable of the project. This helps also the organization to keep the knowledge inside the organization as they are not "obliged" to share knowledge and techniques with clients in every step of the project. The fact that the whole planning of the project should be set before the execution of it, it creates the need of extensive documentation, as the organizations need knowledge and experiences from history (previous similar projects) so that they would be able to avoid problems, troubles and risks. Furthermore, this planning in the beginning of the project could help both product and team members. Product could have a higher cohesion as everything would be designed in once, people could plan better their time as their responsibilities are set from the beginning avδ they could be used in multiple projects.

On the other hand, the heaters of this methodology and those who consider it as obsolete as mentioned above, believe that there are more disadvantages than advantages. The fact that everything relies heavily on requirements phase leads on not having space for errors which makes planning phase a quiet pressure process. Another important disadvantage is that if an activity is done, it is too expensive and difficult to make changes on it. This strict confrontation of planning phase has as a result that the quality assurance would be too late which means that probably would not be useful for the this project but probably for the forthcoming events. Another characteristic of waterfall is that the deadlines are strict and unexpected problems are difficult to be phased. Furthermore customer's contribution during

the project take part only in the beginning, so it probably that they do not know what they exactly want.
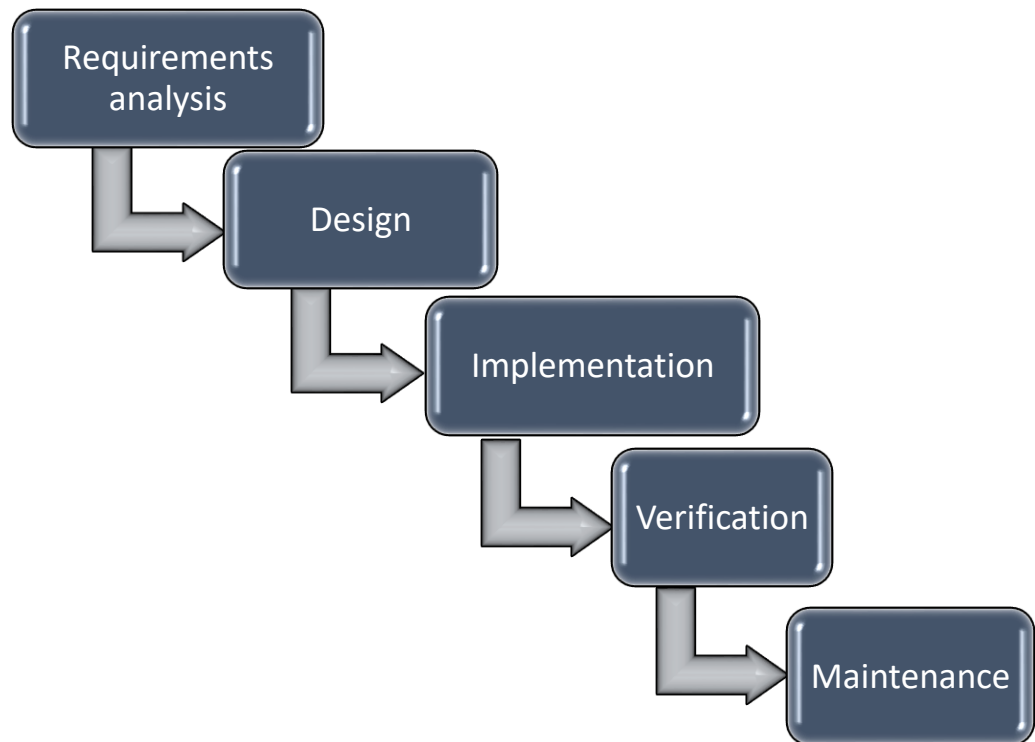
All the phases of waterfall methodology are depicted in the chart above. The first step is the analysis of the requirements of the project. Usually, this information comes from the customer, it is about an agreement between the two sides (project manager & project team with clients), and thus all the deliverable would be set. Thus, all the documentation which would be done in this stage is going to be more helpful further in implementation. Design is the phase that all the planning of the project would be done and all the needed information will be from the previous stage (requirements analysis). The next phase is implementation, at

this time everything is planned would be executing, then in the verification phase all the appropriate tests would be done, so that the project would be closed in the maintenance phase. In the last phase, all the documentation is going to be kept from the organization as "knowledge" for the next projects, as well as the deliverables would be evaluated.

3.3 Agile/Scrum project management

Over the years, there is an accepted philosophy regarding development processes, which supports that it is a well understood approach that can be planned, estimated, and successfully completed. However, in practice, it has proven incorrect, thus SCRUM supports that development process is something unpredictable and quite complicates, thus it could be described as an overall progression. Through the years numerous approaches to improving the system development process have been tried. Scrum theories define development process as a loose of activities that combines known, workable tools and techniques with the best that a development team can advise to build systems. Since, these activities are loose; controls to manage the process and inherent risk are used. Scrum is an enhancement of the commonly used iterative / incremental object-oriented development cycle.

Generally speaking when a project is simple it is not hard to know in advance the work which is needed, but the more complex a project is the more difficult to predict the work it is. This is one of the reasons using scrum management, as it is about a system of independent agents operating under an appropriate set of rules. Significant ascertainment is also that if know everything about a project and nothing would be discovered, the usage of scrum is needless.

Scrum shows management how to guide a project along its optimal course, which unfolds as the project proceeds. The advantage of the continuous feedback is that the project could be modified under circumstances, as well as it helps in better understanding of value of deliverables through the early tests.

According to Gary Convis, president of Toyota Motor Manufacturing Kentucky, the role of managers in a healthy, thriving, work environment is "to shape the organization not through the power of will or dictate, but rather through example, through coaching and through understanding and helping others to achieve their goals". Scrum is a methodology of project management which have been implemented in large scale the last decades. It has started to be used in software projects, but its supporters believe that it could be implemented in every kind of project as it is almost effortless comparing traditional methodologies and very simple to manage complex projects.

The definition of the Scrum is that is a framework within which people can address complex adaptive problems, while productively and creatively delivering products of the highest possible value. The main characteristics of scrum are that it is lightweight, simple to understand but difficult to master. Scrum firstly appeared is dated in the early 1990s as a process framework which has been used to manage complex product development. Scrum is not a process or a technique for building products; rather, it is a framework within which you can employ various processes and techniques. Scrum makes clear the relative efficacy of your product management and development practices so that you can improve.

The Scrum framework consists of Scrum Teams and their associated roles, events, artifacts, and rules. Each component within the framework serves a specific purpose and is essential to

Scrum's success and usage. The rules of Scrum bind together the events, roles, and artifacts, governing the relationships and interaction between them. The rules of Scrum are described throughout the body of this document. Specific tactics for using the Scrum framework vary and are described elsewhere.
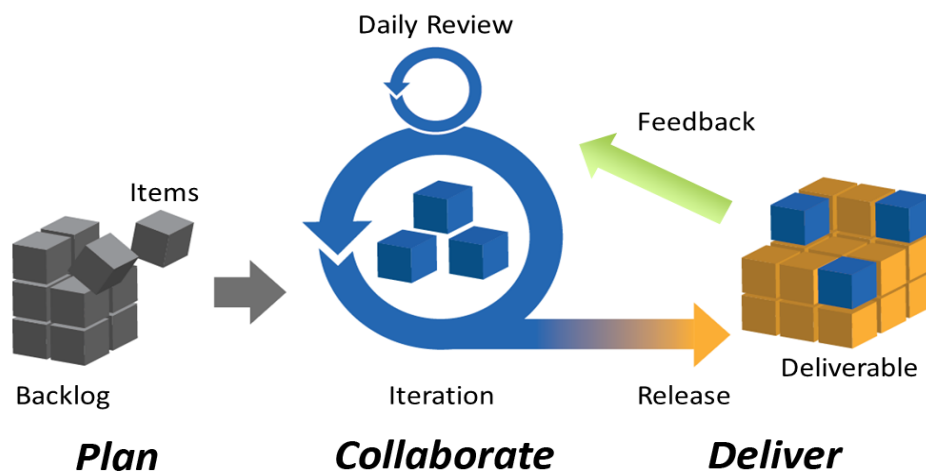
One of the most popular Agile methodologies, nowadays, is Scrum. The increasingly use of it instead of the traditional way of waterfall is mainly based that Scrum is an adaptive, iterative, fast, flexible and effective methodology designed to deliver significant value quickly and throughout a project. As it is mentioned also above, projects are leaded by their constraints, however, Scrum framework is structured in such a way that it supports product and service development in all types of industries and in any type of project, irrespective of its complexity. Successful implementation of this methodology has been proved over the years and the key benefits of using it are: Adaptability, Transparency, Continuous Feedback, Continuous Improvement, Continuous Delivery of Value, Sustainable Pace, Early Delivery of High Value, Efficient Development Process, Motivation, Faster Problem Resolution,

Effective Deliverables, Customer Centric, High Trust Environment, Collective Ownership, High Velocity, and Innovative Environment.

