Analysis and Comparison of Project Management Standards and Guides

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Abstract. With the increasing scale of systems and products, many large companies ask different suppliers to manufacture the components of the final systems or products. Thus, managing projects dedicated to complex systems engineering is very tricky and ensuring the success of projects is a real issue. Many project management tools, techniques and even standards or guides have been developed by different organizations in order to support the management of such projects. For project managers, selecting and relying on immediately operational methods, tools and references (standards and guides) for a project manager to lead his project represents a true difficulty. The purpose of this paper is to introduce, analyze and compare the most famous project management references (PMBoK, ISO 21500 and ISO/IEC 29110) to provide a global and a detailed views on project management methodological guidelines, in order to facilitate the choice of a project management reference to help the project manager to manage the project effectively, thus to improve the success rate of projects.

Introduction

Project Management (PM) plays a critical role in the implementation of projects in all the organizations or companies, wherever they are small or large. Using PM methods and tools cannot ensure the success of a project, but it can improve its chances of success. PM has been practiced for thousands of years that can be dated back to the Great Pyramid of Giza [1,2]. Many methods and tools have been developed since and are now available and routinely used by projects managers. Among them, the Gantt chart, the Critical Path Method (CPM), the Work Breakdown Structure (WBS) and the Earned Value Management (EVM) [3]. If some methods for developing systems are easier to manage than others and some more likely to succeed, particularly in large-scale projects, using project management references, standards or compendiums of good practices, is also a way to support and guide project management [4,5]. The first PM reference was the PMBoK Guide, a Guide to the Project Management Body of Knowledge; it was published by Project Management Institute (PMI) in 1987; the fifth version was edited in 2013 [6]. The ISO 21500 Standard for Project Management is a standard developed by ISO (International Organization for Standardization) from 2007, later released in the September 2012 [7]. The last international standard is the ISO/IEC 29110 elaborated by the sub-committee 7 of Joint Technical Committee 1 of the ISO and IEC (International Electrotechnical Commission) and dedicated to the very small entities [8]. It was first published in 2012. For project managers, determining which standard or guide is more suitable for their projects means spending a lot of time to read, analyze and compare these three references. So the purpose of this paper is to make this analysis and to compare the three project management standards or guides to help the project managers to facilitate their selection.

The current situation in the domain of PM is stated in section 2. Section 3 briefly introduces and compares the three PM references. A conclusion on the comparison of them is given in section 4.All manuscripts must be in English, also the table and figure texts, otherwise we cannot publish your paper.

Current situation

History and definition of Project management. The Great Pyramid of Giza, the Colosseum in Rome and the Great Wall of China are testimonies of successful construction projects. In the 2570's BC, the ancient records show that there were managers for each of the four faces for the Great Pyramid when they were built. According to historical data, the labor force was organized into three groups: soldiers, common people and criminals when the Great Wall of China was built [9]. The origins of the theory of project management correspond with the development of Gantt chart, named by the creator Henry Gantt, in 1917. It is the forefather of project management. In the 1950s, the Navy employed the modern project management methodologies in their Polaris project. During the 1960s and 1970s, many methods or tools were developed, for instance, the CPM, Program Evaluation Review Technique (PERT) and WBS. At the same time, a lot of organizations were built to promote the methodology of project management, such as the American Association of Cost Engineers (AACE), the International Project Management Association (IPMA) and the PMI. Indeed, PM covers a wide field of applications where associations historically played and still play an important role [1,9].

Many organizations define what project management is. The PMI states that "Project management is the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements" [6]. The ISO 21500 defines the PM this way: "Project Management is the application of methods, tools, techniques and competencies to a project" [7]. The definition of PMI emphasizes the purpose of PM is to meet the project requirements. The application of project management can meet the requirements better; short the cost and time to finish the project [6,7].

Evolution of project management references. Many standards or guides were developed by the different organizations from the 1987's. PMBoK Guide was first published as a white paper by PMI in 1987; it was an attempt to document and standardize project management practices [6]. The first edition appeared in 1996, the second edition in 2000, a third in 2004, a fourth in 2009 and the last version in 2013. In 2012, the International Organization for Standardization (ISO) recognized the importance of formalizing the practices of project management; they published the standard ISO 21500 in 2012 [7]. Last but not least, another standard for project management, focusing on very little companies, ISO/IEC 29110, appeared in also appeared at the same date [8].

