Complex Product Development Approach Considering Value and Cost for the Stakeholders Along the Product Lifecycle

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***Abstract*—This paper aims to propose and demonstrate a method for assessing cost and the value for Stakeholders along complex products lifecycle. The method includes the product analysis to identify all the lifecycle phases and respective activities, the stakeholder mapping, classification and selection, relationship to the product and, at final, the data weighing to give a normalized view of cost and value perceived by the stakeholders during the product entire lifecycle. The method runs alongside the early product development process showing how cost and value may vary according to the product lifecycle. Metrics derived in the method can be used to manage the stakeholders to aim get successes during the life of a complex product. The method is demonstrated on the SARA suborbital system developed by the Institute of Aeronautics and Space and the Brazilian industry, in São José dos Campos, SP, Brazil. SARA is a small Brazilian satellite for microgravity experiments with reentry in atmosphere. This project is adequate for demonstrating the method due the complexity involved. Main stakeholders in the project are scientists, systems architects, industry, funding agencies. In an article presented in the 2008 International Aeronautical Congress the initial studies were shown and now the method is presented in its final version.**

***Index Terms*—complex product, cost, value, product development, stakeholders analysis**

I. Introduction

The complex product beyond be a complex itself can be considered a complex engineering system due the involvement of many components, many interconnections and many functions as defined by Kolmogorov [1]. In 2004 Magee and Weck [2] introduced the classification based in the human wants for characterization of complex systems. The method presented in this article is addressed to complex product development and it was begun to be developed through the observation of the space products development and it was addressed to be used in SARA project. SARA can be considered a complex system with many interactions with other systems, many components and if considered the human wants factors, it can be classified for social and educational and communication as well. As human wants are considered in the system complexity classification, the stakeholders are very important players in the complex system lifecycle. Parmar at al [3] has questioned the Stakeholder Theory and its application for business with focus on the value creation and trade, the ethics of capitalism and managerial mindset whose can be applied direct to the product lifecycle. The value creation and the cost perceived by the stakeholders the whole time are key factors to determine the success of a product. Freeman [4] has considered stakeholder as more than the shareholders and customers, stakeholders are all individuals or group of individuals who affect or can be affected by the business. Considering that the product is the reason for a business existence, the same concept can be extended to business product. The stakeholders can be considered as all individuals or group of individuals whose have some relationship with the product or system. The INCOSE Handbook defines that Systems Engineering has to deal with the technical and business requirements in order to deliver quality products which satisfy the user's needs [5].

This article is part of a doctoral program and aims to discuss a method approach to try to obtain, analyze and weigh the value and cost perception for each product stakeholder during its lifecycle. The method will be described in details and will be presented the conclusions obtained by its application in a small but complex system – SARA: a small Brazilian satellite for microgravity experiments, a satellite of atmosphere reentry. To have worked in this project as a Systems Engineer to develop the embedded electronic control system it was possible to get the opportunity to have contact with many different stakeholders involved in the project. Also it was possible to get the way of behavior from the stakeholders and analyze the value and costs perceived from their relationship to the product. Part of this work is based in

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study and observation of the stakeholders involved in the project and part of it is based in values and costs estimated using the approach of the method developed to anticipate the values and costs being analyzed before the product project begin.

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II. Motivation for This Work

The attributes of cost and value in a product which can be perceived by the stakeholders in a wide scope where the whole group of stakeholders could be considered is not a practice nowadays in a product development or new product development (NPD). Many frameworks have being proposed to deal with the NPD and new product introduction (NPI). Some frameworks based on Lean approach applied to product lifecycle management (PLM) by Hines at al [6], critical success factors, tools, metrics and techniques applied to the processes of NPD by Nadia Bhuiyan [7], an analytical framework based in process interactions by Martínez León at al [8] and others, where a complete literature review, is presented. Those frameworks propose to discuss the processes to develop a NPD and problems in get the customer voice to try capturing its wants to develop products that satisfy the customer's needs and to provide success to the business enterprise. How all the important stakeholders can influence, directly or indirectly the product is a question that is not clear and it can be crucial for the product success in its lifecycle. This seems to be a lack of analysis to be considered when new product development is taking place and is not addressed by the literature.

If all the stakeholders could be considered and all their relationship in terms of value and cost could also be analyzed, i.e., how they perceive the product or will perceive the product during its lifecycle could be important to drive the focus in the stakeholder management in order to eliminate and/or mitigate risks during the phases where the stakeholders perceive more costs than values. The proposed discussion in this article is based on how to analyze the product's important stakeholders for the entire lifecycle If all stakeholders could be considered and all their relationship in terms of value and cost could be analyzed, i.e., how they perceive the product or will perceive the product during its lifecycle could be important to drive the product selection and development.

III. The Proposed Method

The proposed method to assess cost and value to the stakeholder along the product lifecycle (MACVS-PLC) is divided into 5 steps:

1) Map the process activities for each one of the product lifecycle phases.
2) Map all the stakeholders or group of stakeholders involved during each phase of the product lifecycle;
3) Classify the stakeholders based on their interests and power of influences;
4) Identify the relationship of each stakeholder with the product.
5) Weigh the stakeholder relationship with the product and create a matrix of value and cost perceived.