A very important characteristic of Scrum's operation is that every member turn into a manager which is responsible of their own fate. Furthermore, team members are always confronted by challenges which they should handle with the more creative and effective way that are not planned by a framework.

The system of development process is quite complicated and complex, so the need of maximum flexibility and appropriate control is more than required. Development teams could be enable to operate adaptively within a complex environment using imprecise processes. That's why, the appropriate methodologies are those which support and encourage the flexibility, and they have a high degree of tolerance for changes in any case. Some of the environment variable could change during a project are: Availability of skilled professionals, stability of implantation technology, stability and power of tools, effectiveness of methods, domain expertise, new features, methodology, competition, time, funding, and other variables such as time. As mentioned above, project team should be familiar with all of them and capable to adapt them.

The primary difference between the defined (waterfall, spiral and iterative) and empirical (Scrum) approach is that Scrum assumes that the analysis, design, and development processes in the Sprint phase are unpredicted.

Scrum has the advantage to respond to changing requirements once the project has started, as well as it is designed to be quite flexible, thus it provides control mechanisms for planning a product release and then managing variables as the project progresses. This advantage has

incremental meaning for the organizations, as they are cable of changing the project and deliverables at any point in time, delivering the most appropriate release. Furthermore, it could work as an excellent training environment for all parties in an organization, because of the sharing tacit knowledge about development processes through small collaborative teams. At the end, it is highly important to point out that Scrum is a methodology, which make team members to feel free to devise the most ingenious solutions throughout a project, as learning occurs and the environment changes.
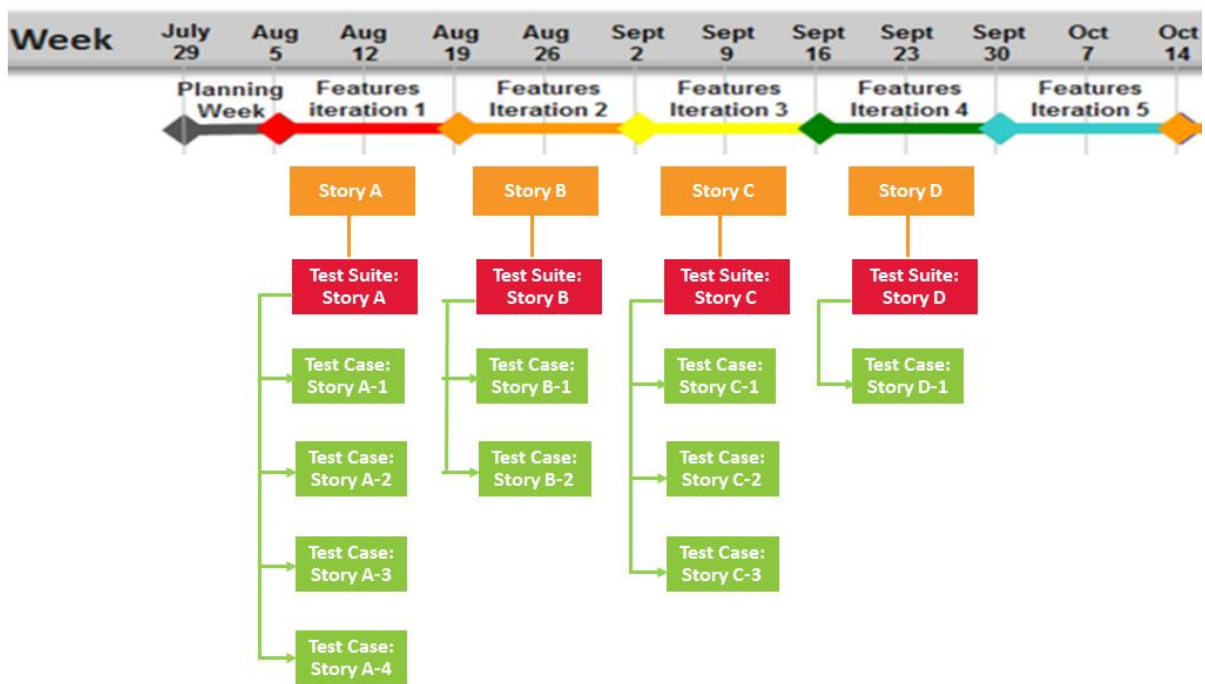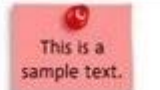
As it has been theoretically described the Scrum methodologies and its advantages, as well its disadvantages, it is time to analyze what it works in practice. First of all, a team who works "under" this theory consists of a Product Owner, the Development Team and a Scrum Master.

More deeply , Product Owner is always a person not an organization, probably Product Owner represent the desires of an organization, but the responsibilities of Product Owner id to maximize the value of the product, as well as the work of the Development Team. Furthermore, Product Owner has a unique role in handling of a project and this is, managing the Product Backlog, which consists of all the items that would be done during the project. Thus, Product Owner should ensure that Product Backlog is visible, transparent and understood for everyone as the Development team is going to work on them. Regarding to Scrum Teams, they are always people who deliver products either iteratively or incrementally, as well as they maximize opportunities for feedback. Development Teams consists of people who are responsible to deliver the potential product in the end of every Sprint, which is the duration through a development effort and could vary in every project based on the duration of it, usually sprints last from 1 to 4 weeks. An important characteristic of a sprint is that during it, changes which could affect the Sprint goal or the quality goals are forbidden, however the scope could be clarified and Product Owner could renegotiate with Development Team. Furthermore, Scrum teams could deliver products iteratively and incrementally and as a result the opportunities of feedback are in the pick. The main characteristic of the teams is that their size is small enough to remain nimble and large enough to complete significant work within a Sprint. At the end, Scrum Master is responsible for the Development Team, so they ensure that Scrum theory, practices and rules are clear for every member.

The daily work of a team who works under the instructions of Scrum methodology is to have every a short meeting every day in order to express how much work have been done the previous day, the troubles they faced with, as well as the goals they tried to achieve for this day. In the end of every Sprint they need to schedule the next one, its duration has been

already decided in the planning of the project. Through this repeatability during an executing of the project, it is clear how important is feedback for Scrum methodology, as Development Team has the opportunity to improve the features of the product in every step and not in the completion of it.

Chapter 4

4.1 Business Process Management

A process is "an organized group of related activities that work together to create a result of value" or "a network of customer – supplier relationships and commitments that drive activities to produce results of value.

Process models are typically activity network models. Ambiguities, uncertainties, and interdependencies of activities their results, their assigned people and their tools make product development processes extremely complex and challenging to model. In other words, a business process is a complete, dynamically coordinated set of activities or logically related tasks that must be performed to deliver value to customers or to fulfill other strategic goals. That's why Business process has been defined as the set of activities, which are required to achieve a common goal. These activities may be performed by people or systems and are completed either sequentially or in parallel. In other words, process is everything get done during a project, thus they have such an important confrontation by companies.

Business Management Process (BPM) is a management discipline focused on using business processes as a significant contributor to achieving an organization's objectives through the implement, ongoing performance management and governance of essential business processes. Business process management (BPM) can be defined as a disciple of design,

modeling, execution, monitoring, and optimization business processes to increase profitability. The fact that BPM is a disciple rather than a technology or a tool has increasingly importance, as it is not a merely software organizations purchase and install to fix a business issue without people's contribution. In fact, a key difference between workflow and BPM software is that the BPM software goes beyond merely automating work to helping people with continuous process improvement. An important fact relate to BPM is that it is successful under the condition that it continuously meets predetermined goals both within a single project scope and over a longer period of time.

As the saying goes, the only constant life is change, thus as organizations change, the environment changes, technology changes (very rapidly nowadays), processes need to change as well. It is highly important to consider business process management as a continuous cycle by its parts (design, modeling, execution, monitoring, and optimization), so if a step is changed all the cycle would be affected and the best suggestions would be eventually implemented. Through this way, organizations are able to make continual and incremental improvements to the process.

Moreover, BPM is a management approach focused on aligning all aspects of an organization with wants and needs of clients. Its advantage is that promotes business effectiveness and efficiency but strive for innovation, flexibility, and integration with technology. Another pro of business management process (BPM) is that attempts to improve processes continuously, thus it could be characterized as "process optimization process". The significant difference of BPM with the traditional hierarchical management is that make organizations enable to be more effective, more efficient and more capable of change. Generally speaking, the most

significant BPM advantages are efficiency, visibility, control, flexibility, speed, production management, performance management, and resource management, which all compromise booster factors for organizations' performance.