Next section introduces the three project management standards or guide.

Analysis and comparison of project management standards and guides

This section introduces the three project management references then analyzes, compares and aligns them.

Introduction of the three references

PMBoK. With the development of project management, the PMBoK has been released many times from 1996 to now. This guide aims at providing knowledge, processes, skills, tools and techniques that have a significant impact on the project success [6]. The first part of this guide provides the subset of the project management body of knowledge that is generally recognized as good practices.

It defines 47 processes in the first part of this guide into 10 Knowledge Areas (KA) about the professional field, project management field or area of specialization, such as the project scope management and project cost management. In the second part, this guide re-groups the processes to form a project management standard. It defines the five process groups based on the five stages of the project implementation: initiating process group, planning process group, executing process group, monitoring and controlling process groups and closing process groups [6]. It details the input, tools and techniques, output and the data flow diagram of each process in the ten KA. At each stage of the systems engineering (SE), one can use all or part of the five process groups; any set of processes can also be reused for any stage of SE.

It defines a table that provides the project management process group and knowledge area mapping for the readers in order to help them better under the processes . The Fig. 1 shows the structure of PMBoK.
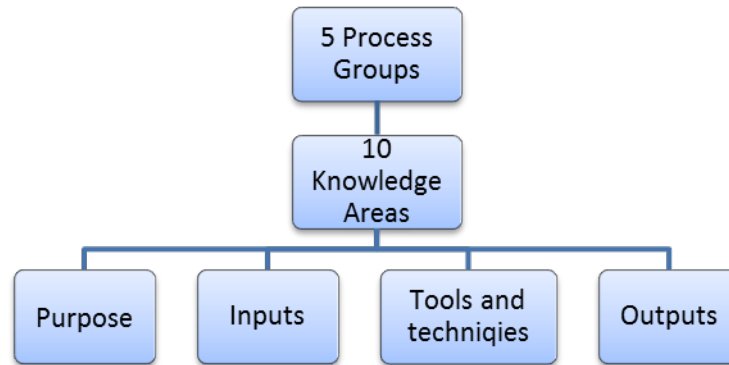
Fig. 1 structure of PMBoK

ISO 21500. Like the PMI, the ISO organization also recognized the importance of improving the performance of project management in order to enhance the competition of companies, and published the ISO 21500 Guidance in project management in 2012 [7]. It is an international standard on project management. The ISO started to edit this standard from 2007 and finished in 2012. This guide aims to provide guidance for project management and can be used by any type of organizations.

It defines 39 processes that group into 5 process groups (like the 5 process groups of PMBoK) and 10 groups of subject (like the 10 KAs of PMBoK). The five process groups can be used at any stage or sub-project or throughout the project. Each process contains the purpose, input and output (deliverable, a result, a document ...). The structure of ISO 21500 is shown in the Fig. 2.
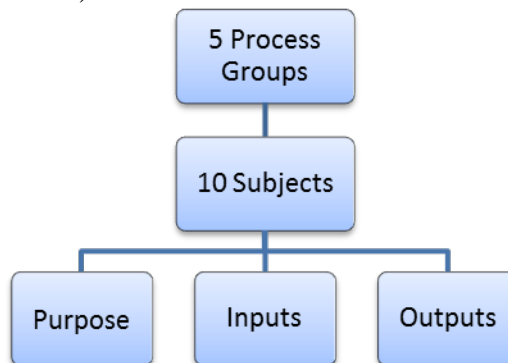
Fig. 2 the structure of ISO 21500

ISO/IEC 29110. With today's large scale projects, it is compulsory for companies to buy the product as the components of large systems or products from suppliers, often small companies, so many small companies were created quickly to meet this requirement. For ensuring the quality of projects or systems, it is necessary to help the very small entities (VSEs) develop high quality products. Considering this, the ISO organization developed a guide named "Software engineering – Lifecycle profiles for very small entities" [8]. This guide considers VSEs as entities with less than 25 employees [8]. There are five parts of this guide: 1) Overview (ISO/IEC TR 29110-1), 2) Framework and taxonomy (ISO/IEC TR 29110-2), 3) Assessment guide (ISO/IEC TR 29110-3), 4) Profile specification (ISO/IEC TR 29110-4) and 5) Management and engineering guide (ISO/IEC TR 29110-5). The fifth part deals about implementation management and engineering guide for the small entities. This guide is suggested to be used with some project management and software implementation processes and outcomes from the standard ISO/IEC 12207 and products from ISO/IEC 15289 [8].