The Fig. 1 illustrates the method processes in an IDF0 modeling technique [9] and some proposed tools will be presented to apply the method.

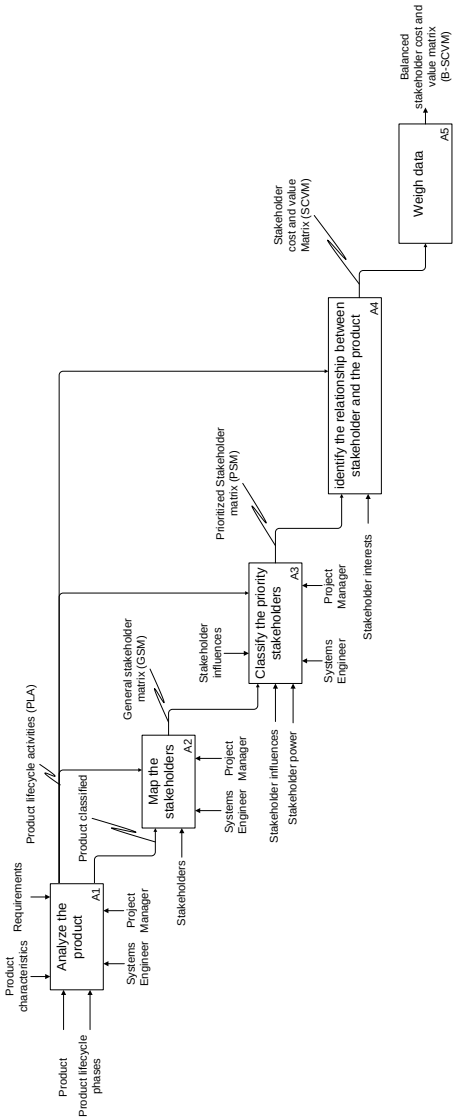

Figure 1. Value and cost to stakeholder analysis method process

A. The Product Lifecycle Activities Mapping

The first step is to understand the whole product lifecycle. The Fig. 2 depicts the inputs, actors, controls and outputs for the function block to be done at the first step of the method.

Inputs

- Product: Is the product to be developed
- Product lifecycle phases: Are the phases with all the activities need for the entire lifecycle.

Mechanism (actors)

- Systems Engineer (SE): The main activities are, analyze the requirements, the product

characteristics, and the lifecycle phases to classify the product. The SE helps to map the activities that will be executed in each phase.

- Project Manager (PM): The main activities are, analyze the product characteristics and lifecycle phases in order to help the SE classify and organize and map the activities for each phase.

Control

- Product characteristics: The attributes inherent of the product such as the estimated cost, the estimated time, and the interfaces with other systems, the regulation restrictions, the installation needed, the demand quantity, and the infrastructure need to produce and test.
- Requirements: The product requirements which define the needs to be delivered during the lifecycle phases. As examples: mean time between fails (MTBF) is a requirement which can bring up some special need for the operation phase.

Outputs

- Product lifecycle activities: During the analysis of the product function is necessary to the output, the completed list of activities related to the product by phase. That list of activities will be used as control to the rest of functions on the method processes.
- Product classified: the product that be analyzed along its lifecycle.

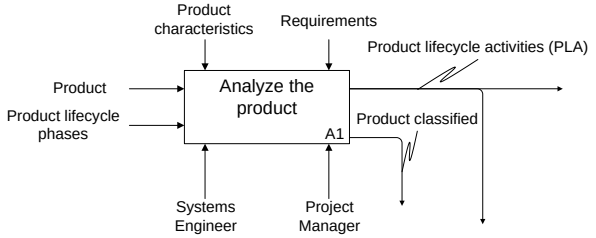

Figure 2. Analyze the product.

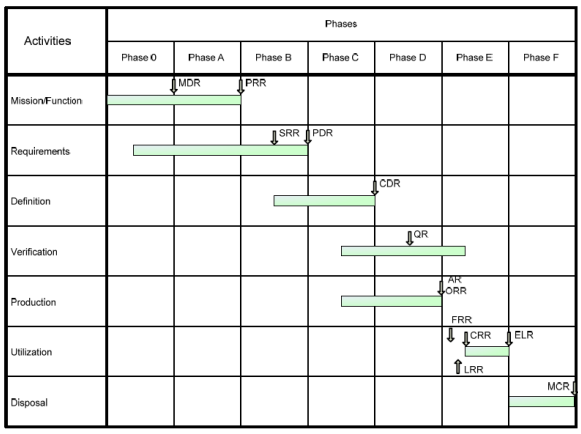

Figure 3. Typical project lifecycle - ECSS-M-ST-10C

For space projects the ESA-ECSS standard for system development describes the process with the main activities showed in Fig. 3 [10].

