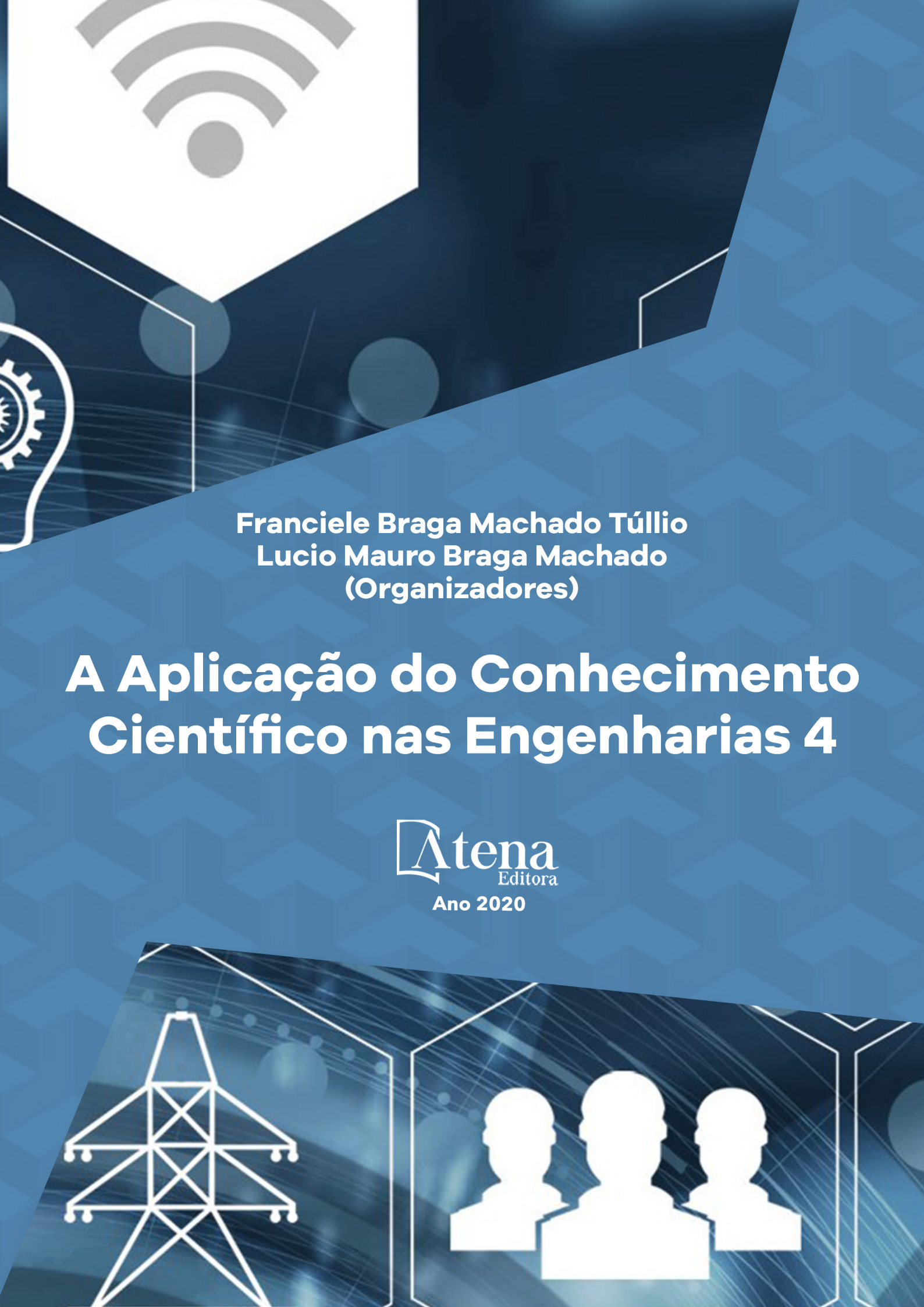

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A Aplicação do Conhecimento Científico nas Engenharias 4

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A Aplicação do Conhecimento Científico nas Engenharias 4

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APRESENTAÇÃO

A obra “Pesquisa Científica e Inovação Tecnológica nas Engenharias 4” apresenta dezesseis capítulos em que os autores abordam pesquisas científicas e inovações tecnológicas aplicadas em diversas áreas de engenharia.

