

Scope Management on Software Projects

An updated approach to maturity levels and services in the Gaia Scope Framework

Darlan Dalsasso

Departamento de Computação, Universidade Estadual de
Londrina - UEL
Londrina, Brazil
darlan_dalsasso@hotmail.com

Rodolfo Miranda de Barros

Departamento de Computação, Universidade Estadual de
Londrina - UEL
Londrina, Brazil
rodolfomdebarros@gmail.com

Abstract— Software development is a complex activity and one of the most important activities to be developed in working with the requirements of each software project. This work addresses the development of the Gaia Scope Framework [3], as a tool and as a methodology to be followed by engineering and product scope management in software projects. The structure of the framework is composed of services. These services are the activities to be developed and are divided into different levels of maturity, where the goal is to get the company to reach the optimized level. Allied to that, the main work is the diagnostic evaluation questionnaire and the implementation process of the framework. This article presents an update of the maturity levels and services that had been initially defined, due to the need to make the framework easier to understand and take care of. The main objective of this study is the development of the Gaia Scope Framework, and that it guides and assists system and software engineers in the production of complete, correct and unequivocal requirements that meet the needs of users.

Keywords - quality; software; framework; requirements; project management.

I. INTRODUCTION

Software development is an activity that is constantly evolving. The search for new techniques that will help and improve the way to build software with higher quality and that mainly meets the needs of its users motivated the development of the Gaia Scope Framework.

Studies are carried out and applied in the corporate and academic environment with the objective of developing better techniques and tools that assist in the development of software; the Gaia Scope Framework focuses on the scope of products in software projects because it has its focus on what 'needs' to be developed in software.

Many of the difficulties that are encountered are often due to not knowing which activity needs to be developed first and what sequence of steps is needed later. There is also the situation of knowing what is the ultimate goal to be achieved, but not knowing how to achieve this goal.

In this study, we are proposing the development of a framework for managing the product scope in software projects, known as the Gaia Scope Framework.

The framework has undergone an update the levels of maturity. In the first version they were known as: undefined,

known, managed, quantitatively managed, optimized. In the current version, the levels have been updated to: undefined, known, defined, managed, and optimized. In the same way, the services of the first version were: establishing the strategy, planning the scope management, collecting the requirements, defining the scope, creating the project analytical framework (EAP), validating the scope, controlling the scope, costs, the time, stakeholders, and the last service was in continuous improvement. In the current version, services are known as: establishing strategy, requirements and scope research and analysis, requirements / scope specification and negotiation, requirements / scope validation, requirements / scope management, maintenance and requirements / improvement (involves all areas and scope management services). This update was necessary due to the in-depth study and the need to make the framework more coherent and functional in relation to the purpose of the framework, which is to facilitate working with the elicitation, specification, approval, management and control of the product scope in the known projects as requirements.

This framework can be treated as a tool to be used or a methodology to be followed because it expresses through services the activities that need to be developed and how they can be carried out to reach the final objective.

The services are divided into levels of maturity so that the implementation of the framework is gradual and incremental. An example would be the following: in order for the company/institution to achieve the defined level of the framework, it must be able to develop the services that comprise this level, which are: requirements specification or scope negotiation and the requirements validation service. When reaching the objectives of each of the two services, it is understood that the defined level has been successfully achieved, which enables the company/institution to seek to develop the services of the above level that is managed.

One of the ideas that surround the framework is that users can develop the activities necessary to successfully reach the services that make up each level of maturity in a gradual way, until reaching all services of the highest level, which is optimized, where it is possible to affirm that all services of the levels have been successfully achieved [3].

The structure is different from other works like [1][7], [8][12] because it not only suggests what needs to be developed but also the goal to be delivered. In the case of the

Gaia Scope Framework, the services are responsible for presenting the information that needs to be elaborated.

An example is that each service presents some templates that can be used by analysts to develop their work. Services are key items within the framework, as they facilitate the conduct of analysts in the work required to achieve the expected goal.

The Gaia Scope Framework is formed by different services, which are the activities to be performed, which have a structure composed of different information, such as service description, document templates, questions related to the diagnostic questionnaire, among other information.

Referring to the Gaia Scope Framework, the level of maturity refers to knowing how adequate, apt and matured the company is to carry out or develop the implementation of the necessary services for the management of the scope of software products. The maturity level also facilitates the institutionalization and application of services in a gradual way.

