

Article

Applicability-Compatibility Analysis of PMBOK Seventh Edition from the Perspective of the Construction Industry Distinctive Peculiarities

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Abstract: Project management standards, like PMBOK, have had a considerable role in developing this field of knowledge and promoting it as a professional expertise in project-oriented industries, such as the construction industry. The latest version of PMBOK, seventh edition—2021, has been released with substantial changes, and the conventional process-based system has been converted to a performance-based approach. This study aimed to investigate the recent edition of PMBOK, to explore its application and adaptation regarding the specific characteristics of the construction industry. For this purpose, utilizing a hybrid methodology of text mining and survey method, at first, the content of the text was analyzed by software in combination with experts' opinions. In a parallel survey, the distinctive attributes of the construction industry were investigated, and in the next step, the way that this sector can benefit from the emerging framework was examined. The results show the construction industry has special peculiarities in the form of four different project types with specific phases in typical lifecycle and reveal the potential applicability of performance domains in the construction projects and the compatibility of project management principles. This study is one of the first attempts to review the novel presented standard of PMBOK seventh edition and contributes to the present knowledge by analyzing the construction industry in relation to this issue.

Keywords: evolution of PMBOK; seventh edition; construction industry; project lifecycle; management standard; text analysis

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1. Introduction

Nowadays, project management processes and procedures, in the form of standard tools and techniques, are considered as one of the main elements of organizational administration systems in the construction industry, an industry that has a considerable role in any national economy through its infrastructure and production projects [1]. Sometimes, these standards are so vital to the organization that are kept as confidential documents, especially in the petroleum industry or industrial megaprojects, because they are crucial tools for materialization of top objectives of the organization, establishing value through projects. A good standard in the field of project management is assessed considering certain criteria, such as clearly defining the scope and framework, determining the required changes for all organizations, describing the performance evaluation method, supporting with the instructions and examples, utilizing strong terminology and lexicon, and predefining standardized items.

It is noteworthy that previously in the professional organizations, project manage-

ment frameworks and procedures were considered as one of modules categorized under one of expertise sections. Not only are these guidelines recognized as separate standards, but the more specific areas of application, such as the government sector or construction works, have their own dedicated frameworks. However, application of a standard for internal tasks of a project-oriented organization can be interpreted as a technology transfer process [2], because technology involves the use of better techniques to accomplish activities. An appropriate standard reduces the costs and time needed to manage a new effort and at the same time diminishes internal misunderstandings and conflicts between team members. Thus, to avoid prospective conflicts among experts, it is highly recommended that the same standard should be deployed through all the departments of an organization. On the other side, adopting a standard in a specified industry will guide the market, suppliers and other service companies to have an accepted benchmark to adapt their efforts with. This fact becomes more and more constructive when outsourcing and out-contracting are common practices of organizations throughout an industry, when buying goods or services. Accordingly, deploying a standard in an organization has two functions of establishing regulated internal relationships and understanding external connections [3]. A few studies have tried to classify the standards of project management. For instance, in an investigation, [4] identified four distinguished standards in the context of project management: De jure (official) standards, like ISO 10006 and ISO 21500; de facto (participatory) standards, like PMBOK and Prince2; specialized standards, including in-house guidelines like scrums; and maturity models, like the Organization Project Management Maturity Model (OPM3) and Capability Maturity Model Integration (CMMI). It is important to mention that some tools in the project management context, like contract forms and agreement frameworks, follow law base processes and specific legal procedures to make them standardized [5]. Answering the question of which standard is more effective is dependent on too many organizational and environmental factors and can be considered as a fully open-ended and tightly context-related problem [2]. To overcome the challenge of standard selection for an organization, many factors should be taken into account, like the consensus between all stakeholders, being adaptable with the nature of the organization and their projects and bearing string potential to bring added value into the organization [6]. However, some factors, including market requirements, in-house challenges, bearing the cost of standard deployment and fittingness of the standard with organization strategies, should be taken into account if standardization of activities is considered for implementation. It should be restated that the most specific attribute of a project, namely “*uniqueness*”, causes all project-based attempts to have a “*tailor-made*” approach to planning and execution based on an approved standard or guideline [7]. Project management tools and techniques can save more than \$150 billion per year in the US [8] and about \$97 billion per year in public construction projects in Canada [9]. Despite the complex nature of construction projects, which make this part of the economy very complicated and at the same time very profitable, the real scope of construction industry against other industries, has not been exactly defined. The other drawback here in the construction industry is the fact that none of the technical standard development entities in this industry have developed a major standard for project management in this completely project-oriented sector of economy, although there are some curbed guidelines for this purpose [10].