A pesquisa científica é a principal ferramenta para produzir conhecimento e inovação para uso da sociedade.

Esta obra apresenta diversos textos científicos que abordam temas ligados a engenharia aeroespacial, que buscam melhorar materiais, equipamentos e métodos aplicáveis a evolução nessa área do conhecimento.

Diversas aplicações da matemática, estatística e computação também são exploradas pelos pesquisadores nesta obra.

Esperamos que o leitor se deleite nas pesquisas selecionadas e que estas possam contribuir para a produção de ainda mais pesquisas. Boa Leitura!

Franciele Braga Machado Túllio
Lucio Mauro Braga Machado

SUMÁRIO

CAPÍTULO 1 1

A RELEVÂNCIA DA PRODUÇÃO ACADÊMICA E PESQUISA CIENTÍFICA NO ENSINO SUPERIOR DOS CURSOS DE ENGENHARIA

Fabiano Battemarco da Silva Martins
Patrícia Guedes Pimentel
Marcelo de Jesus Rodrigues da Nóbrega

DOI 10.22533/at.ed.1102013011

CAPÍTULO 2 17

APLICATIVO DEDICADO AO DIMENSIONAMENTO DE PARAQUEDAS

Rafael Andrade E Silva
Maurício Guimarães da Silva

DOI 10.22533/at.ed.1102013012

CAPÍTULO 3 26

APLICAÇÃO DE MODELOS MATEMÁTICOS NA SIMULAÇÃO NUMÉRICA DA PRODUÇÃO E EXPORTAÇÃO DE SOJA NO ESTADO DO TOCANTINS ATÉ 2025

Laina Pires Rosa
Leandra Cristina Crema Cruz
Pedro Alexandre da Cruz

DOI 10.22533/at.ed.1102013013

CAPÍTULO 4 39

APPROACH PROPOSAL FOR CRITICAL SOFTWARE PROCESSES SELECTION FOR SPACE PROJECTS IN VERY SMALL ENTITIES (VSE)

Gledson Hernandes Diniz
Ana Maria Ambrosio
Carlos Henrique Netto Lahoz
Benedito Massayuki Sakugawa

DOI 10.22533/at.ed.1102013014

CAPÍTULO 5 48

APRIMORAMENTO DE UM MÉTODO DE PREDIÇÃO DA CONFIABILIDADE DE EQUIPAMENTOS ELETRÔNICOS MILITARES E ESPACIAIS

Carlos Eduardo da Silva Santos
Ana Paula de Sá Santos Rabello
Marcelo Lopes de Oliveira e Souza

DOI 10.22533/at.ed.1102013015

CAPÍTULO 6 57

CADEIA DO QUEROSENE DE AVIAÇÃO NO BRASIL EM UM SISTEMA DE INFORMAÇÃO GEOGRÁFICA

Pedro Henrique Beghelli
Josiane do Socorro Aguiar de Souza Oliveira Campos
Maria Vitória Duarte Ferrari

DOI 10.22533/at.ed.1102013016

CAPÍTULO 7 77

CORTADOR DE GRAMA AUTOMATIZADO

João Vitor Silveira Cercená
Ana Carolina Marcelo da Silva
Luiz Gustavo de Souza Soares
Vaime Trescher de Morais Junior

DOI 10.22533/at.ed.1102013017

CAPÍTULO 8 86

EFEITO DA ADIÇÃO DE 0,15%ZR E DO TRATAMENTO TÉRMICO DE ENVELHECIMENTO ARTIFICIAL NA LIGA AL-6%MG NAS PROPRIEDADES MECÂNICAS

Beatriz Seabra Melo
Natália Luiza Abucater Brum
Vinicius Silva dos Reis
Victor Lima Melo
Mateus José Araújo de Souza
Carlos Vinícius de Paes Santos
Marielle Maria Medeiros Vital
Adriano Aleixo Rodrigues
Denyson Teixeira Almeida
Altino dos Santos Fonseca
Emerson Rodrigues Prazeres
José Maria do Vale Quaresma

DOI 10.22533/at.ed.1102013018

CAPÍTULO 9 99

ESTUDO DE CASO: ANÁLISE DO AMBIENTE ORGANIZACIONAL DE UMA EMPRESA DE EQUIPAMENTOS DA ÁREA DE SAÚDE

Larissa de Carvalho
Daniele Martins de Almeida
Rubya Vieira de Mello Campos
Rony Peterson da Rocha