The Gaia Scope framework includes the diagnostic assessment questionnaire and the framework implementation process. One of the main ideas is to make services simple and objective, easy to understand. The main idea for the development of this framework was the fact that we know that one of the main causes of the failure in software projects is the existence of difficult-to-interpret requirements, poorly defined, or sometimes due to poor management of requirements, among other factors. These difficulties can compromise all the work that will be developed in relation to activities related to software requirements.

In the software industry is also known that activities related to engineering and requirements management need special attention, since it is a complex and fundamental activity that justifies the development of this framework; if the work related to the requirements is performed correctly, complete and unambiguous, the chance to develop and deliver software that meets the needs of end users is bigger.

This article is divided as follows: in Section 2, the concepts of requirements engineering will be discussed. Section 3 refers to project scope management. Section 4 discusses Information Technology (IT) services concepts and the idea of maturity levels. Section 5 presents a comparative study of engineering and requirements management. Section 6 will address the Gaia Scope Framework and their advantages. Subsection A of Section 6 presents the maturity levels of the Framework Gaia Scope. Subsection B of Section 6 introduces the integration of maturity levels with their respective services. Section 7 presents the conclusions and future works about the study.

II. REQUIREMENTS ENGINEERING

As we approach the software development context, we need to keep in mind what we are going to build for, and to whom we are going to build it for. We can simply understand that a requirement can be a need that has to be satisfied or even a property of a product that already exists [11].

This reflects in the discovery of the minimum details of the product that will be implemented and in the

understanding of all the stakeholders involved. In general way, it is called requirements or requirements engineering.

The task of obtaining the knowledge and understanding the requirements is a problem to be solved and presents itself one of the most complex challenges faced by analysts and software engineers [7]. This is due to the fact that often the customers themselves are in doubt of what they really expect the software to do.

The requirements are the descriptions or specifications of the application to be developed, its operating restrictions, and the services they will offer [8]. These specifications serve as the basis for all the work that is going to be done ahead and are critical to the correct understanding of what is needed to be developed.

The vast amount of tasks and techniques that make analysts aware of what is needed to be developed is called software engineering [7].

Requirements engineering can also be understood as a process that is used to identify, analyze, develop the documentation and verify the resources that the application must offer and the constraints that need to be considered in the development of the solution [8].

Analyzing the concepts presented above, it is possible to be aware of the complexity that such activity has in the software development process.

Obviously, the greater the competence in performing the activity of identifying and documenting the requirements in a simple, clear and objective way, thus maintaining a good management of these activities, can cause the produced work product to have a greater chance and probability of success.

So, the Gaia Scope Framework aims to assist analysts and software engineers in performing their daily work tasks in a standardized, simple and controllable way.

III. PROJECT MANAGEMENT AND PROJECT SCOPE MANAGEMENT

We can identify the existence of projects in practically everything around us. To find a new job, to open a company, to carry out a university, to write a scientific article, among others, involves understanding the needs that we intend to develop in order to reach the main objective, and also, its management in an efficient way to know where we are in the project.

In company/institution, the idea of design becomes more practiced, according to the large number of projects that happen in the world at the same time. Many of these projects are about the development of software to meet the most varied demands of the market.

A survey conducted by the Project Management Institute shows that company/institution, seeking to achieve a high degree of performance in their projects implement twice the number of strategic initiatives that are successfully carried out (76%) from the comparison to low performance company/institution, (38%) [10].

To understand how is possible to be able to evolve in our project, we need to seek continuous improvement, adopting strategies that make it possible to get the most out of the performance and quality of the product generated.

In addition to that, high-performance company/institution lose twelve times less money when compared to non-high performing company/institution., leaving \$ 20 million lost to high-performing companies and \$ 230 million lost to company/institution, that were non-high-performing. This amount is considered for each U \$ \$ 1 billion spent in project expenditures [10].

So that, it is known the difference between company/institution, that are high performance and the ones that are not.

The amount of losses is so bulky that makes us wonder how many projects could be developed with the resources that are lost.

The development of software projects fits well in this need, which leads us to seek to develop them, thinking carefully about the format of projects, and consequently, giving emphasis to the area of project scope management, which is the basis of all work.