The first part of this guide aims at introducing the guide briefly, such as the processes, lifecycle and some other concepts. The purpose of the second part of this guide is to introduce the concepts for software engineering standardized profiles for VSEs and defines the terms common to the documents

of the VSE profile set. The third part provides the definitions of the process assessment guidelines and the compliance requirements that are used to meet the purpose of the defined VSEs profiles. It defines the specification for all the profiles of the Generic Profile Group (GPG) in the fourth part. In the last part, it gives an implementation management and engineering guide for the entry profile of the GPG. According to the purpose of this paper, we focus on the fifth part of this guide.

In fact, according the reports and studies, it is obvious that the VSEs have difficulties to use the international standard during their project because the scale, the time and the resource of the VSEs [8]. For those reasons, this guide just defines two processes: the project management (PM) process and the software implementation (SI) process. But this guide allows the VSEs to adapt themselves to this guide by adding their processes and tailoring the activities or processes. The structure of ISO/IEC 29110 is shown in the Fig. 3.
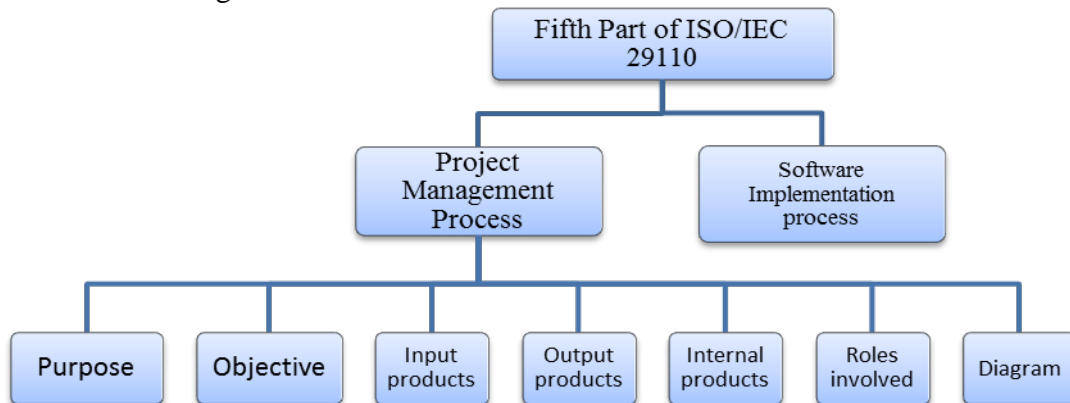

Fig. 3 Structure of the fifth part of ISO/IEC 29110

Analysis and comparison of the three references. The three references introduced above are the most famous standards or guides for project management. After a brief introduction to them, the purpose of this section is to compare them generally and in details to provide the project managers a global view in order to choose the suitable standard or guides to implement their project.

General Comparison of the three references. This section compares the three references according a set of general criteria: the number of processes of references, the target audience, level of details, proposition on tools and techniques, year of publication and the revision frequency.

The PMBoK has the largest number of project management processes, the ISO 21500 has 39 processes and the ISO/IEC 29110 just has one process management process; note that the detailed comparison of processes in the three references will be addressed where processes from each reference will be identified, detailed and aligned. The target audiences for them are different. The PMBoK and ISO 21500 are intended to be used by any scale company, although there are some studies pointed out that the VSEs have the difficulties to relate themselves with the international standards. The ISO/IEC 29110 focuses on the VSEs, and it allows the VSEs to adapt themselves to the guide by adding some elements from their own practices.