DOI 10.22533/at.ed.1102013019

CAPÍTULO 10 110

ESTUDO DA VIABILIDADE TÉCNICA PARA O EMPREGO DE MADEIRAS “ALTERNATIVAS” EM ESTRUTURA TRELIÇADA (BANZOS PARALELOS) PARA COBERTURA (TELHADO DE AÇO – INCLINAÇÃO 10°), COM VÃOS ENTRE 16 A 26 METROS

Allan Christian Alves da Luz
Roberto Vasconcelos Pinheiro
André Luís Christoforo
Francisco Antônio Rocco Lahr

DOI 10.22533/at.ed.11020130110

CAPÍTULO 11 125

METODOLOGIA DE PESQUISA PARA ENGENHARIAS

Ricardo Junior de Oliveira Silva
Dayse Mendes
Jéssika Alvares Coppi Arruda Gayer

DOI 10.22533/at.ed.11020130111

CAPÍTULO 12 132

PROBLEMAS DE PROGRAMAÇÃO DA PRODUÇÃO: UMA VISÃO GERAL DOS MÉTODOS DE SOLUÇÃO

Márcia de Fátima Morais
Rony Peterson da Rocha
Larissa de Carvalho

DOI 10.22533/at.ed.11020130112

CAPÍTULO 13 147

SATELLITE TELEMETRY AND IMAGE RECEPTION WITH SOFTWARE DEFINED RADIO APPLIED TO SPACE OUTREACH PROJECTS IN BRAZIL

David Julian Molano Peralta
Douglas Soares dos Santos
Auro Tikami
Walter Abrahão dos Santos
Edson Wander do Rego Pereira

DOI 10.22533/at.ed.11020130113

CAPÍTULO 14 165

SISTEMA DE IDENTIFICAÇÃO DE ACESSO EM AMBIENTE ESCOLAR PARA CONTROLE DE SEGURANÇA

Gleison Stopassola
Alexandre Dalla'Rosa

DOI 10.22533/at.ed.11020130114

CAPÍTULO 15 174

TESTE EM COMPONENTE CRÍTICO DE USO ESPACIAL: ENSAIO DE DOSE IONIZANTE TOTAL, (TID - TOTAL IONIZING DOSE) EM TRANSISTORES 2N2222A

Bruno Carneiro Junqueira
Silvio Manea
Rafael Galhardo Vaz
Odair Lelis Gonçalez

DOI 10.22533/at.ed.11020130115

CAPÍTULO 16 185

UM BREVE ESTUDO SOBRE AS CÔNICAS E SUAS APLICAÇÕES

Wendell de Queiróz Lamas
Giorgio Eugenio Oscare Giacaglia

DOI 10.22533/at.ed.11020130116

SOBRE OS ORGANIZADORES 199

ÍNDICE REMISSIVO 200

CAPÍTULO 4

APPROACH PROPOSAL FOR CRITICAL SOFTWARE PROCESSES SELECTION FOR SPACE PROJECTS IN VERY SMALL ENTITIES (VSE)

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ABSTRACT: Space software projects have different required quality according to their criticality, and their quality is highly influenced by their development lifecycle processes. Since 2010, ISO/IEC 29110 set of standards and guides has been used to assist and encourage Very Small Entities (VSEs), defined by ISO as organizations or projects having up to 25 people, in assessing and improving their software development process. This paper proposes a lightweight set of processes to be applied for critical space software development in VSEs, and the criteria for selecting these processes based on the profiles definition from ISO, applicable to space software and covering the features of the European Cooperation for Space Standardization (ECSS) set of space software standards.

KEYWORDS: Software processes; Profiles; VSE.

1 I INTRODUCTION

Standardization is a significant instrument for increasing quality and communication among stakeholders during planning and implementation of projects, while it also helps to reduce risks and costs associated, making business more profitable as less time is spent on non-productive work (Yilmaz, O'Connor, & Clarke, 2016). Standards published by committees, international technical entities or regulatory agencies influence the development of software, through guidelines for processes and software products considering their associated risks (MUNCH, ARMBRUNT, KOWALCZYK, & SOTO, 2012).