A project is an enterprise that does not repeat itself, and which has a clear and logical sequence of events or activities to be developed which seeks to achieve a clear and specific objective, that is accomplished and led by people, considering parameters of time, cost, resources involved and quality [10].

By understanding that each project is unique and theoretically has an established beginning and end, we need to seek to develop the right requirements, primarily by lowering the time for survey and validation of requirements.

According to the Project Management Institute (PMI), a project is a temporary effort, with the aim of creating a product or service considered unique. It is ended when the project objectives are: met, have not been successfully achieved, can not be achieved or the need for the project is over. It can still be ended if it is the client's will or sponsor [9].

Project quality can also be understood as the source of customer satisfaction and project success. When clients are satisfied, we can measure the project success [6].

Project scope management encompasses the activities necessary to ensure that the project includes only what is necessary for its development, nothing else [9].

It means that when we develop projects, we need to think only about what is necessary to be done and delivered, not worrying about activities and artifacts that are not part of the scope.

The Gaia Scope Framework will serve as a tool to be used or a methodology to be followed that will address the key activities that need to be created to ensure that the development and management of the product scope is performed in a correct, complete, clear, modifiable, prioritized, verifiable and traceable.

It will contribute to generating the effective, efficient, reliable and quality product that reach the needs of the product scope management area, but mainly, achieving the needs of the users.

IV. IT SERVICES AND LEVELS OF MATURITY

The Gaia Scope Framework is developed in the service format as discussed below, in section VI. These services are the activities to be built up or can be understood as the objectives to be achieved.

The purpose of a service is to offer something value to customers, enabling them to accomplish their expected results in a measurable way [3]. Obviously, each of these services aims some value for the project in a unitary way, and all of these services add high value and success in the activities of engineering and requirements management in a general way.

The services strategy refers to IT skills in the generation of service assets [4]. Services are classified as intangible assets, not presenting physical characteristics, but can generate economic benefits for company/institution, [4].

The value consists of two main components that are utility and assurance, where utility is about what the customer receives, and it turns the guarantee on how this value is provided to customers [2].

Another characteristic of the services is due to the fact that clients do not have to bear certain costs and risks [2].

Finally, service management is a set of specialized organizational skills aimed at providing value to all of its customers in the form of services.

The Gaia Scope Framework is developed using maturity levels, as discussed below, in section VI.

Maturity levels are a combination of processes or activities and process empowerment [5].

It is possible to understand that maturity levels are composed of a set of processes that need to be satisfactorily achieved or contemplated, achieving the minimum expected favorable results to ensure that such process is considered satisfactory or unsatisfactory.

Process capability refers to the set of skills to meet business objectives, both current and future, meeting what is required in each process [1].

Each process has its value within the maturity level. It is worth emphasizing that each process has a significant value, which, together with the other processes that make up the level, cause the level of maturity to be reached.

The level of maturity of an company/institution, makes it possible to gain a better understanding of its future performance. This is due to the fact that by the logic, after the company/institution, reaches a certain level, it means that it has the minimum of excellence in the processes that develops from that level, being able to work to implement the processes of the upper levels, that is, trying always to reach improvement in their processes.

It is worth mentioning that once an reaches a level of maturity, it has to work to maintain it, because if it does not, it may not go through an eventual reevaluation of the level in the future.

V. COMPARATIVE STUDY ON ENGINEERING AND REQUIREMENTS MANAGEMENT

In the opportunity to develop this research, and as a way to better understand the main initiatives regarding

requirements engineering, a comparative study was developed between the main references of this area.

In order to develop this study, the works of Ian Sommerville, Roger S. Pressman, MPS-BR, CMMI, in their most current versions were analyzed.

Through the analysis of the literature, it was possible to better understand the activities proposed by each author regarding requirements engineering, and an important asset was developed for the development of the Gaia Scope Framework, which is about updating services as also update the maturity levels that will make up the framework.

This study made it possible to change the version of the services being proposed, as we are going to see later.

A comparative study is presented. See Table I.