The main objectives of this investigation were twofold: to extract the new-orientations of the PMBOK in comparison to the previous versions and to examine the crucial aspects of the novel concepts regarding the construction industry. However, the study was designed to analyze the latest version of the PMBOK, the seventh edition, released in 2021, in comparison to the previous versions and to investigate the application of this standard into the projects of the construction industry. Therefore, the main two questions that the current study aimed to answer were:

1. What are the main improvements of the current version of PMBOK in comparison to previous editions?

2. How the construction industry can benefit from the novel introduced concepts in the current edition?

Thereafter, in the following paragraphs, firstly the role of PMBOK of PMI in the standardization of project management concepts has been investigated; then, based on the introduced methodology, two topics of comparison of the current version to the previous one and scrutiny of the adaptability and compatibility of the seventh edition of PMBOK with construction industry characteristics have been explored.

2. PMBOK and Mainstream of Standardization in Project Management

The word “*Standard*” is rooted in Middle English and refers to a benchmark to measure a parameter. Hundreds of organizations throughout the world have developed thousands of technical standards using committees and working groups [11]. According to the International Standard Organization (ISO), a standard, which could be about making, managing, delivering or supplying, defines the best techniques in performing different expertise activities based on the vast people engaged in their field [12]. In addition, the European Committee for Standardization defined a standard as a technical document that supports principles, guidelines and definitions in a specific technical field, which may be prepared at the international, national or even organizational level, defining replicable methods of doing tasks [13]. Thus, a standard facilitates relationships between various internal and external stakeholders through constructing consensus and common tongue between them. Conversely, the greater admission and reception of a standard among professionals will result in greater credibility and validity. Project management standards improve organizational processes by focusing on skills of human resources, required tools and technologies and the surrounding environment [2]. There are many standards and guidelines all over the world, at different levels, for project management that define the rules, terminology, principles, processes, tools, techniques, etc. for administrating projects. Some of the most recognized project management standards are ISO 21500:2012, Guidance on Project Management by the International Organization for Standardization (ISO), PRINCE2 by CCTA (the central computer and Telecommunications Agency), Project and Program Management (P2M) by the Engineering Advancement Association of Japan, the IPMA Competence Baseline (ICB) by the International Project Management Association, project management standards issued by the German Institute for Standardization (DIN 69901-69905), standards for quality management in project management issued by the International Standards Organization (ISO 10006) and PMBOK by the Project Management Institute (PMI). These standards try to define project objectives, focus on the quality, facilitate the communications and present the tools for project management for professionals [14]. Despite distinctions, almost all project management standards include the following: terminology to define concepts, terms and phrases; areas of knowledge, main principles or main objectives; an administration system and its sub-systems or elements, for example inputs, processes and outputs; the typical life cycle of a project and different phases, which sequentially result in goal attainment; a description of project position in the organizational pyramid in relation to business objectives and value creation [15].

Actually, an organization can be very complicated and surrounded by many internal and external parameters. External entities may include the clients, the customers, competitors, regulatory bodies, investors and many other entities. Internal assets include human resources, strategies and plans, developed business cases, IT infrastructures, organization architecture and structure, systems and methods, etc. The enterprise strategy should be aligned with the vision and mission of the organization, the portfolio, the program and the project and operation management system, whereas objectives of portfolio management refer to value creation by business. It is notable that the concept of effective performance domains is not a very novel idea, because this framework previously has been furnished to demonstrate the impact of the portfolio plan on organizational strategy. Additionally, it is important to direct internal policies of the organization

with external effective parameters, because projects are often the main building block to fulfill the strategic goals. Thus, it is important to have exact project success factors to evaluate the benefits [16–20].

On the other hand, the project management knowledge areas and concepts should contribute to the direction of organizational strategy, which identifies opportunities. The recognized opportunities should be assessed and the selected ones, in the form of business cases and approved feasibility studies, lead to projects. The projects in turn, should produce the deliverables, final products and added value. This can be considered as the value creation process from enterprise strategy to project management. The importance of evaluation of project outputs becomes more when the organization has more than one portfolio, and each of them relates to different business plans.