The phases are distributed such as:

- Phase 0 - Mission analysis/needs identification
- Phase A - Feasibility
- Phase B - Preliminary Definition
- Phase C - Detailed Definition
- Phase D - Qualification and Production
- Phase E - Utilization
- Phase F - Disposal

During the phases, some milestones are set to review in order to take the decision to continue or not the development process:

- MDR – Mission Definition Review
- PRR – Preliminary Requirements Review
- SRR – System Requirements Review
- PDR – Preliminary Design Review
- CDR – Critical Design Review
- QR – Qualification Review
- AR – Acceptance Review
- ORR – Operational Readiness Review
- FRR – Flight Readiness Review
- LRR – Launch Readiness Review
- CRR – Commissioning Result Review
- ELR – End-of-life Review
- MCR – Mission Close-out Review

B. The Stakeholder Mapping

The second step is to map all the stakeholders related to the product by phase and activities. The stakeholder analysis has been treated in business approaches and references are frequently found, 'frameworks' and "issues" [11], "stakeholder-focused criteria" [12], "stakeholding" and "stakeholder society" [13], "stakeholder-agency theory" [14], stakeholders related to policy, health, civil, and other projects programs to better definition of how to deal with the interested individuals or groups [15]. The "stakeholders" are people or organizations that have some direct or indirect interest (or stake) in the intended system or product [16]. So, all stakeholder identified, are people or organizations represented by responsible people.

The Fig. 4 depicts the function block for the stakeholder mapping.

Inputs

- Product classified: The own product analyzed in the first process.

Stakeholders: All the stakeholders related to the product by activities and phases. The stakeholders here must be considered as the Freeman [4] consideration that, the stakeholders are all individuals or group of individuals who affect or can be affected by the business.

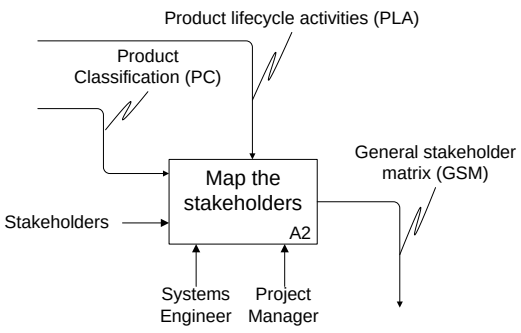

Figure 4. Map the stakeholders.

Mechanism (actors)

- Systems Engineer (SE): The main activity is to make a matrix with the stakeholders into lines and activities and phases into column.
- Project Manager (PM): The PM needs to help the SE to gather data and build the general stakeholder matrix (GSM).

Control

- Product lifecycle activities: The activities will be used to build the GSM.

Outputs

- General stakeholder matrix (GSM): A matrix with all stakeholders into lines and product lifecycle activities and phases into columns.

C. The Stakeholders Classification

The third step is to classify the stakeholders by importance, elucidating the potential influence to the product. The output is a prioritized stakeholder matrix (PSM) based on the stakeholder interests and their power to influence the product. The Fig. 5 depicts the priority stakeholders classification process.

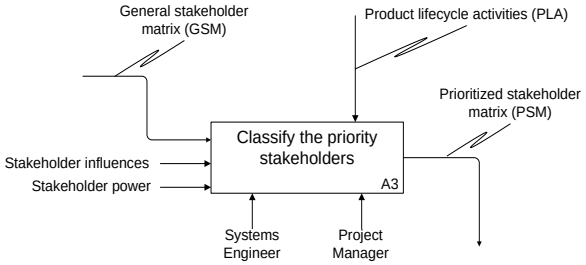

Figure 5. Classify the priority stakeholders.

Inputs

- General Stakeholder Matrix (GSM): The GSM is a matrix with all the stakeholders along the product lifecycle and is used to classify the stakeholder to compose the prioritized stakeholder matrix (PSM).
- Stakeholder influences: The stakeholder influences are negative or positive depending in how the stakeholder feels the product. They are very qualitative and subjective aspects which need to be collected by the SM and SE analyzes of the stakeholder profile, interviews, and surveys, when possible.
- Stakeholder power: The stakeholder power over the product is very important due the influence it can have on the product. If the stakeholder has interest and also power on the product, he can influences the product and needs to be including into the PSM.

Mechanism (actors)

- Systems Engineer (SE): The SE actuates in this phase to analyze the power and influences of each stakeholders in order to classify them into the PSM.
- Project Manager (PM): As the SE, the PM actuates in analyzing the stakeholders to include them into the PSM

Control

- Product lifecycle activities: The lifecycle activities will be used to build the PSM.

Outputs

- Prioritized stakeholder matrix (GSM): A matrix with all stakeholders into lines and product lifecycle activities and phases into columns, classified by interests, power over the product and influences.