One of the possible uses of standardization for software development is the concept of Standardized Profile (SP), which is defined by ISO as a "set of one or more base standards and/or SPs, and, where applicable, the identification of chosen classes, conforming

subsets, options and parameters of those base standards, or SPs necessary to accomplish a particular function". A possible analogy is that a profile is like a bill of materials composed of parts of standards such as ISO/IEC/IEEE 12207 or ISO/IEC / IEEE 15288. (ISO, 2015)

Although it is commonly assumed that the organizational performance is increased by using reference models for process assessments and improvement (Goldenson & Gibson, 2003), this is not a common practice, as they are usually adopted by just a small number of organizations, mainly large and medium-sized ones (Kalinowski, Weber, Santos, Franco, Duarte, & Travassos, 2015).

Most of the space software have been developed by small groups (Lahoz, Richter, & Rico, 2015), demanding particular attention to this scenario with establishment of process approaches suitable for small organizations. In Europe, 85% of the information technology (IT) sector's companies have up to 10 employees and in Brazil, IT companies with up to 19 people account for around 95% of companies. (Laporte, Séguin, Boas, & Buasung, 2013)

Agencies such as ESA and NASA have been proponents of space standardization for a long time, but frequently small organizations are not ready to comply with their stringent requirements. Most of the software development standards do not specifically aim the needs of small enterprises, although they represent the majority of software market. (O'Connor & Laporte, 2010)

Research has shown that small organizations usually lack the resources to implement the standards as they do not have the necessary resources and maturity in the development process (Laporte, O'Connor, & Paucar, 2015).

For many small software companies, it is a major challenge implementing controls and structures to properly manage their software development activities (Larrucea, O'Connor, Colomo-Palacios, & Laporte, 2016). Small organizations typically have limited ways to be recognized in their domain as producers of quality systems within budget and schedule, consequently they may be put aside from space projects (Rodríguez-Dapena & Lohier, 2017).

Very Small Entities (VSEs), defined as entities (enterprise, organization, department or project) with up to 25 people, have had their importance developing products and services recognized by industries worldwide (Laporte, Séguin, Boas, & Buasung, 2013), even though ISO acknowledged that many organizations are not ready to fulfil the whole set of requirements from standards such as ISO 15504/330xx (ISO/IEC, 2008) or CMMI (SEI, 2010). Therefore, the ISO/IEC 29110 series of systems and software engineering process standards and guides were developed, aiming a more realistic way of implementing process standardization (Larrucea, O'Connor, Colomo-Palacios, & Laporte, 2016).

The objective of this paper is to present the structure and basic contents of the

proposal approach for selecting processes profiles from a new profile group, which we named VSE Critical Profiles, comprising simplified and flexible sets of processes for software development in VSEs within the space domain compliant with its quality requirements and considering their typical resources limitations.

2 I METHODOLOGY

This work comprises an approach for critical software development in VSE, comprising the definition and application of a VSE Critical profile group based on ECSS-Q-ST-80C (ECSS, 2017a) and ISO/IEC 29110 (ISO/IEC, 2011b) standards and related literature.

The profiles approach is issued to give assistance for selection and appliance of processes for space related software development, helping to ensure that a development organization establishes appropriate processes and procedures that result in quality space software.

There is a potential risk in not using the full implementation of the space software specifications from the adopted standards, such as ECSS or NASA. Managing risks on projects includes risk assessment and a mitigation strategy for those risks. Consequently, a risk mitigation scheme must be designed to eliminate or minimize the negative impacts on the project according to the potential impact of this risk.

As a reference approach for determining the kind of assessment to be performed on candidate projects, *Order 8110.49 Chg 1 - Software Approval Guidelines* (FAA, 2011) was used, as in its Chapter 3 it contains information about determining the level of FAA Involvement in Software Projects. That content was reviewed, adapted and used as basis for the evaluation proposed in this paper.

3 I RESULTS AND DISCUSSION

This section comprises the proposal for determining critical space software processes affordable for VSE with specific criteria to evaluate projects candidate to use a minimal processes approach based on profiles definition, minimizing the risks by addressing specific profiles to projects given their associated risk based on an evaluation result.