A characteristic of Business processes is that it is highly significant for organizations to realize their great variety. There are many ways to categorize the processes and some of the criteria are complexity, duration, volume, industry, and department. The main reason of this need is that some types of processes are not well-suited to being managed within BPM software, which has highly importance for organizations' tackling the processes.

As mentioned above, business process management is a discipline consisting of 5 phases: design, modeling, execution, monitoring, and optimization. Let explain more each phase in order to understand the existence during a project.

❖ Design: Process Design contain not only the identification of existing processes, but also the design of potential processes. A characteristic in this phase is that good design could reduce the number of troubles over the lifetime of the process.

❖ Modeling: In this phase all the combinations of variables would be introduced based on the theoretical design

❖ Execution: There are some ways in order to execute the processes of a project, one of them is to develop or purchase an application, which do the required steps. Another one is to use a combination of software and human intervention.

❖ Monitoring: In this phase the process performance is measured, as monitoring encloses the tracking of every individual process. Thus, all information could be easily seen and statistical results could be provided.

❖ Optimization: The retrieving process performance information is included in this phase and it comes from modeling and monitoring phase. Through this could be found all the potential improvement activities and overall this creates greater business value.
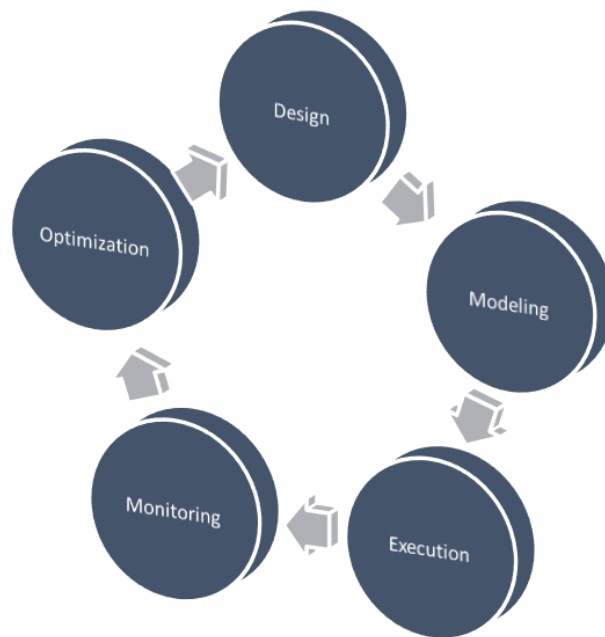
The world of business processes has changed dramatically over the past few years. Processes can be coordinated from behind, within and over organizations natural boundaries. A business process now spans multiple participants and coordination can be complex.

The proven positive effects of using BPM has led to be created a Business Process Modeling Notation which would be described deeply more above. But which are the success factors of business process management? There are a lot of theories regarding them and according to every one there are different factors which lead to success, however there are some which are almost always included in the list of the success factors of business process management. Some of them are the top management support, project management, project champions, communication, inter-departmental cooperation, end-user training. Moreover, it is highly

significant to be mentioned that apart from the success factors, there are also some which lead to a failure and one very important is the misunderstanding of the BPM which has a result the misapplication of it. As a conclusion of all the above, BPM can help in the execution of a strategic program by enabling a better match between the organizational strategy and a company's business process, BPM could influence both the strategy of the organization and the most critical areas for success, but all of these under the condition of well understanding and applying of BPM, as well as continuous improvement which prerequisite, the assurance of up-to-dated business process models.

4.2 Business Process Model and Notation

Business Process Model Notation (BPMN) is developed by Business Process Management Initiative (BPMI) with a way to provide knowledge to everyone who is dealing with business. BPMN is a model which helps organizations to represent all their procedures graphically. Thus, it is first goal of this technique is to be readable and understandable by all business users regardless to their background. Another characteristic of this model is that it should be able to create a standardized bridge for the gap between the business process design and process implementation. Thus, the result of using BPMN is a network of graphical objects, which are activities and the flow controls that define their order of performance.

Until BPMN, there has not been a standard modeling technique developed that addresses these issues. BPMN has been developed to provide users with a royalty free notation. This will benefit users in a similar manner in which UML standardized the world of software

engineering. There will be training courses, books and a body of knowledge that users can access in order to better implement a business process.

Business Process Model and Notation (BPMN) is a tool which provide businesses with the capability of understanding their business procedures in a graphical notation and will give organizations the ability to communicate these procedures in a standard manner. Furthermore, the graphical notation will facilitate the understanding of the performance collaborations and business transactions between the organizations. This will ensure that businesses will understand themselves and participants in their business and will enable organizations to adjust to new internal and B2B business circumstances quickly.

The Business Process Model Notation (BPMN) is a graphical notation that depicts the steps in business process; it depicts the end to end flow of a business process. The notation has been specifically designed to coordinate the sequence of processes and the messages that flow between different process participants in a related set of activities.

BPMN is targeted at a high level for business users and at a lower level for process implementers. The business users should be able to easily read and understand a BPMN business process diagram. The process implementer should be able to adorn a business process diagram with further detail in order to represent the process in a physical implementation. BPMN is targeted at users, vendors and service providers that need to communicate business processes in a standard manner.

Representing more deeply the BPMN; it is a set of graphical elements are used in every BPD in order to create simple diagrams which are also familiar to most business analysts, as the role of BPMN is to create a simple mechanism for creating business process models, while at

the same time being able to handle the complexity inherent to business processes. Within the basic categories of elements, additional variation and information can be added to support the requirements for complexity without dramatically changing the basic look-and-feel of the diagram. The four basic categories of elements are:

✓ Flow Objects

The symbols which belongs to Flow Objects are: Event, Activity, Gateway

✓ Connecting Objects

The symbols which belongs to Connecting Objects are: Sequence Flow, Message Flow, Association

✓ Swimlanes
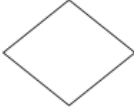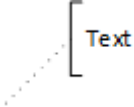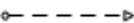
The symbols which belongs to Swimlanes are: Pool, Lanes

✓ Artifacts

The symbols which belongs to Artifacts are: Data Object, Group, Annotation

The most commonly used symbols are represented in the table above:

Table 4.2.1

Task		Gateway	
Intermediate Event		End Event	
Start Event		Collapsed Sub-Process	
Expanded Sub-Process		Text Annotation	
Sequence Flow		Association	. . . .
Message Flow		Message	
Data Object		Data Store	
Group		Pool / Lane	

The usage of BPMN in business is large and important for the operation of an organization. They use it in order to transfer the information to different audiences. BPMN is designed to cover many types of modeling and allows the creation of process segments as well as end-to-end business processes, at different levels of fidelity.

Chapter 5

5.1 Initial Implementation

The implementation of the processes would take place with both methodologies, as it mentioned above as well. Through waterfall model, the processes are designed linear, there are dependencies among the activities and all the activities follow a logical series. On the other hand, the agile approach shows a different approach of product development processes, as all the components are in a backlog and the team could choose which of them could implement in every sprint. The fact that is quite useful for the team, as it helps them to be more flexible and receive the feedback from every component earlier.

Trying to achieve a better representation of the product development processes using both models, a real – tangible product has been used as an example, it is an ultralight bike. The decomposition of the deliverable product represented in the WBS of the project, which consists of the root of planning the workflow of the product, the dependencies among the activities, and help to organize the resources would be used on it. Through WBS of the project, the first level of the procedures are represented, afterwards in the BPMN diagram a deeper analysis of two activities has been set in order to understand better the sequence of them. The two chosen activities are an example; the same work could happen in every activity as deep as the team wishes. Furthermore, the two activities has been chosen on purpose,

because one of them (engineering carbon frame) is related with the internal environment and the other one (outsourcing eGear) with external.

Reading to the BPMN diagram, using waterfall methodology all the activities has designed in a linear model. Based on WBS every different part consists of a different phase, in which there are activities with a variety of duration. There are dependencies among all the activities, which are included in one phase and then there is connection with the next phase. The main characteristic of this diagram is that if not all the activities of one phase are not finished, the project team could not proceed in the next activities, which derives from the liner planning.