D. The Relationship Between Stakeholders and the Product

The main process for the stakeholder cost and value perceived from the product is the relationship between stakeholder and the product. In the Competitive Engineering book, Tom Gilb [17] defines the stakeholders as *"A stakeholder is any person, group or object, which has some direct or indirect interest in a system. Stakeholders can exercise control over both the immediate system operational characteristics, as well as over long term system lifecycle considerations (such as portability, lifecycle costs, environmental considerations and decommissioning of the system). The views and needs of stakeholders have to be sought and listened to."*

The stakeholder relationship to the product can determine the way it will treat or interact to the product, when this is presented to the respectively stakeholder. The Fig. 6 depicts the process to identify the stakeholder relationship with the product.

Inputs

- Prioritized Stakeholders Matrix (PSM): The PSM is the most important stakeholders to be considered on the product relationship analysis.
- Stakeholder interests: The stakeholder interests are used to classify the stakeholders through their connection to the product.

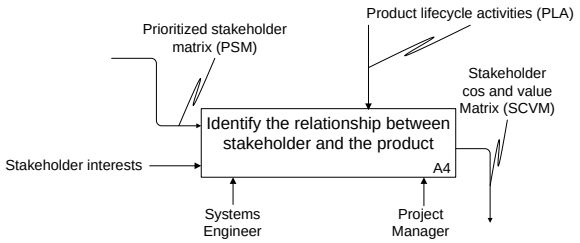

Figure 6. Identify the relationship between stakeholder and product.

Mechanism (actors)

- Systems Engineer (SE): The SE actuates in this phase to analyze the interests of each stakeholder in order to know what kind of behavior it will have in relation to the product.
- Project Manager (PM): As the SE, PM actuates in analyzing the stakeholder to try capturing their feeling to the product, about cost or value.

Control

- Product lifecycle activities: The lifecycle activities will be used to build the stakeholder cost and value matrix (SCVM).

Outputs

- Stakeholder cost and value matrix (SCVM): A matrix with the stakeholder cost and value

perceive along the product lifecycle. Each stakeholder needs to have its own SCVM, describing into lines the attributes considered and into columns the product lifecycle activities.

E. The Value x Cost Matrix Weighting

The weighting process is to balance the cost and value as a unique number for the stakeholder relationship with the product lifecycle activities. The result is a matrix which shows the stakeholder point of view on the product in several phases and activities performed in the product during its lifecycle. The objective is to have a rough but important systemic view of the stakeholder behavior in relation to the product based in a systematic way to get, analyze and weigh the stakeholder relationship with the product. Fig. 7 depicts the process to weigh the value and the cost to generate the balanced stakeholder cost and value matrix (B-SCVM).

Inputs

- Stakeholder cost and value matrix (SCVM): The SCVM is used as input to the process of weighting data. It brings the value and cost listed for each stakeholder in each activity of the product lifecycle matrix that will be converted into a balanced SCVM (B-SCVM).

Mechanism (actors)

- Systems Engineer (SE): The SE activity is of weigh and concatenates all the stakeholder's values and cost into one factor to view the perceived feeling of the stakeholder along the product lifecycle.
- Project Manager (PM): The PM needs to help the SE to build the B-SCVM.

Outputs

- Balanced stakeholder cost and value matrix (B-SCVM): A matrix with each stakeholder into lines and product lifecycle activities and phases into columns. The data field value represents the positive or negative perceived feeling of the stakeholder along the product lifecycle. Positive sense means value perceived and negative sense means cost perceived.

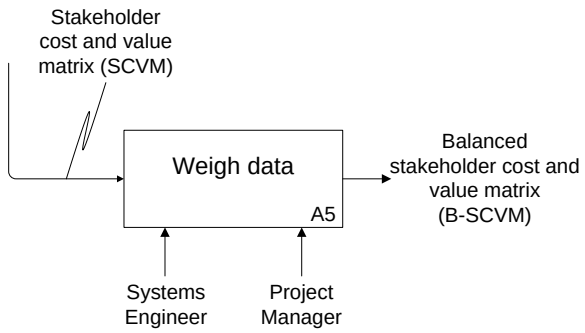

Figure 7. Weigh data.

IV. The Method Application

To use the method to assess cost and value to stakeholders along the product lifecycle (MACVS-PLC) is important to use some existent tools to get and analyze data during the first steps. The objective of the MACVS-PLC is to try demonstrating that value and cost for the stakeholders along the product lifecycle, if analyzed at the initial product development phase, can contribute to better understand the acceptance or rejection for the product by its stakeholders.

The MACVS-PLC is suitable to the complex product development which has many interactions between subsystems and between other systems, long term development cycle, technological innovation, many constraints, environmental testing acceptance process and of course many stakeholders. Fleming and Sorenson [18] have analyzed the technology as a complex adaptive system and considered the new product invention either as a new synthesis of existing and/or new technological components or a refinement of a previous combination of technologies combination. Thus the technology is a constant process of recombinant searches for better combinations and configurations of constituent technologies. The new product development (NPD) and new service development (NSD) proposed by Christoph Loch and Stylianos Kavadias [19] presents a necessary infrastructure to support the NPD and this NSD needs to be developed before or together the NPD to warrant the success for the product. It also can be considered that complex product and/or system as NPD and NSD need to be analyzed in terms of stakeholders due the high capital investments and high risks involved.