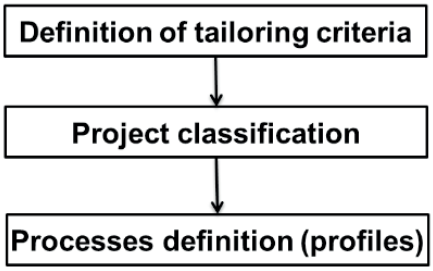

Figure 1 presents the proposed 3-step approach.

Figure 1: 3-step approach

3.1 Definition of tailoring criteria

The following considerations are examples of what may influence the profile level to be used in the software development process:

(1) The software criticality classification level(s), as determined by a dependability and safety analysis of the software products, using the results of system-level safety and dependability analyses.

(2) The product attributes (such as size, complexity, system functionality or novelty, and software design).

(3) The use of new technologies or unusual design features.

(4) Proposals for novel software methods or life cycle model(s).

(5) The knowledge and previous success of the organization in software development to comply with the objectives of space software standards (ECSS).

Therefore, to determine which parameters impact process selection for space software projects in VSE, this first step comprises an evaluation of the project's characteristics to determine the tailoring criteria, shown in Figure 2.

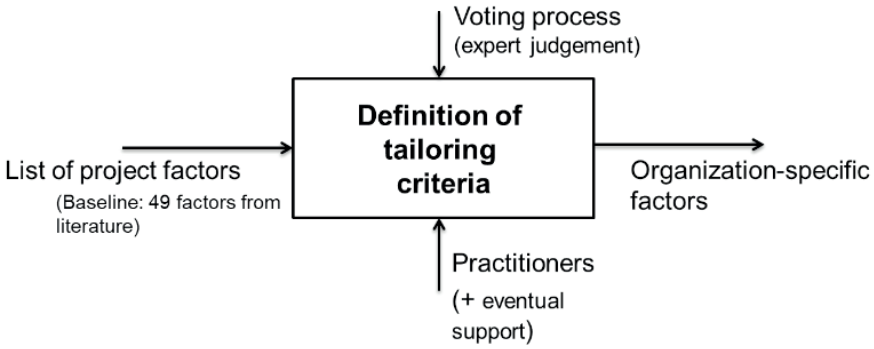

Figure 2: Determination of tailoring criteria

3.2 Project classification

3.2.1 General

This section provides the criteria for determining to what extent apply the

presented profiles in determining the software aspects for a given project:

- When the Software Product Assurance (SwPA) should be involved (for example, planning, development, integration/verification, or final software approval).
- The extent of SwPA involvement in the project (for example, how many reviews are conducted; how much surveillance is delegated; and how much and what types of documented data are reviewed, submitted for approval and approved).
- The areas for SwPA involvement, parts of the software processes where the SwPA should focus its involvement to ensure fulfillment of the appropriate objectives (for example, focus on plans, design, or code).

Figure 3 illustrates this step.

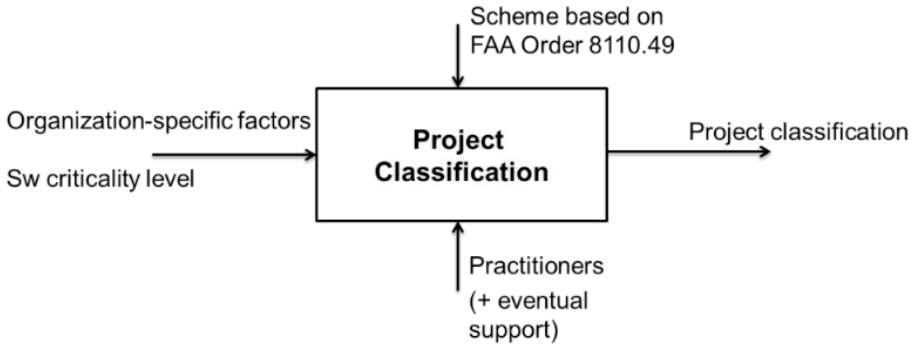

Figure 3: Project classification

3.2.2 Determining the tailoring criteria

This section discusses the usage of tailoring criteria for determining the Profile to be applied in the software project. An assessment has to be carried out and documented at the start of the software development project to enable the SwPA to plan and address the project details as early as possible. There are two major areas of criteria: software criticality level and project-specific aspects.

a. Software criticality classification criteria

The first criterion for determining the PLA for the software aspects of a project is the software criticality classification of the software product being developed or modified, which comes from a system-level analyses that leads to the criticality classification based on the severity of failures consequences.