5.2 Case Study

As it mentioned above, the product used as an example is an ultralight bike. The composition of the deliverable product is designed via WBS. There are 4 main phases for the product development, the first one is the engineering activities, the second is the prototyping of the model, the third one includes all the testing activities, then there is a small series production phase and the last phase is the release of the product. All these activities appeared in the WBS below.
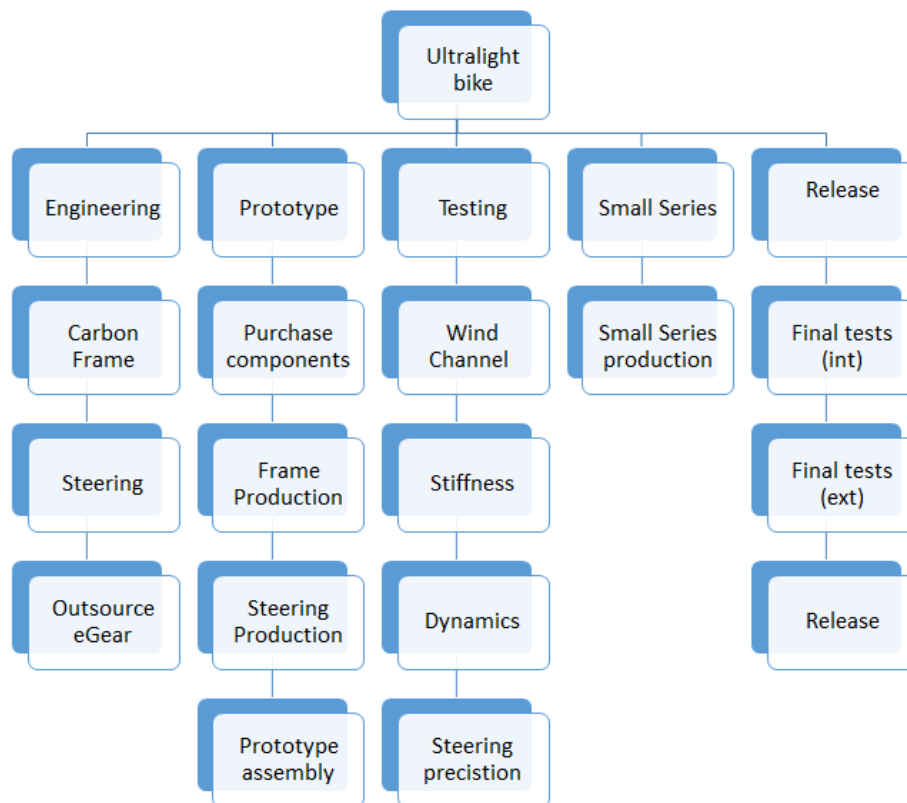
Afterwards, using BPMN model there is a graphical depiction of the whole procedure of the project. Through it, every phase consists of a group of activities, which are connected with dependencies and there is a linear design among them. One important characteristic is that the integration of one phase is prerequisite for the next one. For example, every activity in engineering phase must be completed in order to proceed in the prototype phase. In the BPMN diagram below, the whole process of the product development of the ultralight bike is represented. Not only there is a logical sequence among the activities, but also there are strict dependencies in some cases.
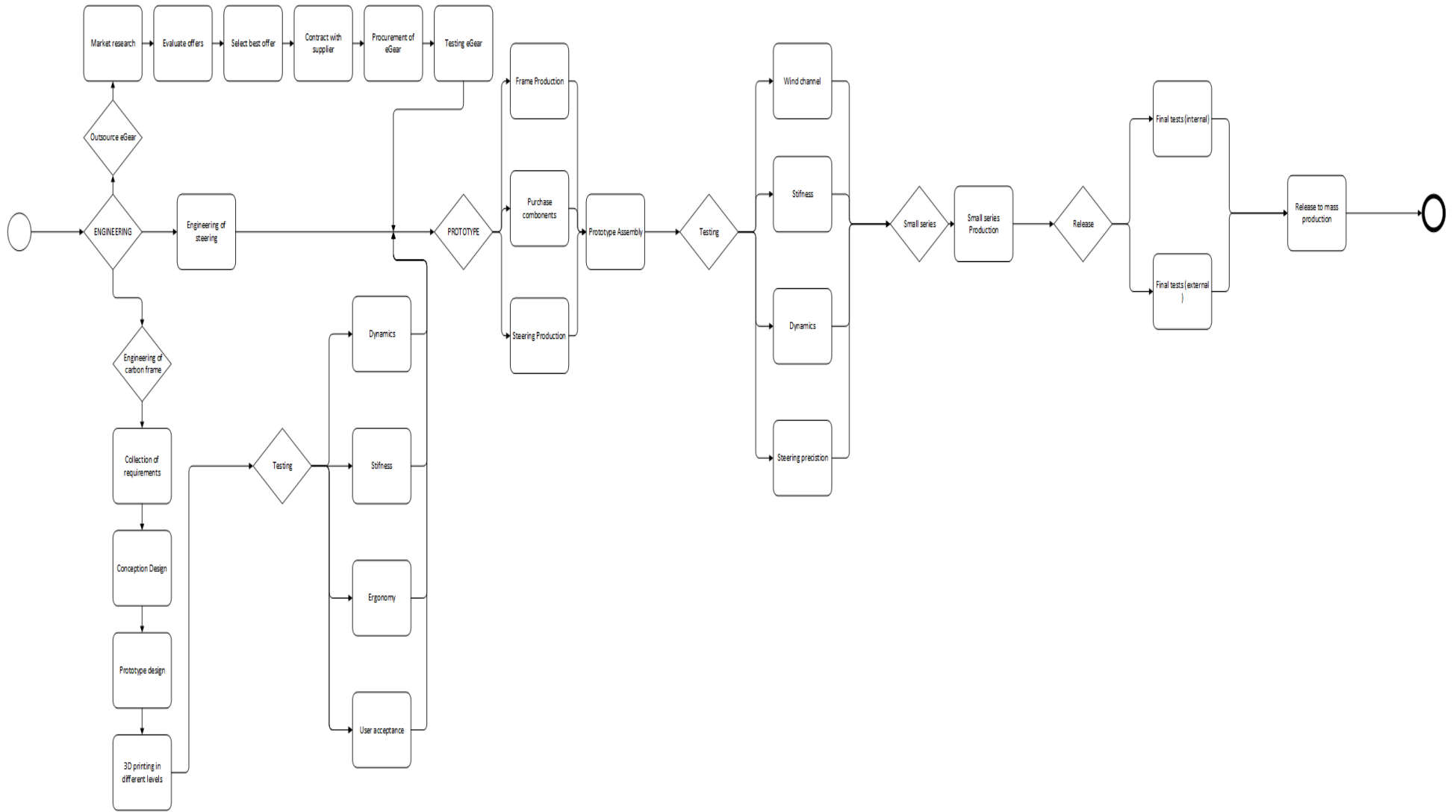
Regarding to the agile approach of the project using scrum management, all the activities are included in the backlog. Thus, in every sprint the team is responsible to decide which of them they will implement. There is not a decided plan before the beginning of the project, but in the beginning of the sprint, they fill in the activities in "their planning diagram".

Analyzing deeper the project in the following table, the duration of each activity is appeared and the assumption that the project team consists of 10 members and everyone could accomplish every activity would help to represent the whole procedure of the project in a Gant chart using waterfall methodology and every sprint using scrum project management.

Table 5.2.1

Description	Duration	Work in hours	Description	Duration	Work in hours
Engineering carbon frame	5 days	40	**Purchase components**	1 day	5
Collection of requirements	3 days	15	**Frame production**	2 days	30
Conception design	2 days	30	**Steering production**	1 day	10
Prototype design	4 days	40	**Prototype assembly**	8 days	60
3D printing in different levels	3 days	20	**Wind channel**	1 day	8
Dynamics testing of carbon frame	1 day	5	**Stiffness testing**	1 day	6
Stiffness testing of carbon frame	1 day	6	**Dynamics testing**	1 day	5
Ergonomic testing of carbon frame	1 day	4	**Steering precision**	1 days	8
User acceptance of carbon frame	2 days	8	**Small series production**	10 days	100
Engineering of steering	2 days	20	**Final tests (int)**	5 days	50
Outsource eGear	4 days	30	**Final tests (ext)**	5 days	50
Market research	2 days	18	**Release**	1 day	3
Evaluate offers	2 days	10			
Select best offer	1 day	8			
Contract with supplier	2 days	20			
Procurement of eGear	2 days	10			
Testing eGear	1 day	4			

In the following Gantt chart, the implementation of the project using waterfall model is represented. All the activities are connected as soon as possible; their dependencies are clear as their connection is through a line in the chart, as well as the sequence among them. The red activities are those, which are characterized as critical and any delay on them it is going to cause delay overall project. On the other hand, there are some blue activities, which are not in critical path and there is a slack for them either they could start later either they could finish earlier without causing any delay in the project. This time lag for delay is represented in the cart with a green line. Furthermore, through this chart, we could some more useful information about the project. Some of them are; the duration of every activity, as every activity is depict as a square in a timeline, the whole duration of the project, the start day and finish day of it and so on.