Stakeholders		
Research	Conception	Phases/Activities
Idea generation		
Selection		
Presentation and decision		
Organization	Development	
Planning		
Partness contract		
Preliminary design		
Simulation		
Detailed design		
Prototyping (Engineering Model)		
Testing		
Production infra structure	Production	
Qualification Model manufacturing (QM)		
Qualification tests		
Flight Model manufacturing (FM)		
Acceptance tests		
Preparation for the Lunch campain	Utilization/ Support	
Final integrated test		
Launch		
Recovery	Retirement	
Disassembling		
Maintenace		
Reuse		
Discard		

Figure 8. Product lifecycle activities - basic version

First step: the product classification is to analyze if the product is eligible or not to adopt the MACVS-PLC. Kolmogorov [1] considers the complex product that one's which involves many components, many interconnections and many functions. The product classification also can be done based on its characteristics and requirements for development, producing, operation and disposal phases. The more critical design requirements the product has, the more complex it is. The basic requirements to be considered are: the number of interfaces to other systems, the technological components and the parts, the multidisciplinary degree of knowledge the team needs have, needed number of internal and partners development teams, need for formal verification and validation review, the complexity of the acceptance tests, the integration level with other systems, the operational infrastructure complexity, the legal restrictions for operation and disposal. In summary, the requirements for development, production, operation and disposal need to be analyzed to classify the complexity. The MACVS-PLC is not applicable for the development of simple products due to the detailed analyzes process.

All the activities for each product lifecycle phases need to be allocated in a list, by phase. The product lifecycle depends on the product type and the organization which will develop it. The INCOSE SE Handbook [5], based on ISO/IEC 15288:2008 [20], shows the basic phases as: exploratory research, concept, development, production, utilization/support and retirement. It can be sub divided into basic activities as illustrated in Fig. 8.

Stakeholder n		Stakeholder 2	Stakeholder 1	Stakeholders		
			×	Research	Conception	Phases/Activities
		×		Idea generation		
				Selection		
				Presentation and decision		
				Organization	Development	
				Planning		
				Partness contract		
				Preliminary design		
		×	×	Simulation		
		×	×	Detailed design		
				Prototyping (Engineering Model)		
				Testing		
				Production infra structure	Production	
				Qualification Model manufacturing (QM)		
				Qualification tests		
				Flight Model manufacturing (FM)		
				Acceptance tests		
				Preparation for the Lunch campain	Utilization/ Support	
				Final integrated test		
				Launch		
				Recovery	Retirement	
				Disassembling		
×				Maintenace		
				Reuse		
×				Discard		

Figure 9. General stakeholder matrix – GSM.

Second step: all the stakeholders need to be captured for each activities of the product lifecycle. Once the activities for the product lifecycle are gathered is necessary to get all stakeholders in order to build the GSM. The stakeholder mapping is a difficult task due the future uncertain for all the interfaces and relationship that the product will have. The activities for the product lifecycle will guide the stakeholder mapping process. Fig. 9 illustrates a basic general stakeholder matrix (GSM) showing the stakeholder related to the respectively activities it has some relationship with the product. The important on this step is to capture the entire possible stakeholders in the product.

Third step: the stakeholders need to be classified according to how they can influence the product and their power to influence. Based on the ©BGMI Tools-templates [21] sheet, for stakeholder's diagnostic, was built the prioritized stakeholder matrix (PSM). The Table I illustrates a modified ©BGMI sheet for the stakeholder diagnostic, to be used in this step.

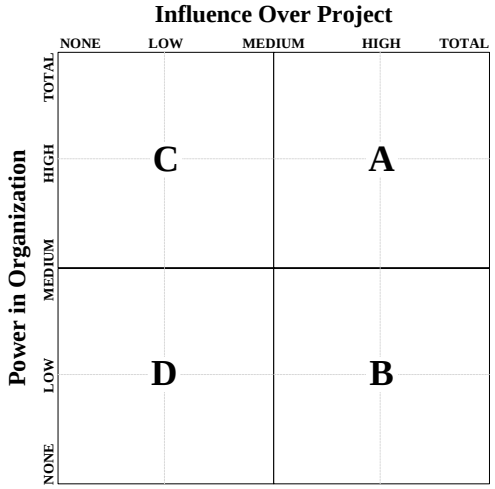

Figure 10. Power/influence category.

TABLE I. PRIORITIZED STAKEHOLDER MATRIX (PSM).

Stakeholders		Power / influence category (A, B, C, D)	Impact of product on stakeholder (H, M, L)	Prioritized stakeholders
1	Stakeholder 1			
2	Stakeholder 2			
n	Stakeholder n			

The stakeholders are classified into the correct quadrant by the usage of the power/influence category depicted in Fig. 10. After the classification the stakeholders, the criterion adopted is of consider only category A and B as key stakeholders. Lynda Bourne and Derek Walker [22] have described the influence between stakeholders with power and no power. Some stakeholder without apparent power can influence other with real power. If possible, is also important classify those stakeholders into the categories A or B. Also stakeholders that are considered to receive high impact from the product need to be including into the PSM.