The software criticality classification is used as a starting point, applied as shown in Table 1. For example, a Level D software project would initially indicate a PLA ONE; however, a Level A project might lead to PLA THREE or N/A. For the cases where the proposed profiles are considered not applicable (N/A), the project is supposed to adopt the original standards of the given area, ECSS in this case.

Software criticality	Profile Level
D	ISO/IEC 29110 or ONE
C	ONE or TWO
B	TWO or THREE
A	THREE or N/A

Table 1: Software criticality classification criteria

b. Project-specific criteria

Table 1 shows duality for all software criticality classifications. Therefore, it is necessary to look at other relevant project criteria for determining the PLA. In this work, the project criteria proposed are divided in organization and product. The organization aspects are summarized in Table 2, the product aspects in Table 3, and the uses of those tables are explained in section 3.2.3.

#	Criteria	Scale	Grade			Score
			Min		Max	
1.	Developer critical software experience					
1.1	Experience with space software development.	Scale:	0	5	10	
		Experience:	< 2 yrs	2 - 4 yrs	4 yrs	_____
1.2	Experience with ECSS system.	Scale:	0	5	10	
		Experience:	< 2 yrs	2 - 4 yrs	4 yrs	_____
1.3	Experience with other critical software standards.	Scale:	0	5	10	
		Experience:	< 2 yrs	2 - 4 yrs	4 yrs	_____
2.	Demonstrated software development capability					
2.1	Capability assessments (i. e.: SEI CMM, ISO 9001)	Scale:	0	5	10	
		Ability:	Low	Med	High	_____
2.2	Development team experience average based on relevant software development experience.	Scale:	0	5	10	_____
		Experience:	< 2 yrs	2 - 4 yrs	4 yrs	
3.	Developer software service history					
3.1	Entity software quality assurance organization and configuration management process.	Scale:	0	5	10	
		Quality:	Low	Med	High	_____
					Organization Score:	_____

Table 2: Organization Criteria

4.	System and software application					
4.1	Complexity of the system architecture, functions and interfaces.	Scale:	0	5	10	
		Complex:	High	Med	Low	_____
4.2	Complexity and size of the software and safety features.	Scale:	0	5	10	
		Complex:	High	Med	Low	_____
4.3	Novelty of design and use of new technology.	Scale:	0	5	10	
		Newness:	Much	Some	None	_____
4.4	Software development and verification environment.	Scale:	0	5	10	
		Environ:	None	Older	Modern	_____
					Product Score:	_____

Table 3: Product Criteria

3.2.3 Criteria description

1. Developer Software Certification Experience

1.1 Experience with space software development.

Time (in years) during which the developer entity has worked with space software projects.

1.2 Experience with ECSS system.

Time (in years) during which the developer entity has worked with ECSS system based space software projects.

1.3 Experience with other critical software standards.

Time (in years) during which the developer entity has worked with critical software projects.

2. Demonstrated software development capability

2.1 Capability assessments (i. e.: SEI CMM, ISO 9001)

Previous capability assessments reports results.

2.2 Development team experience average based on relevant software development experience.

Team's experience in software projects considered similar to the project under evaluation.

3. Developer software service history

3.1 Entity software quality assurance organization and configuration management process.

Evaluation of the entity's organization and processes maturity.

4. System and software application

4.1 Complexity of the system architecture, functions and interfaces.

Number of different functions and interfaces of the system under development.

4.2 Complexity and size of the software and safety features.

Number of safety features and their size.

4.3 Novelty of design and use of new technology.

Number or percentage of new features and/or methodology of the system under development.

4.4 Software development and verification environment.

Maturity of the development and verification environment.

3.3 Adequate Profiles Selection

As result of the software development project assessment the Profile Level Applicability (PLA) is defined as described in Figure 3, allowing the usage of Table 3 for the selection of adequate profiles for software projects.