Chart 5.2.1 Waterfall model
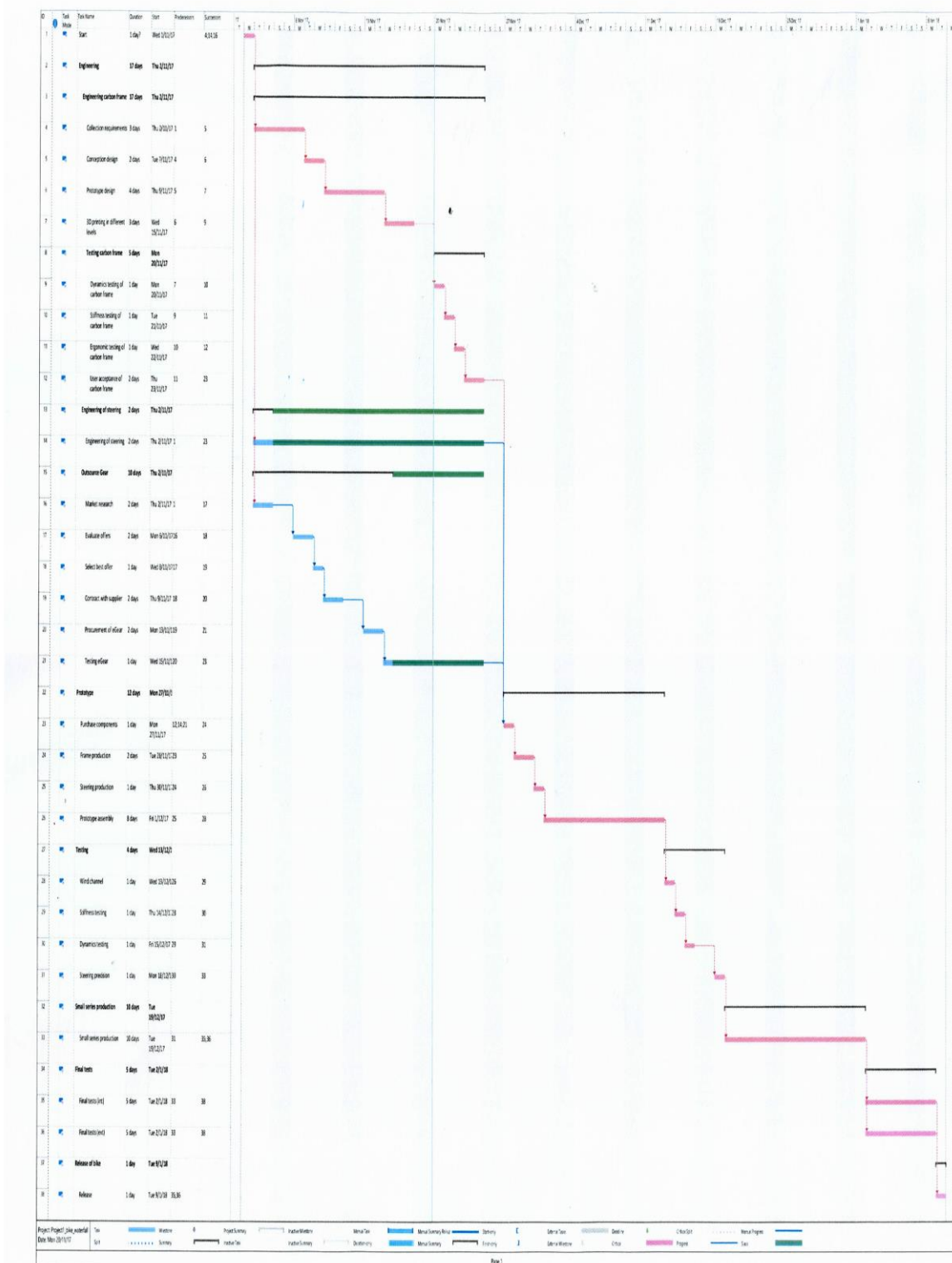
The next step is to align the resources in every activity. As it mentioned above we have assumed that our team consists of 10 members, thus we named them as A Engineer, B Engineer and so on. Every engineer is responsible for some activities, and some of them are responsible in one activity as a small team. Thus, in the next Gantt chart, we can notice that there are some over allocation on the resources; some of our engineers need to work more than their maximum. Through the resource diagram (there is an example of A engineer and F Engineer), which is below, the over allocation of the resources is represented clearly. The over allocation means that any engineer has to work more their maximum in the same time.
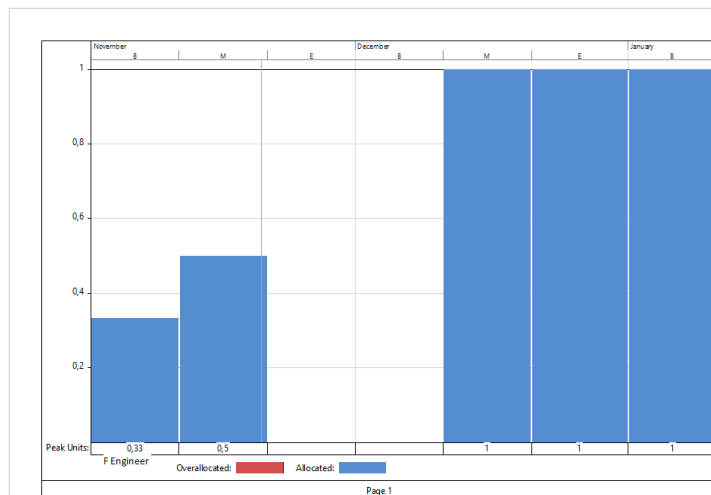
Chart 5.2.2 Waterfall model after resources
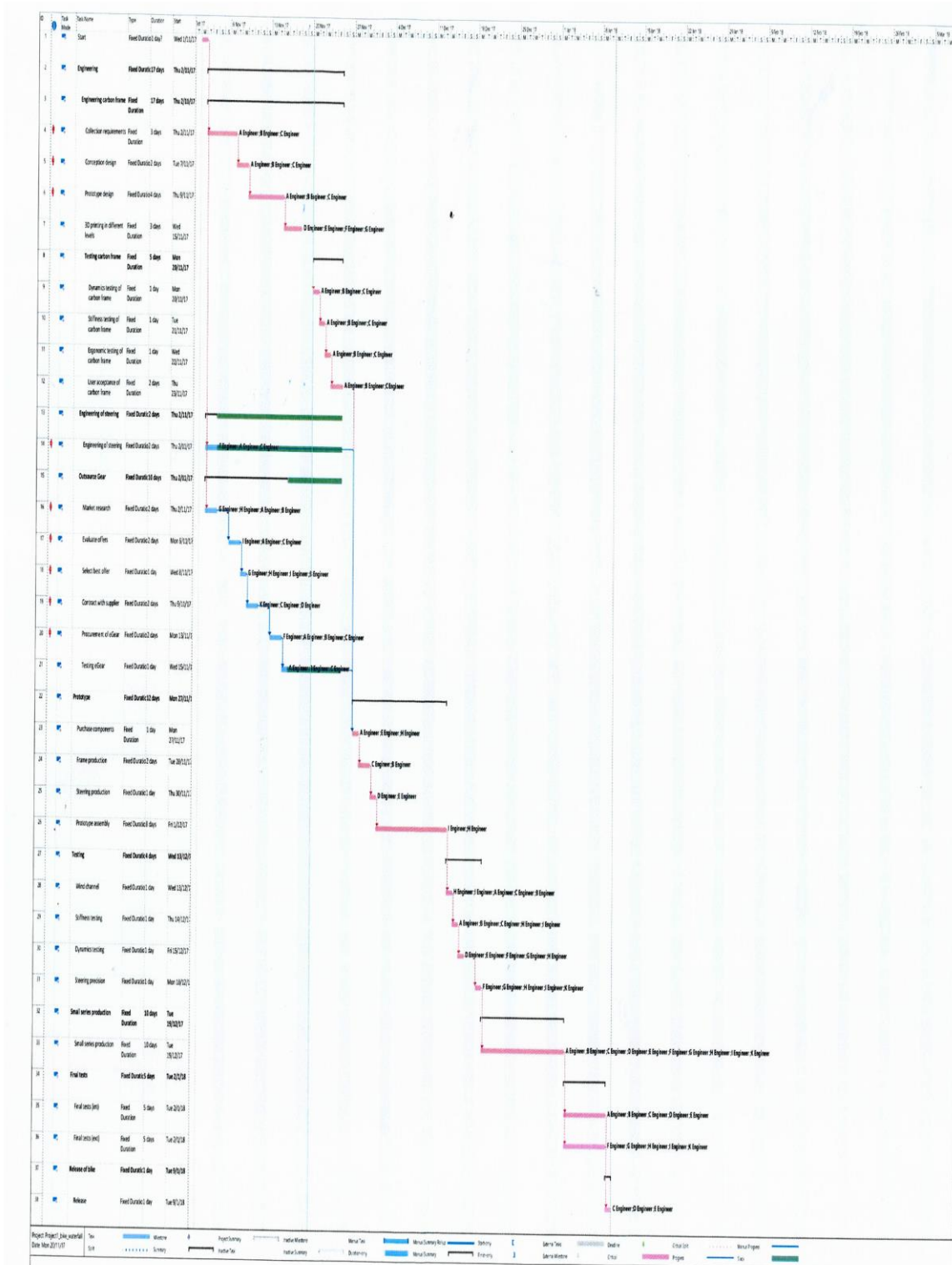
Resource diagram 5.2.1
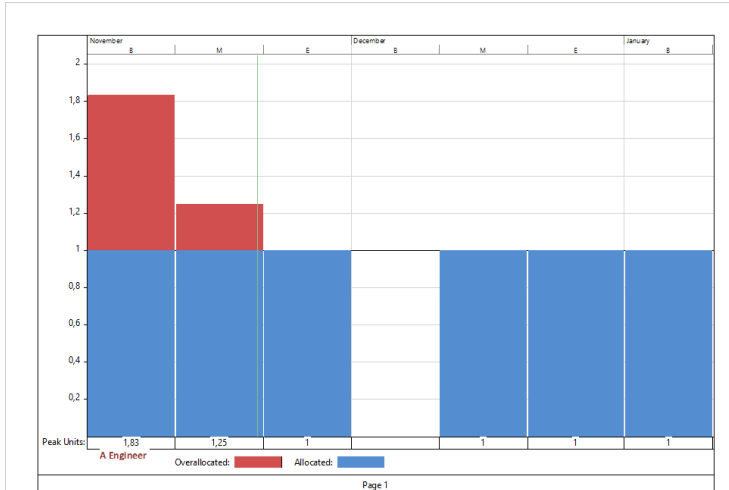
Example A Engineer