The main question to identify the stakeholder can be:

1) Does the stakeholder know the product in this phase?
2) Does the stakeholder have some actuation on the product in this phase?
3) Does the stakeholder have some relationship with product in this phase?

To classify the stakeholder power in an organization and its influence over the project, a basic survey needs to be answered. Appendix A shows the classification example. About the product impact on the stakeholder is the first degree of the intensity that the SE and PM can perceive that the product will influence the stakeholder. It will be further analyzed in the fourth step.

Stakeholder cost and value matrix - SCVM

Stakeholder name:

Activity:

Questions	Weight				
	Extremely sure	Very Sure	Moderatedly sure	Slightly sure	Not sure
Could the product help increasing my education?					
Could the product help improving my financial situation?					
Could the product propiciate some gains?					
Could the product help increasing my marketing situation?					
Could the product help improving my political situation?					
Could the product help promoting myself or my business?					
Could the product preserve my tradition aspects?					
Could the product utilization give me some gains?					
Could the product help improving social aspects?					
Could the product help improving cultural aspects?					
Could the product bring me some damage?					
Could the product bring me some insecurity?					
Could the product bring me some loss?					
Could the product bring me some spent?					
Could the product bring me some threat?					
ΣValues	0%	0%	0%	0%	0%
ΣCosts	0%	0%	0%	0%	0%

Figure 11. Stakeholder value and cost matrix – SCVM.

Fourth step: based on the product stakeholder interests, even qualitatively, it is possible to identify the value and cost the stakeholder perceive about the product. The stakeholder interests are based on its relationship with the product, the characteristics and features the product has. Kai Gilb in its "Evo: Evolutionary Project Management" manuscript [23] presents an approach of the Stakeholder Values & Product Qualities which describes that a product has interactions with the stakeholder, considered qualities. From the other side the stakeholders have values which can be translated into requirements to be included into the solution for the product development. In the Donald E. Sexton Value above Cost book [24] he introduces the concept of customer value added CVA® that defines customer the *"Perceived value is the maximum that the customer will pay for your product or service"*. Also is possible to assign the cost as the amount of money to pay or the risk probability related to the product. Sometimes the stakeholder only perceives cost in its relationship with the product.

After a PSM built with the stakeholders listed and classified is time to understand the interests which involve the stakeholder with the product. Fig. 11 depicts the the survey of the stakeholder cost and value matrix (SCVM). The values are ordered in sequence of positive aspects perceived by the stakeholder and the costs are the negative ones. The summation of values and costs are normalized to enable the comparison between cost and value in a percentage way.

Fifth step: for the final step is important weigh the value and cost perceived by the stakeholders and try to translate that in a graphical view of system. The source data to input into the B-SCVM comes from the SCVM, built for each stakeholder.

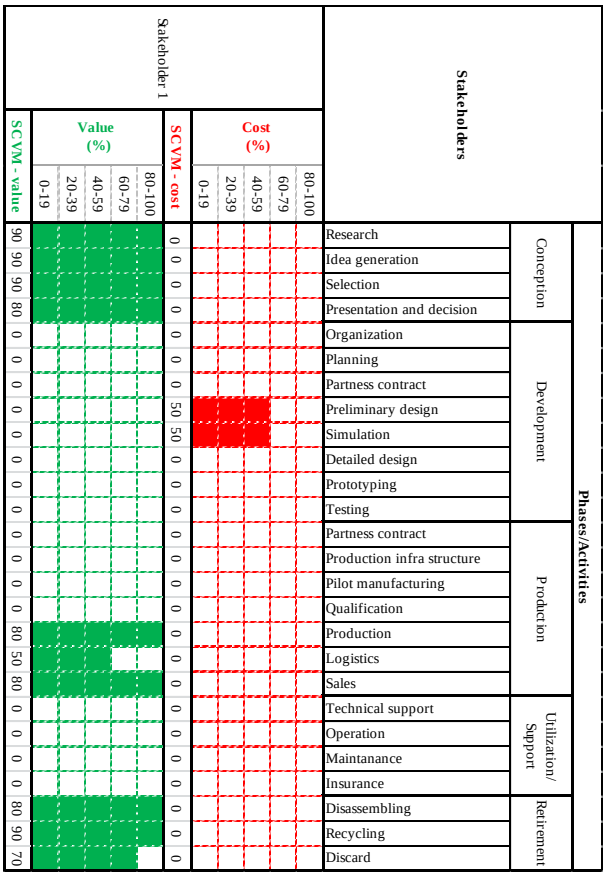

Figure 12. Balanced stakeholder cost and value matrix – B-SCVM.