TABLE I. MAPPING AND RELATIONSHIP OF ENGINEERING ACTIVITIES AND REQUIREMENTS MANAGEMENT

Mapping and relationship of engineering activities and requirements management	
Ian Sommerville [8]	Viability Study
	Elicitation and Requirements Analysis
	Requirements Specification
	Requirements Validation
	Requirements Management
	Software Reuse: Does not specifically address the process
Roger S. Pressman [7]	Conception
	Survey
	Elaboration
	Negotiation
	Specification
	Validation
	Management
	Reuse of Software: It is approached within the construction of the analysis model
	Historical database: Mentioned within the requirement survey activity and within the construction of the analysis model
MPS-BR [1]	The understanding of the requirements is obtained from the suppliers of requirements
	The requirements are evaluated on the basis of objective criteria and a commitment of the technical team to these requirements is obtained
	Bi-directional traceability between requirements and work products is established and maintained
	Revisions to project work plans and products are conducted to identify and correct inconsistencies with requirements
	Requirements changes are managed throughout the project
	Organizational Culture: It is mentioned in the process attribute that

	refers to whether project execution is managed.
	Historical database: Does not deal specifically with these terms but can be seen the use of historical data in the activity "Changes in requirements are managed throughout the project"
	Lessons learned: It does not deal specifically with these terms but you can see the use of historical data in the activitey "Changes in requirements are managed throughout the project," which can generate lessons learned.
CMMI [12]	1 - Develop customer requirements (Formed by the activities of eliciting needs and transforming the needs of those involved in customer requirements.)
	2 - Develop product requirements (Formed by the activities of establishing product and product component requirements, allocating product component requirements and identifying interface requirements.)
	3 - Analyze and validate requirements (Formed by the activities of establishing operational concepts and scenarios, establishing a definition of required functionality and quality attributes, analyzing the requirements and analyzing the requirements to achieve balance and validate requirements.)
	REQUIREMENT MANAGEMENT
	(Formed by the activities of understanding requirements, obtaining requirements commitment, managing requirements changes, maintaining bidirectional traceability of requirements, ensuring alignment between project work and requirements)
	Reuse of Software: Addresses the idea of reuse of software in the area of requirements development
	In requirements management, the needs passed by the organization are considered. This gives an idea of the consideration of organizational culture.
	Historical database: Addresses requirements database and history of requirements changes. This refers in some way to the historical database.
	Lessons learned: Does not directly mention lessons learned, but does mention the use of history of requirements changes.
Gaia Scope Framework	Establish strategy
	Requirements / scope survey and analysis
	Requirements specification / scope and negotiation
	Validation of requirements / scope
	Requirements / Scope Management (- Involves control of requirements / scope; - Involves control and change management; - Involves requirements / scope traceability)
	Maintenance and requirements / scope history (Involves reuse of requirements - Involves historical database - Involves lessons learned - Involves company/institution culture and company/institution process assets)
	Continuous improvement (Involves all areas and services of scope management)

From this comparative study, we were able to extract the best practices applied in each of the references, where it was possible to design the services that will compose the Gaia Scope Framework.

Soon we were able to create a framework that serves to manage product scope in software projects of any size.

VI. GAIA SCOPE FRAMEWORK

The Gaia Scope Framework is a tool to be used or a methodology to be followed to assist the engineering and management of the product scope in software projects.

From this proposal, leaders and requirements engineers will have a greater ease to surveying, specifying, validating, and managing the product scope of their software projects, thus ensuring greater management, ensuring ease of handling during the work that must be developed and achieving greater assurance and integrity of information.

The composition of the framework will be through services that will be divided into different levels of maturity, as will be analyzed next.

The idea of working with services is due to the fact that we focus on delivering value to users, who will be clients of the framework.

Each service consists of the following elements; service description, document templates, questions related to the diagnostic questionnaire, vocabulary, tools and techniques, performance indicators and workflow.

The service description will provide an objective and direct context about the service. Document templates are basic standards that can be used.

The questions related to the diagnostic questionnaire refer to verifying through this questionnaire whether the service in question is answered or not.

The vocabulary refers to the terms used in the service. The tools and techniques represent what can be used to develop the service. The performance indicators are the parameters that are used to measure the progress and service. And finally, the workflow is the process of each service.

Another point is that the implementation through maturity levels facilitates the deployment process, since it will happen gradually as the company/institution, is able to achieve the objectives of each service.