Example F Engineer

Trying to solve the trouble of over allocation, we used the leveling method twice. In the first trial, we kept all the dependencies of the project the same and in the second one, we have no such strict dependencies. In the first example we could notice that the over allocation trouble remains, while in the second on it has been resolved. However, the duration of the project has been increased without affecting the work on the project. These two trials are represented below:
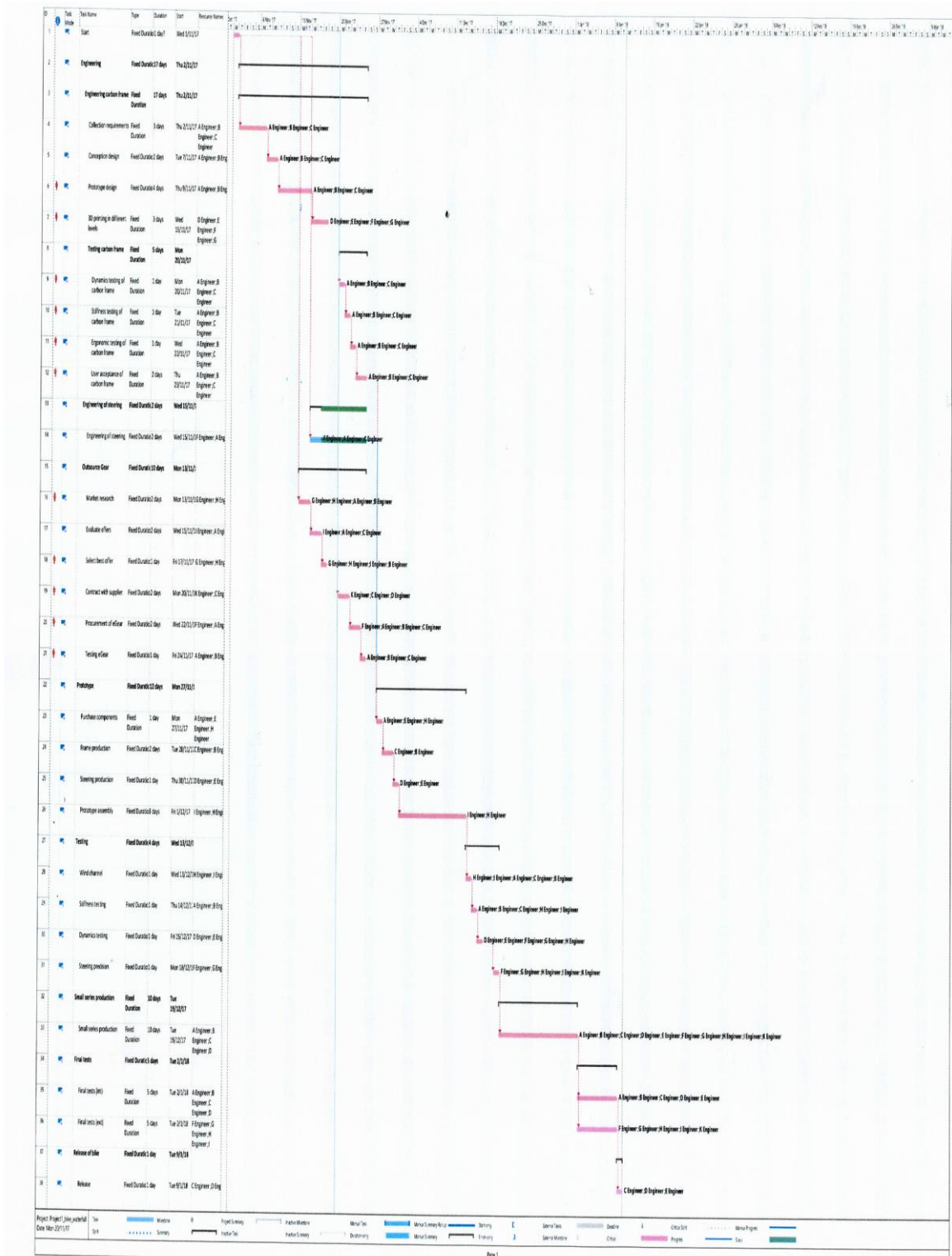
Chart 5.2.3 Waterfall model after 1st levelling
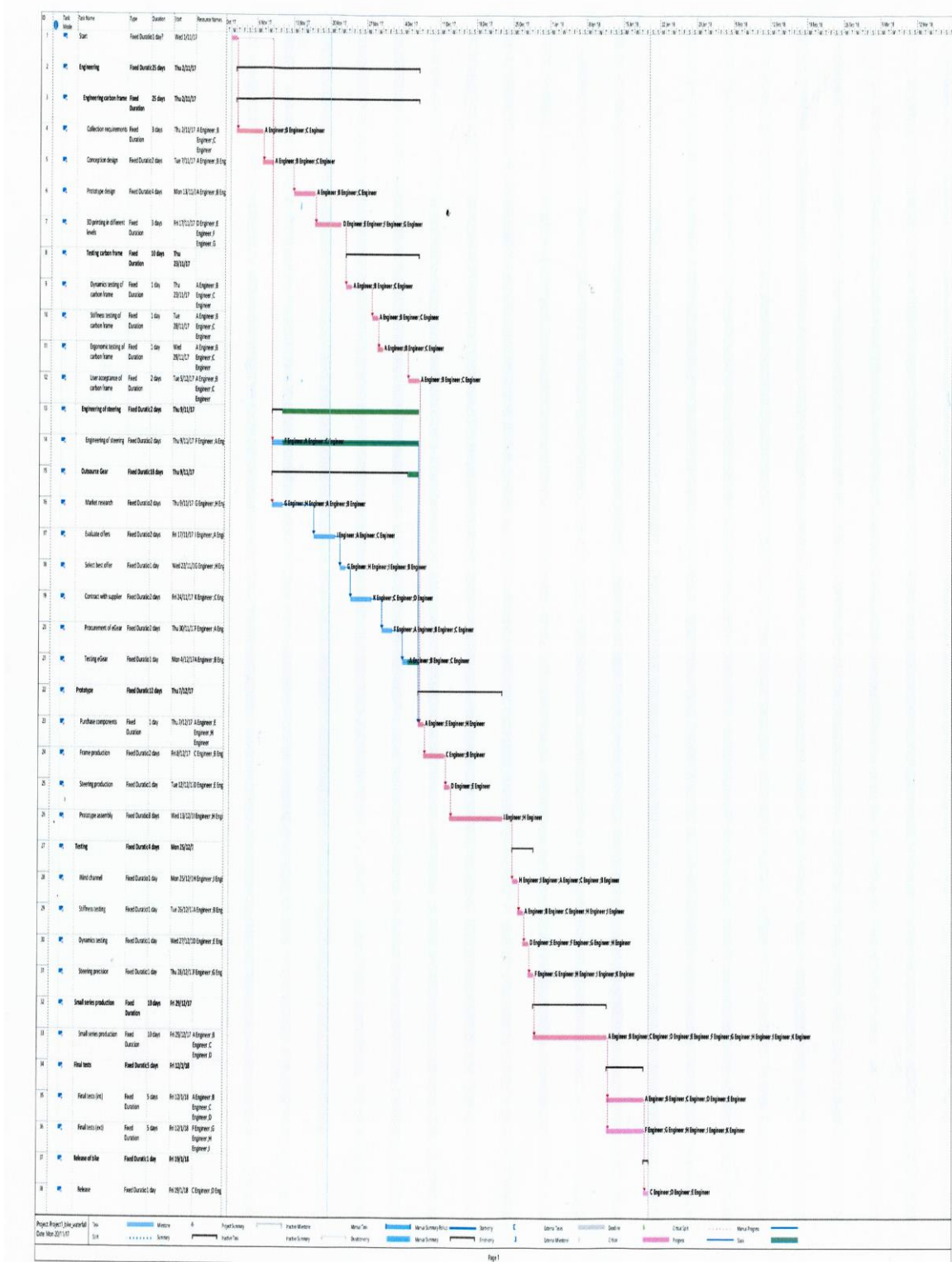
Chart 5.2.4 Waterfall model after 2nd levelling