B-SCVM is a graphical tool to give an overview of the product lifecycle and how the stakeholders perceive the product in terms of cost and value. At the project initiation phase during the concept or even the early development, the B-SCVM could help in planning the difficult activity of stakeholder management and previewing the probable risk of pros and cons the product will face front of its stakeholders. Fig. 12 depicts the main objective of the method MACVS-PLC which is to have a stakeholder summary of its perception of the product during its lifecycle. The complex product development involves high risks due the complexity of activities, large scale of interfaces, a lot of requirements,

a long term development, and multi-disciplinary knowledge, and heavy testing campaign, a large amount of human and physical resources and difficulties to understand the stakeholder's voice. For the long list of needs and risks involved the B-SCVM can be an alternative tool to understand the stakeholders, the main players of this game.

V. SARA CASE

SARA is a suborbital satellite used to make experiments in micro-gravity environment. It reaches the micro-gravity environment conditions in minutes after launching and keeps this condition also for few minutes. SARA is a product composed of a multistage rocket solid-fuel, an electronic embedded system, and the micro-gravity experiments. At the ground level there is a station system to prepare the launcher, a mechanical support to the rocket, a telemetry system, a flight termination system and radar to track the rocket trajectory. The embedded system also has a parachute system to smooth the fall of the capsule of the experiment. The case demonstration has the following premises:

- The method was applied through the team observation data gathering;
- The SARA project was not put in operation, not launched yet. It is planned for this year;
- The embedded system was completely new development and based on lessons learned from other products already developed for this area;
- The rocket is a one of solid-state fuel type already used in other missions.
- The main objective for the MACVS-PLC method applied to SARA project/product was to demonstrate the viability to use it. The main objective for the MACVS-PLC method applied to SARA project/product was to demonstrate the viability to use it. It was not developed before the SARA project has start running.

First step – Analyze the product

1) Product classification: The project/product can be considered complex due the high volume of requirements, long term development, a lot of interfaces internal and external to other systems, a considerable number of stakeholders, a big amount of resources physical and human, and a multidisciplinary knowledge to develop it.
2) Lifecycle activities: This project is considered a project of space product and it was adopted the ECSS-M-ST-10C standard [10] to manage the project. So the lifecycle definition is a tailored version from ECSS-M-ST-10C basic product lifecycle.

Second step – Map the stakeholders

1) GSM: Using the PLA generates a list of all potential stakeholders involved in this product – the GSM. The GSM was built with aid of the PM, SE and some expertise engineers from the development and revision team.

Third step – Classify the priority stakeholders

1) PSM: To classify the stakeholders it was used the power/influence classification survey (Fig. 10) and the impact received from the product.

Fourth step – Identify the relationship between stakeholder and the product

1) SCVM: Using the SCVM was considered the relationship between stakeholder and the product based into its interests. Some stakeholders were interviewed and others, with no possibility to be interviewed directly were analyzed through the similarity with other stakeholder's behavior. Some groups of stakeholders can be created when they have the same interests in the product. As an example, the developers can be grouped into a unique stakeholder, the developer team.

Fifth step – Weigh data

1) B-SCVM: Using the SCVM from each stakeholder the values were transposed to the B-SCVM and as this is a spreadsheet from Excel; the graphs were built by the SVCM field.

A synthesized B-SVCM for SARA product is showing at the Appendix B – Fig. 16.

VI. CONCLUSION

In a world scenario where the changes are becoming common and faster than the old times and customers always are searching to have more fit products to their needs, tools and methods whose have objectives of anticipate the customer voice and reduce the risks of unsuccessful development have place to be study and applied at the early product conception phase. Those initiatives help to avoid the loss time, resources and conduct the project to low return on investment (ROI).

The MACVS-PLC method is an approach that considers not only customers and shareholders as key stakeholders but is a trying to open the mind of the complex new product developers to think in advance the how all the key stakeholders will perceive product to be developed and how could be their relationship with it. It often won't define whether a product idea and its associated solution could or not could be the best one. For that many other tools and frameworks can be used, the Quality Function Deployment (QFD) [25] can widely understand and the literature review [26] and comprehensive review [27] can be further analyzed. In the voice of the customer prof. Abiee Griffin and Jonh R. Hauser [28] they concentrate in identify the voice of the customer using the QFD and show the process and how efficient are the interviews with number of customers interviewed and how to apply the process. The important to keep in mind is that the process to gathering information from the stakeholder is a difficult task. They are not able to express their requirements so clear and direct.

This article focuses on showing a method that tries to capture the relationships of stakeholders with the product and most importantly, throughout the life cycle of the product and applied early in the development process. It seems to be an issue to study more carefully to get advantages and minimize risks of unsuccessful in new product development.

The method MACVS-PLC was applied to the SARA product only in part of its lifecycle, starting from development until to the retirement phase. The method showed to be useful to help in the risk management activity along the project management process by considering stakeholder aspects. The method application is not a simple task. It involves many interviews for the data gathering, and a considerable work to format and consolidate those data to arrive the B-SCVM. Indeed it is more suitable to the complex product due the resources needed and time to get the B-SCVM. The results seem to be useful to identify risks (costs) and values (support) from the stakeholders to the product along its lifecycle. The systems engineer and project manager can use the information as an indicator for the review of the actions to be adopted, either for the product architecture solution or to better organization of information to be communicated to the stakeholders in a proper manner.