The framework will also be composed of an implementation process that is adherent to the software development processes in general, and a diagnostic evaluation questionnaire that will be used to identify, in the first moment, which level of maturity the company/institution is, and also in future revaluations, to know if the level will be maintained, lowered or raised.

The image below, presents the process of gaia scope implementation, which is initiated by the application of the diagnostic evaluation questionnaire, to understand in which level of maturity the company/institution, is.

Then, from the understanding of the maturity level, services are reviewed and optimized so that one can start working to reach the highest levels of the framework, or to maintain the level in which one is.

From the moment the company/institution, understands that it is able to seek the next level of the framework or the time comes for a reassessment of the company/institution, at the level it is in, the diagnostic assessment questionnaire is applied again to identify the company/institution, situation in the activities that are part of the services of the desired level.

In the sequence, the performance indicators in the historical database are registered and the maturity level is redefined, and in the sequence it is checked to see if it meets all the requirements of the level.

In the event of a reassessment, if the requirements are met, the level is maintained, or it is passed to a higher level in case of evaluation for level change.

The specified process is presented below, according to [4]. See Figure 1.

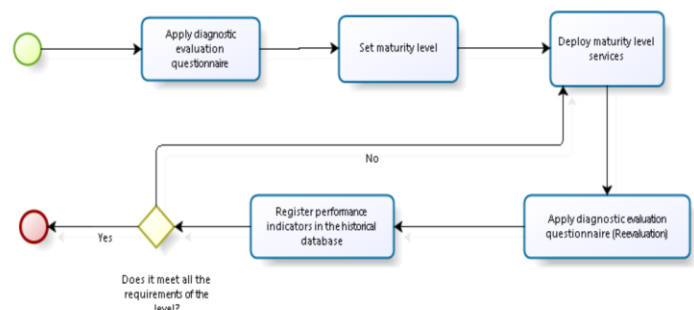


Figure 1. Implantation process of Gaia Scope Framework

A. Gaia Scope Framework Maturity Levels

The Gaia Scope Framework has been updated to become more adherent to its functional objective, which is product scope management in software projects.

The levels that had been initially defined were: undefined, known, managed, quantitatively managed, and optimized [3].

The services that were initially planned were: establishing strategy, planning scope management, collecting requirements, defining scope, creating EAP, validating scope, controlling scope (integration, risks, costs, time, stakeholders) and improvement to be continued.

However, as mentioned, there was a need of updating both the maturity levels and the services to compose the framework, and the comparative study between the different references was important for the more fruitful clarification of the ideas and the main objective of the Framework. Currently the maturity levels are as follows:

- Undefined;
- Known;
- Defined;
- Managed;
- Optimized;

The maturity levels presented are those that are institutionalized in the Gaia Scope Framework currently.

B. Integration of maturity levels with their respective upgraded services.

The maturity levels presented are those that are institutionalized in the Gaia Scope Framework currently.

- Undefined
 - The company/institution, does not have defined and institutionalized processes and artifacts.
- Known
 - Establish strategy
 - Requirements and scope survey and analysis
- Defined
 - Requirements specification / scope and negotiation
 - Validation of requirements / scope
- Managed
 - Requirements / Scope Management
 - Involves control of requirements / scope
 - Involves change control and management
 - Involves requirements / scope traceability
 - Maintenance and requirements / scope history
 - Involves requirements reuse
 - Involves historical database
 - It involves lessons learned
 - Involves company/institution, culture and company/institution process assets
- Optimized
 - Continuous improvement (Involves all areas and services of scope management)

At the indefinite level, company/institution, do not have the knowledge about their scope of requirements, nor about their strategy. At the known level the company/institution, will establish a strategy and know the requirements analytically.

At the defined level, the company/institution, already have important information about the scope, carrying out the specification, negotiation and validation of the scope of requirements. At the managed level, as its name implies, there is management of the requirements scope through requirements management activities, and maintenance of requirements and a historical database.

The highest level is optimized, which suggests a continuous improvement of all the services that are implemented.

This is the current model of the structure of maturity levels and services of the Gaia Scope Framework. To analyze the hierarchy of maturity levels, see Figure 2.