The PMBoK almost has 600 pages, it is the most detailed PM reference; it not only provides the purpose, input and output of each process, and it also presents some PM tools and techniques. The ISO 21500 is a standard without suggestion on tools and techniques. The ISO/IEC 29110 is the least detailed guide among the three references because it focuses on the VSEs. Indeed, considering the scale, budget, number of employees of the VSEs, it just defines some example process or activates of project management to give the referencse to the VSEs. The three references are all very new, there are all published recently and the PMBoK is the fifth edition because the wide use of this guide.

In the next section, we will compare the three references in the term of the structure in order to align them at the structure level. The Table 1summarizes the result of comparison briefly.

Table 1 comparison between the three project management references

	PMBoK	ISO 21500	ISO /IEC 29110

Processes of references	39 processes	47 processes	2 processes
The target audience	Any company	Any company	VSEs
Level of details	◆◆◆◆◆	◆◆◆◇◇	◆◇◇◇◇
Proposition on tools and techniques	Yes	No	No
Year of publication	2013	2012	2012
Revision frequency	◆◆◆◆◆	◇◇◇◇◇	◇◇◇◇◇

Detailed Comparison on the structure level of three references. This section compares the process groups of PMBoK and ISO 21500, and analyzes the PM objective and activities to align the three references at the structure level.

The ISO/IEC 29110 defines 2 processes: project management (PM) process and software implementation (SI) process. The project management process aims to establish and carry out in a systematic way the tasks of the software implementation project [8], and the purpose of the SI process is the systematic performance of the analysis, software component identification, construction, integration and tests [8]. Related to this aim of this paper, we should select the PM process to compare with the other reference because the SI process is related to the systems engineering domain.

As we introduce above, the PMBoK has 47 processes and they are grouped into five process groups and the processes are regrouped into 10 KAs. The ISO 21500 nearly has the same structure. It defines 39 processes organized into 5 groups, instead of the KAs; it defines the 10 subjects related to knowledge of project management field. All the two references (PMBoK and ISO 21500) define the purpose, inputs and outputs in each process, and the PMBoK provides the tools and techniques extraordinarily.

The PM process of ISO/IEC 29110 has a completely different way to present the process. It defines the purpose, objectives, input products, outputs products, internal products, roles involved and the PM diagram. In the section of PM diagram, it defines four activities of the PM process: project planning, project plan executin, project assessment and control and the project closure. Outwardly, the ISO/IEC 29110 has a different way to organize the processes by regarding to the PMBoK and ISO 21500. In fact, aligning to the structures of the other two references, this guide defines two process groups: the project management process group and the software implementation process group. The PM process group presents four process groups (named PM activities in the guide). But at the same time, it also defines 7 PM objectives. In each PM objectives, it suggests to use some processes from the ISO/IEC 12207. So after aligning to the other structure, the 4 PM activities are corresponding to the process groups in the PMBoK and ISO 21500. The 7 PM objectives are corresponding to the KAs of PMBoK or subjects of ISO 21500. In each objective, the ISO/IEC 29110 selects some processes from the standard ISO/IEC 12207. There are 11 processes presented in the PM objectives that are selected from the ISO/IEC 12207.

The corresponding between the structures of the three references is show in the Table 2.

Table 2 corresponding between the structures of the three references

	PMBoK	ISO 21500	ISO/IEC 29110
Process groups	• Initiating • Planning • Executing • Monitoring and Controlling • Closing	• Initiating • Planning • Implementing • Controlling • Closing	• Planning • Executing • Assessment and Controlling • Closure

KAs, subjects or activities	10 KAs	10 subjects	7 objectives

In the next section, we analyze and compare all the processes from the three references in order to align them at the process level.

Detailed Comparison on the processes level of three references. In this section, we first analyze the processes from the three references, then we compare them in order to find if processes are identical or can be aligned; at last we give the detail on the same processes, the process merged of same activities and the special processes in each reference.