After the 2nd trial of levelling, the over allocation trouble has been resolved. This is represented very well in the example resource diagram below:
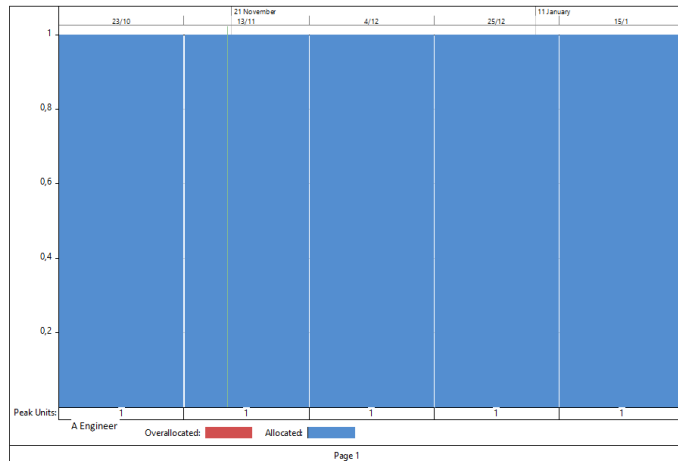
Example A Engineer
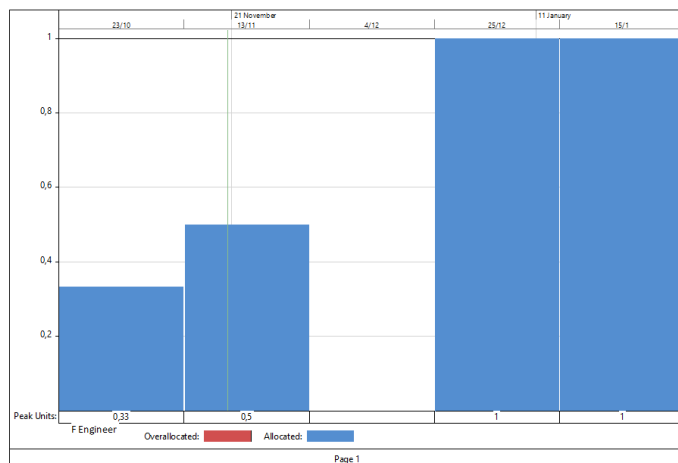
Example F Engineer

The other approach of the project is the following using scum project management. The team based on the tasks table should decide which activities could include in the first sprint and all the planning is taking place in the whole duration of the project. However, for the needs of this thesis we assumed that all the engineering phases are independent among them so they

can start in parallel. Furthermore, every task is repeated and at some point there are tests tasks through them the scrum team could take the feedback and improve the development of the component. In the following Gantt chart the activities with the names; Engineering carbon frame", "Engineering steering", "Outsource eGear", "Prototype" and "Testing Prototype" represent a group of activities, which are recurring in our project, so that we could have the feedback and proceed in improvement tasks. An example of one of this group of activities has been designed as well as with MS Project and it is represented in the Gantt chart below as well.
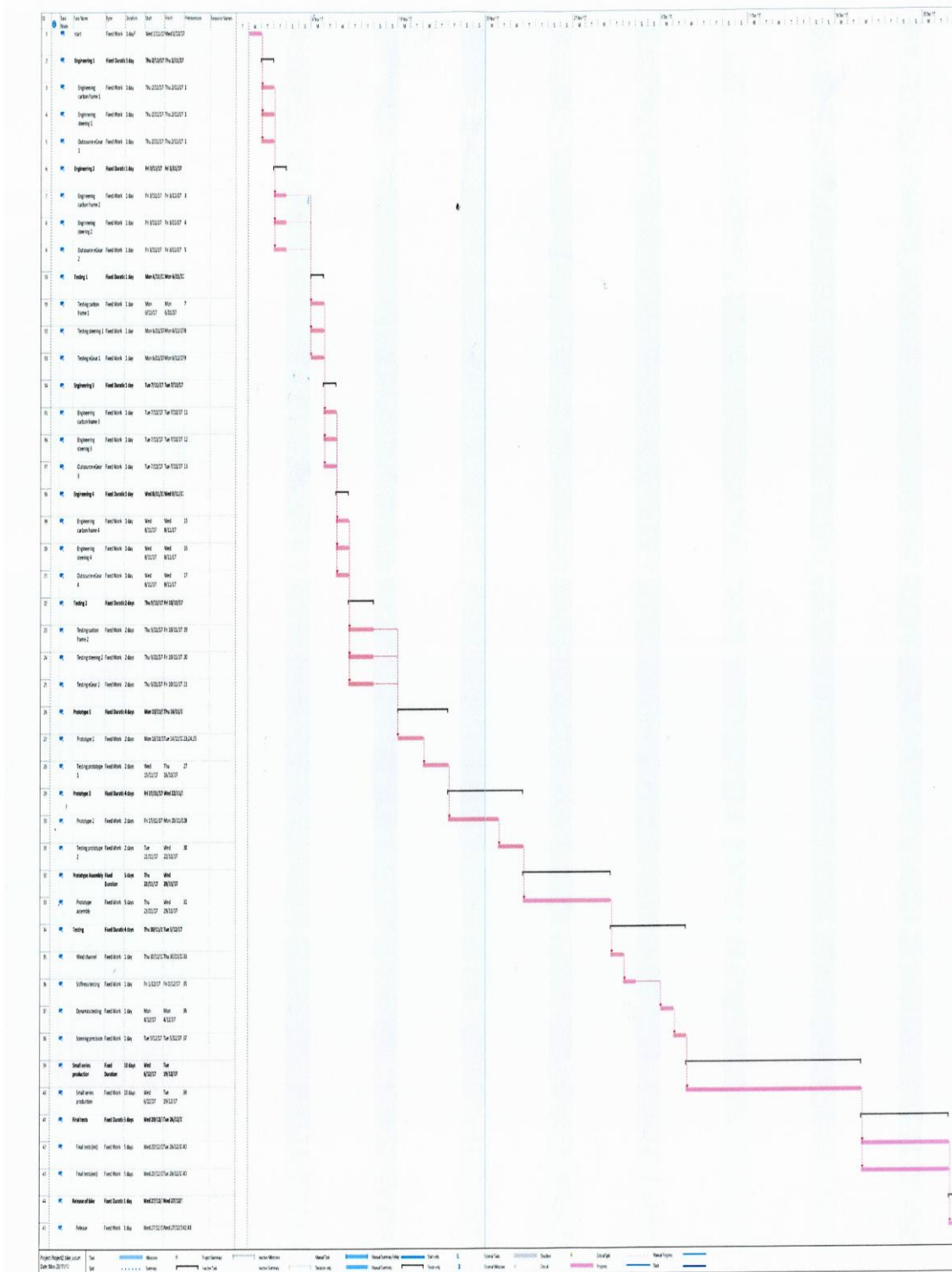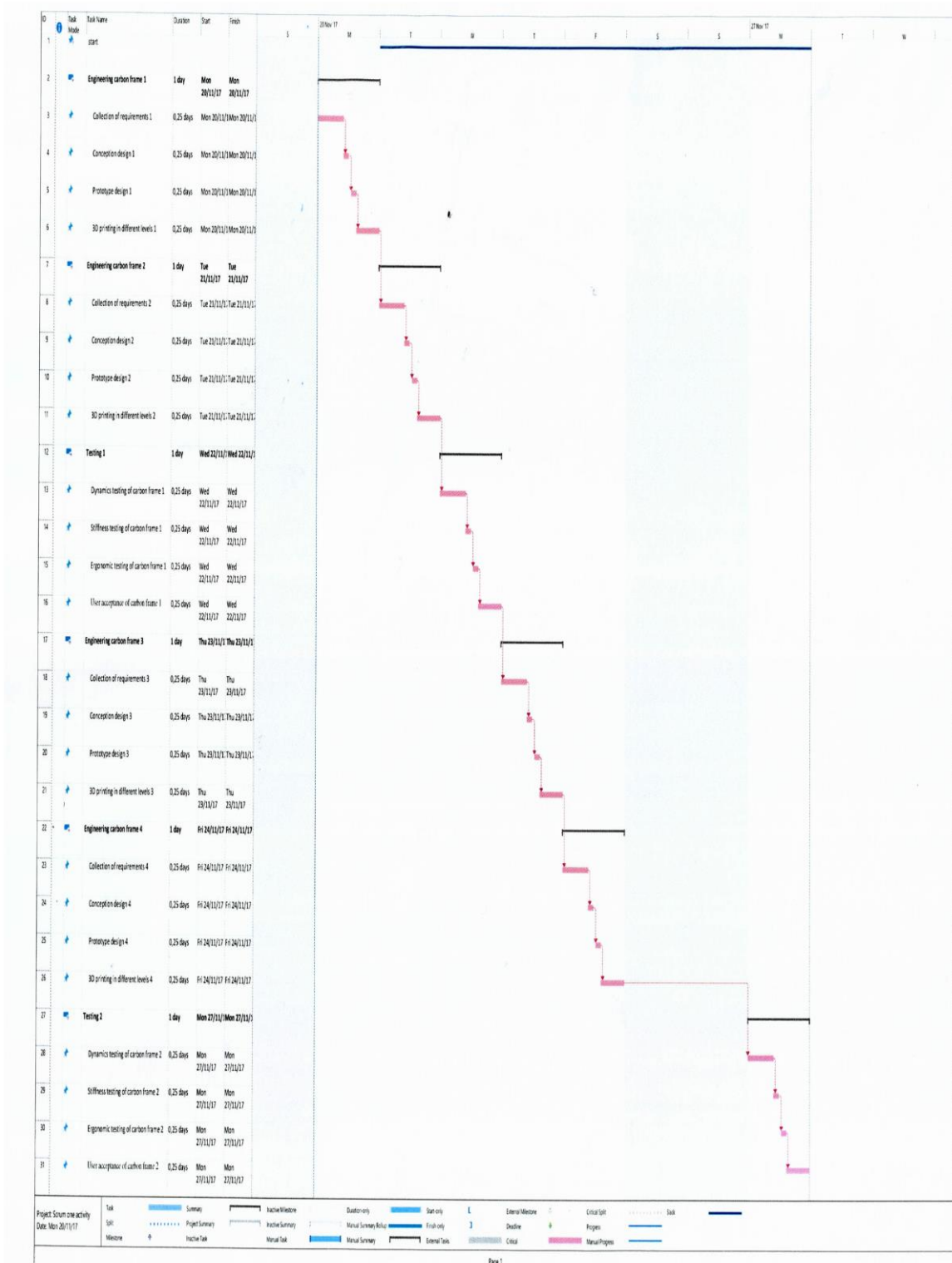
Chart 2.5.5 Scrum model in groups