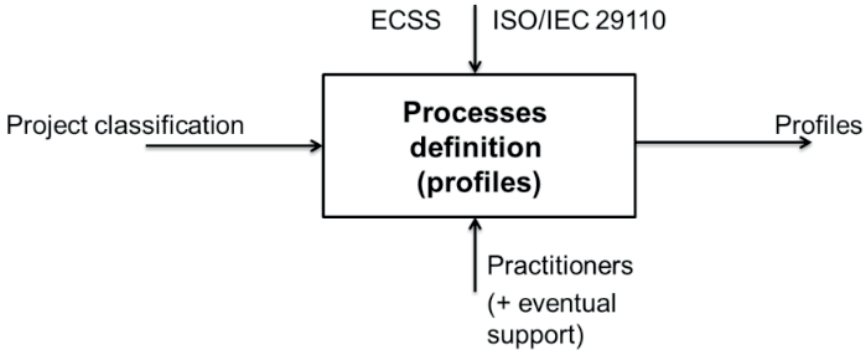

Figure 3: Process definition

	Software Criticality Level			
Project score	**A**	**B**	**C**	**D**
70 < s	N/A	THREE	TWO	ONE
35 < s ≤ 70	N/A	TWO	TWO	ISO/IEC 29110
s ≤ 35	THREE	TWO	ONE	ISO/IEC 29110

Table 3: Profile Level Applicability

4 I CONCLUSION

Based on the Profile Level Applicability (PLA) results, VSEs are able to use a profile from the VSE Critical Profile Group, which considers their limitations, comprising a simplified and flexible set of processes.

The next steps of this work are: conduction of software projects case studies; and evaluation of the completeness, applicability and usability of the proposed VSE Critical Profile Group for critical space software.

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ÍNDICE REMISSIVO

A

Aeroportos brasileiros 57, 58, 59, 60, 62, 63, 65, 66, 67, 68, 72, 73, 74
Álgebra linear 185
ALT 48, 49, 50
Ambiente de tarefa 99, 101, 102
Ambiente espacial 174, 175
Ambiente geral 99, 100, 101, 102, 103, 105, 106, 107, 108
Automatizado 77, 78, 79, 81, 85

B

Banco de dados 51, 57, 165, 169, 170

C

Cadeia de distribuição 57, 66, 71
Classificação 132, 133
Clima organizacional 99, 103, 104, 105, 106, 108, 109
Componente de satélite 174
Controle de acesso 165
Cortador-de-grama 77

D

Dimensionamento 17, 18, 22, 24, 84, 112, 115, 120, 124
Dose ionizante total acumulada 174, 175

E

Economia 75, 77, 105, 120, 193
Eficiência 23, 77, 85, 185

F

Física da falha 48, 49, 50, 52, 53, 54, 55
Foguete 17

G

Geometria analítica 185, 197, 198
Ground stations 147, 148, 150

L

LDA 48, 49, 50
Limite de resistência à tração 86, 87, 88, 92, 93, 94

M

Metodologia científica 125, 126, 128, 129, 130, 131, 206
Métodos de pesquisa 125, 126, 129
Métodos de predição da confiabilidade 48, 52
Métodos de solução 132, 133, 138, 140, 144
Modelagem matemática 26, 28, 37, 146
Modelo de malthus 26, 31, 32, 35
Modelo de verhulst 26, 29, 31, 34, 35

P

Panorama 70, 75, 132
Paraquedas 17, 18, 19, 21, 22, 23, 24, 25
Profiles 39, 41, 43, 46, 47
Programação da produção 132, 133, 134, 135, 136, 137, 138, 139, 140, 145

Q

Querosene de aviação 57, 58, 59, 61, 66, 69, 71, 75

R

Refino de grãos 87

S

Satellites 147, 148, 149, 150, 151, 152, 159, 160, 161, 162, 163, 164
Secções cônicas 185, 186, 187, 188, 197
Segurança 1, 77, 78, 79, 84, 85, 105, 115, 124, 165, 166, 167, 168, 171, 172, 206
Segurança escolar 165
Servidor web 165, 170
Software defined radio 147, 164
Software processes 39, 41, 43
Soja 26, 27, 28, 30, 31, 32, 33, 34, 35, 36, 37, 38
Space systems 147, 174

T

Tocantins 26, 27, 28, 30, 31, 32, 33, 34, 35, 36, 37, 38
Transistor 2n2222a 174, 179, 180

V

Vse 39, 41, 42, 46

Z

Zircônio 86, 87, 88, 90, 97