Stakeholder power/influence category classification survey											
Stakeholder name:											
Questions	Influence					Power					Classification (A, B, C, D)
	None	Low	Medium	High	Total	None	Low	Medium	High	Total	
Does the stakeholder has requirement decision?	x					x					D
Does the stakeholder has budget decision?				x		x					B
Does the stakeholder has management decision?	x								x		C
Does the stakeholder has resources decision?					x				x		A
Does the stakeholder has timming decision?											Unclassified
Does the stakeholder has regulatory decision?											Unclassified

Figure 13. Stakeholder power/influence classification survey.

APPENDIX A STAKEHOLDER POWER/INFLUENCE IN ORGANIZATION SURVEY

To classify the stakeholder power/influence category is necessary to answer some simple questions and identify who the stakeholder does influence. Fig. 13 illustrates the classification survey for the stakeholder power/influence. If in the classification column appears once the latters A or B the stakeholder is classified as key stakeholder.

Stakeholder cost and value matrix - SCVM						
Stakeholder name: Brazilian Space Agency (AEB)						
Activity:						
Questions	Weight					
	Extremely sure	Very Sure	Moderatedly sure	Slightly sure	Not sure	
Could the product help increasing my education?		x				
Could the product help improving my financial situation?	x					
Could the product propiciate some gains?				x		
Could the product help increasing my marketing situation?	x					
Could the product help improving my political situation?				x		
Could the product help promoting myself or my business?			x			
Could the product preserve my tradition aspects?			x			
Could the product utilization give me some gains?			x			
Could the product help improving social aspects?			x			
Could the product help improving cultural aspects?	x					
Could the product bring me some damage?			x			
Could the product bring me some insecurity?		x				
Could the product bring me some loss?		x				
Could the product bring me some spent?				x		
Could the product bring me some threat?		x				
Individual sum of values	30%	10%	40%	20%	0%	
Individual sum of costs	0%	60%	20%	20%	0%	
ΣValues	63%					
Σcosts	60%					

Figure 14. SARA – GSM.

Stakeholder power/influence category classification survey												A
Stakeholder name: Brazilian Space Agency (AEB)												
Questions	Influence					Power					Classification (A, B, C, D)	
	None	Low	Medium	High	Total	None	Low	Medium	High	Total		
Does the stakeholder has requirement decision?				x					x		A	
Does the stakeholder has budget decision?				x					x		A	
Does the stakeholder has management decision?	x						x				D	
Does the stakeholder has resources decision?					x					x	A	
Does the stakeholder has timming decision?					x					x	A	
Does the stakeholder has regulatory decision?					x					x	A	

Figure 15. Categorization example – SARA.

APPENDIX B SARA MACVS-PLC RESULTS

The GSM depict in Fig. 14 considers the lifecycle from Development to Retirement due the data availability.

The Fig. 15 illustrates an example of power/influence classification survey for two stakeholders from the GSM. As it can be seen, the space area researchers were categorized into letter D - no key stakeholder and Brazilian Space Agency into letter A – key stakeholder.

The Fig. 16 illustrates a SARA B-SCVM applied in three of its stakeholders: AEB, Researchers school and Third partners' developers. By the table is possible to see some different modes to perceive the product according to different stakeholders for the same activities of the product lifecycle. The level of cost and values also is presented separately to identify risks and support from the stakeholders respectively. Some stakeholders do not feel any kind of cost or value due to the lack of knowledge of the product, or due to no contact to the product (no relationship). To build the graph of the Fig. 16 (B-SCVM) were use the results of the SCVM survey, presented in Fig. 11.

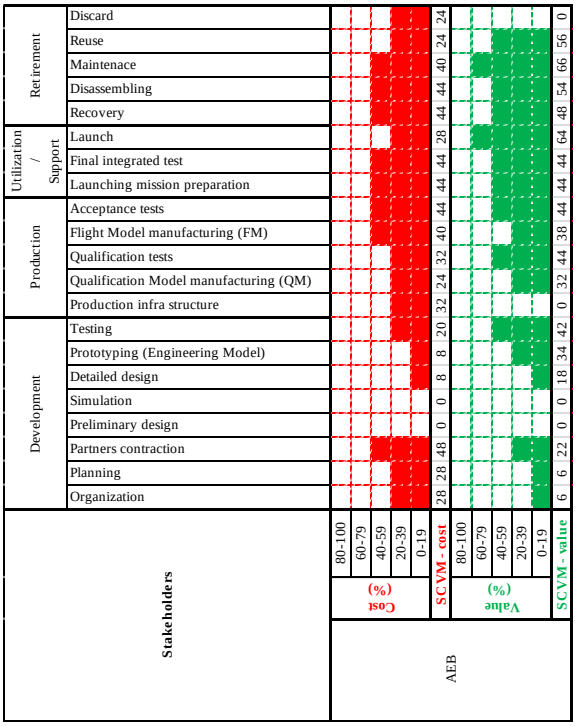

Figure 16. SARA example of B-SCVM.

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