Chart 2.5.6 Scrum model one activity

Chapter 6

6.1 Conclusions

After all the study on business processes and how a product development process could be considered as a project, which has been analyzed in this thesis, we have come into the following conclusions:

- ➢ First of all, we have noticed that every project could be implemented and designed via BPMN and it is independent to the methodology that it used for the project management. The graphical depict could be the same as it is the tool for everyone who is dealing with the project to understand better the logical connection among the activities through the logical depict. Furthermore, this graphical depict is the tool, which represents the steps among the processes and it is designed with a way in order to facilitate the coordination of the process, as well the communication among the project team members regarding to their tasks.

- ➢ Based on the conclusion above, via this thesis, the same project was implemented using two different models-methodologies. All the processes of development a bike was the example project, thus this project was planned by waterfall and scrum methodology, taking into consideration the graphical depict was the result of BPMN implementation. The conclusion of this implementation is that every project could be

implemented with any methodology. Even if the project has the traditional form and it is usually implemented by waterfall model, it is possible to be handled by scrum methodology. However, every organization has its needs and expectations from each project and the decision of the methodology consists part of strategic management.

➢ We noticed, as well that in the resource diagram using waterfall model there are many fluctuations, the chart is not uniform. This is a typical characteristic of waterfall model, which derives from project constrains among the activities. In this thesis, we noticed that using waterfall model, after the assignment of the resources, in resource diagram we had over allocation in resource, which means that an engineer has been assigned by more work than their maximum. In the sequence, after resolving this trouble, we noticed that there are gaps in the diagram, which means that this resource is not used in the maximum

➢ Another conclusion has emerged by trying to solve the over allocation situation in our project, we note that it was not possible without changing some conditions of the project. In the first try, the over allocation problem was not solved, as we tried to solve it without affecting the duration of the project. This happened because there are strict dependencies among the activities. On the second try we left the conditions more flexible and the result was to solve the over allocation trouble. The main conclusion of it is that while the work remains the same the duration of the project has been increased. This was the fact which managed to confront the over allocation, which was constrain in the previous example. However, leaving the duration constrains a bit more flexible, which of course has an effect on the cost.

➢ Regarding to project implementation using scrum project management methodology, we can notice that the feedback we take in every step of the project could be very useful in the sequence of it. Furthermore, there are tests quite early in the projects, which has the advantages to predict or to avoid some potential problems, which could arise, as well as trying to improve every component step by step.

➢ Another important conclusion derives from the resources diagram, as in this case is more smoothly without slack or over allocation. The scrum team in the beginning of every sprint has to decide about the tasks that they are able to implement, it is not pre-designed in the beginning of the project as it is in waterfall projects.

➢ Considered both methodologies, very significant conclusion is that in the implementation using waterfall methodology, some of the activities are critical and some of them not; there are slacks on them, which derives from the serial sequence among the activities and they are not affected on project. However, these slacks consist of dead time on project, as one activity has to wait for the completion of another one and no work is possible to be done. On the other hand, using scrum methodology all the activities are critical, which means that not only if any of the tasks has any delay the whole sprint is going to delay, but also that the whole time is exploitable.

References

1. A Guide to the SCRUM BODY OF KNOWLEDGE (SBOK GUIDE), edition 2016

2. Adel Alshamrani and Abdullah bahattab, A Comparison between Three SDLC Models Waterfall Model, Spiral Model and Incremental / Iterative Model (January 2015)

3. Barry Boehm, Richard Turner, Management Challenges to Implementing Agile Processes in Traditional Development Organizations (2005)

4. David N. Ford and John D. Sterman (1997), Dynamic Modeling of Product Processes Development

5. Griffin Cristina, Roldan Margaret, Swimming up the waterfall agile processes in a waterfall world, 2013

6. Jason Charvat, Project management methodologies selecting, implementing, and supporting methodologies and processes for projects., 2003

7. Ken Schwaber () SCRUM Development Process

8. Marta Indulska, Peter Green, Jan Recker, Michael Rosemann, Business Process Modeling: Perceived Benefits (2009)

9. Martin Devillers, Business Process Modeling as a means to bridge The Business-IT Divide, August 2011

10. Mike Danilovic, Tyson R. Browning, Managing complex product development projects with design structure matrices and domain mapping matrices, (2007)

11. Peter Trkman (2010) The critical success factors of business process management, University of Ljubljana, Faculty of Economics, Kardeljeva pl. 17, 1000 Ljubljana, Slovenia

12. PMBOK Guide 5th Edition

13. Stephen A. White, Introduction to BPMN (2004)

14. Susumu Ogawa and Frank T. Piller, Reducing the Risks of New Product Development (2006)

15. The definition Guide to Scrum: The Rules of the Game

16. Theofanis Giotis, SCRUM: Η πιο απλή ιδέα στον πλανήτη που άλλαξε τα πάντα στο Management!, January 2014

17. Theofanis Giotis, Χρήση της SCRUM για Organizational Change Management, October 2014

18. Tyson R. Browning, Ernst Fricke, and Herbert Negele, (2005) Key Concepts in Modeling Product Development Processes

19. Yiannis Vithynos, CAPM Certification Examination Preparation

20. https://activecollab.com/blog/project-management/waterfall-project-management-methodology/

21. http://www.itinfo.am/eng/business-process-management/

22. https://en.wikipedia.org/wiki/Project_management

23. https://www.pmi.org/about/learn-about-pmi/values

24. http://www.bpmn.org/

25. http://searchsoftwarequality.techtarget.com/definition/spiral-model