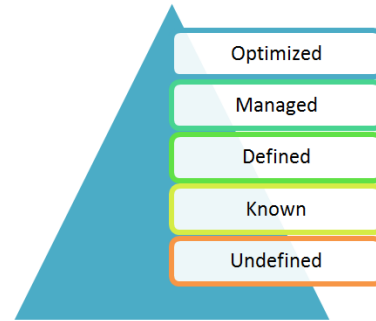


Figure 2. Hierarchy of maturity levels

The Gaia Scope Framework has different advantages, where we can mention the following: A) Possibility of being used by any institution or company/institution, that develops software; B) It is a tool or methodology that does not have acquisition costs; C) Ease of application because it is divided into maturity levels and not bureaucratic; D) Designed to be constantly updated; E) It adds ideas of important references of the area like Roger Pressmam, Ian Sommerville, Mps-Br, CMMI, among other bibliographies; F) Simple and objective; G) The requirements for the development of software that supports the Gaia Scope framework are already being analyzed.

VII. CONCLUSIONS AND FUTURE WORK

The development of the Gaia Scope Framework is an initiative that comes to assist any agent that is directly or indirectly involved in the area of engineering and requirements management.

The development of this tool, which can also be understood as a methodology, meets the need of many company/institution, which is to identify and manage their requirements in the best possible way.

Allied to the simplicity that the framework values, it is still possible to emphasize that it is free, which facilitates even more the use by them.

It is important to clarify that the research work, as well as the necessary adjustments continue to guarantee continuous improvement in the framework, but the basis of the whole study is already structured by defining and updating the levels of maturity and services that the framework will Contemplated, which were presented in this article

It is expected that, with the development of this framework, it will be possible to better identify and manage the requirements in software projects, aiming at a work that is carried out with ever more quality, guaranteeing the identification, analysis, development, documentation and requirements, which will be the basis for the development of all project needs.

The work that will be carried out in the future deals with the detailed specification of each service and its elements, the development of the diagnostic evaluation questionnaire, the implementation of the framework in the Gaia company, the analysis of the results after the application in at least two projects, and if necessary, making the necessary adjustments,

until the institutionalization of the final version of the framework.

And then, the finalization of the software requirements specification to be developed that will support what the framework values.

ACKNOWLEDGMENT

I would like to thank Dr. Rodolfo Miranda de Barros for his help, advice and guidance for the development of this work.

REFERENCES

- [1] Association for the Promotion of Excellence in Brazilian Software. General Software Guide. Brasilia: SOFTEX. January, 2016.
- [2] Bon, Jan Van., 2012. ITIL [recurso eletrônico] : guia de referência, edição 2011, Elsevier. Rio de Janeiro.
- [3] Dalsasso, Darlan., Barros, Rodolfo Miranda de, GAIA scope: Framework for the project scope management in software development process. In, *11th Iberian Conference on Information Systems and Technologies (CISTI)*, 2016, Gran Canaria, v.1. p. 1-6, 2016.
- [4] Freitas, Marcos André dos Santos., 2013. Fundamentals of IT service management, Brasport. Rio de Janeiro, 2nd edition.
- [5] Koscianski, André., Soares, Michel dos Santos., 2007. Software quality: learn the most modern methodologies and techniques for software development, Novatec Editora. São Paulo, 2nd edition.
- [6] K. L. Madhuri and V. Suma, Influence of domain and technology upon scope creep in software projects. In. *International Conference on Advances in Electronics, Computers and Communications, ICAECC 2014*, pp. 1-6, 2014.
- [7] Pressman, Roger S., 2011. Software Engineering A Professional Approach, AMGH. Porto Alegre, 7nd edition.
- [8] Sommerville, Ian., 2011. Software Engineering, Pearson Prentice Hall. São Paulo, 9th edition.
- [9] A project management knowledge guide (PMBOK guide) / (text and translation) Project Management Institute. - 5 ed. - São Paulo: Saraiva, 2014.
- [10] Viana, Ricardo Vargas., 2014. Practical handbook of the project plan: using the PMBOK Guide, Brasport. Rio de Janeiro, 5th edition.
- [11] Vazquez, Carlos Eduardo. Simões, Guilherme Siqueira, 2016. Requirements engineering: software oriented to business, Brasport. Rio de Janeiro.
- [12] Software Engineering Institute. (2010). CMMI for Development, Version 1.3. *Carnegie Mellon University*, (November), 482. <http://doi.org/CMU/SEI-2010-TR-033> ESC-TR-2010-033.