To compare processes, we proceed this way: we consider the ISO 21500 and the ISO/IEC 29110 referred to PMBoK. First we compare the ISO 21500 with the PMBoK, then we compare the ISO/IEC 29110 with the PMBoK. The comparison of the ISO 21500 with the PMBoK revealed 27 identical processes, the ISO 21500 having 2 processes less than PMBoK (validate scope process and plan stakeholder management process) and it introduces two new process (collect lesson learned process and control resource process). It replace the "define activities process" of project time management knowledge area into the project scope management subject. The ISO 21500 defines the "manage stakeholder process" instead of the "manage stakeholder process'' and the "control stakeholder process" of PMBoK; the "define scope process" instead of the "collect requirements process" and "define scope process" of PMBoK; the "assess risk process" instead of the "perform quantitative risk analysis process" and "perform quantitative risk analysis process" of PMBoK; the "administer contracts process" instead of the "control procurement process" and "close procurement process" of PMBoK; the "define project plan process" instead of "develop project management plan process ". The ISO 21500 rewrite the "estimate activity resource process", "acquire project team" and "develop project team" of PMBoK with the "establish project team process", "estimate resource process", "define organization process" and "develop project team process", "plan scope management process", "plan schedule management process", "plan cost management process", "plan human resource management process" and "plan risk management process".

According to the PMBoK, there is no identical process in the ISO/IEC 29110. But after analyzing the elements of the processes in the 7 PM activities, there are 9 processes selected from the ISO/IEC 12207: Project Planning Process, Measurement Process, Project Assessment and Control Process, Software Acceptance Support Process, Software Requirements Analysis Process, Software Review Process, Risk Management Process, Software Configuration Management Process and Software Quality Assurance Process. All the 9 processes can be all covered by the processes of PMBoK. The result of the comparison on the three references at the process level is shown in the Table 3.

Table 3 differences and similarities between PMBoK and ISO 21500 (PMI)

	PMBoK	ISO 21500	ISO/IEC 29110
The same processes emerge in both references	27	27	–
The process replaced	1	1	
The process combined	14	5	
the process rewrited	3	4	9
The processes only emerges in PMBoK	2	–	–
The processes only emerges in ISO 21500	–	2	–
Total	47	39	

Conclusion on the comparison of the three references. After this comparison of the three project management references, we come to the conclusion that the PMBoK is suitable for the large scale projects, even if it can be used at any time and at any level of projects. Regarding the profile of the VSEs, the implementation of the PMBoK would cost too much time and money; this does not suit the required flexibility of VSEs. The ISO 21500 almost has the same PM processes as the PMBoK,

but it does not provide the tools and techniques for the project manager to manage projects. If the project managers do not consider the suggestion on PM tools and techniques, they can choose any one of the PMBoK and ISO 21500 as the reference. Based on the purpose and the character of ISO/IEC 29110, this standard is better for VSEs because of their features and flexibility. The VSEs also can select the processes from another standard based on the projects, for example the ISO/IEC 12207 and ISO/IEC 15289.

Conclusion

According to the scale of projects, the project managers play an important role in order to assurance the success of project. There is a trend that the large companies buy the components of product from other smaller companies and assemble them at their own companies, and then they deliver the products to the customer [10]. The most famous example is Airbus; many companies want to be selected by the Airbus as its suppliers. So for large projects, project managers constitute a key point because they implement, lead, monitor and control the global project. Although systems engineers still remain essential in engineering projects, their importance declines while the one of project managers rise [11,12]. So in order to help the project managers be familiar with the project management standards or guides, the comparison made in this paper is necessary. This paper introduced, analyzed and compared the most used PM references: PMBoK, ISO 21500 and ISO/IEC 29110 to help the project managers choose the PM reference easier. Based on the comparison, the PMBoK is the most detailed PM guide with the suggestion of PM tools and techniques; the ISO 21500 nearly has the same structure and processes as the PMBoK with the introduction of PM tools and techniques. These two PM references are more suitable for the large companies and large projects with the regular project management implementation. We suggest thta the VSEs use the ISO/IEC 29110 because of the special purpose of this guide. The aim of this guide is to help the VSEs manager their projects effectively and successfully. However, other means must be associated to improve the success of projects, such as the alignment of project management and systems engineering. Some studies [13,14] also analyzed and compared the systems engineering standards and guides, so the development of the tools to aligning the PM and SE can be considered as an interest method assure the success of projects.

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