The founders of the Project Management Institute (PMI) standardized procedures and approaches in 1980 and established the first version of Project Management Body of Knowledge (PMBOK) in 1996. PMBOK, which is identified by the American National Standards Institute (ANSI), is updated periodically using volunteer experts from all over the world [21,22]. The publications of PMI as a not-for-profit professional organization can be categorized into three types of foundational standards, namely PMBOK; Practice Standards and Frameworks, like the Practice Standard for Project Estimating; and Practice Guides, like Benefits Realization Management. PMBOK, prior to the seventh version, was a collection of terminologies, knowledge areas and processes for management of a vast spectrum of projects and has been updated every four years. This standard gathered best practices across the globe and developed a framework based on a waterfall methodology adapted to a predefined lifecycle for industry [23]. Additionally, this standard had been proposed as a valuable collection of tools and techniques that can be used for diverse practitioners [24].

The first edition of PMBOK (1996) was a composition of collected technical documents and gathered scattered guidelines as outcomes of more than 10 years of attempts to improve the project management profession. This document, indeed, is the improved version of the white paper of “Ethics, Standards, and Accreditation Committee Final Report” of 1983 and “The Project Management Body of Knowledge” document of 1987. The first version included 37 processes in five process groups of initiating, planning, executing, monitoring/controlling and closing. This typical project lifecycle-based grouping method of processes in five bundles was kept unchanged until prior to the seventh edition. The second version of PMBOK, released in 2000, corrected some drawbacks and improved it by adding accepted practices and two more processes, increasing the number to 39 items. After four years, in 2004, by gathering experts’ comments all over the globe, the third version was published. This edition included an improvement of glossary section, some new processes were added to the text and some process names were modified. Describing apparent differences between project and product, explaining the stakeholders’ role and expanding the focus on process groups are some main alterations in this edition. In 2009, the fourth edition of PMBOK with the following main modifications was released: description of interactions between process groups, detailed definition of project charter and explanation of earned value management. The fifth version of PMBOK was released in 2013 with more improvements, including adding new a knowledge area of stakeholder management, an important field with diffused content in other areas in the previous edition. In addition, some processes were added into the group of planning in this issue of the standard and some processes were renamed. In 2017, the sixth edition of PMBOK was issued with some considerable changes. In this version, the agile concept, as the predominant approach of project management, was inserted throughout the text, the role of project manager was defined and “Time Management” and “Human Resource Management” had been converted into “Schedule Management” and “Resource Management”, respectively [11,25,26]. Although, this version was enhanced by using a vast spectrum of project management concepts, it still

suffered due to its classic viewpoint around the areas of knowledge, so it was necessary to improve the core concepts of the standard by changing the paradigm.

In the past decade, all branches of world of technology have seen major upheavals over all academic fields and professional domains. Hard technologies, like robotics and drones, and soft technologies, like blockchain/Smart contracts and virtual and augmented reality, have changed all industries dramatically. Particularly in the construction industry, building information modeling (BIM), digital construction and robotic 3D-printer-based building have revolutionized all businesses fundamentally [27–29]. Even soft skills and classic features of construction management, such as contract management, claim and dispute administration and project delivery systems have not been protected from the surge of emerging technologies. In the above-mentioned environment impacted by emerging technologies, it does not seem that the classic methods and tools of management can properly push forward more and more complex projects. So what is the solution? Although answering to this question is not so straightforward, it seems that PMI has found a response to this challenge in overturning the existing methodology of the PMBOK approach. The seventh edition of PMBOK was published in 2021, with drastic reforms and re-structuring, both in ontology and in methodology, in comparison to previous versions as the benchmark. In this edition, the detailed process and group-based view of project management converted to a comprehensive principles-based perspective, which seems to have expanded the applicability of the document for all projects, while at the same time bringing the concepts to higher levels of the organizational pyramid and widening this to even include the shareholders outside the internal system. In addition, the waterfall approach to decomposition of knowledge areas turned into project performance domains. Considering this almost completely rewritten version of PMBOK, the apex of the motivations of change can be stated as “value creation” for the “Stakeholders” of organizations through the most important block of value-adding structure, namely the “Project”. According to the latest version of PMBOK [30], the most apparent drastic changes in the seventh edition, as shown in Figure 1, are listed below:

1. Sequence of inserting main sections of “standard” and “body of knowledge” has been reversed.
2. Five typical process groups of “planning”, “execution”, “monitoring”, “control”, and “closing” have been converted into ten “Project Management Principles”.
3. Ten “knowledge areas” of project management turned into eight main “project performance domains”.
4. Introduction of interactive online platform of PMIstandards+™.
5. Presents two sections on “Tailoring” and “Models, Methods, and Artifacts”.

However, some of significant changes that have improved the guideline and caused maturity of the PMBOK between years of 1996 to 2021 have been summarized in Table 1 comparatively.

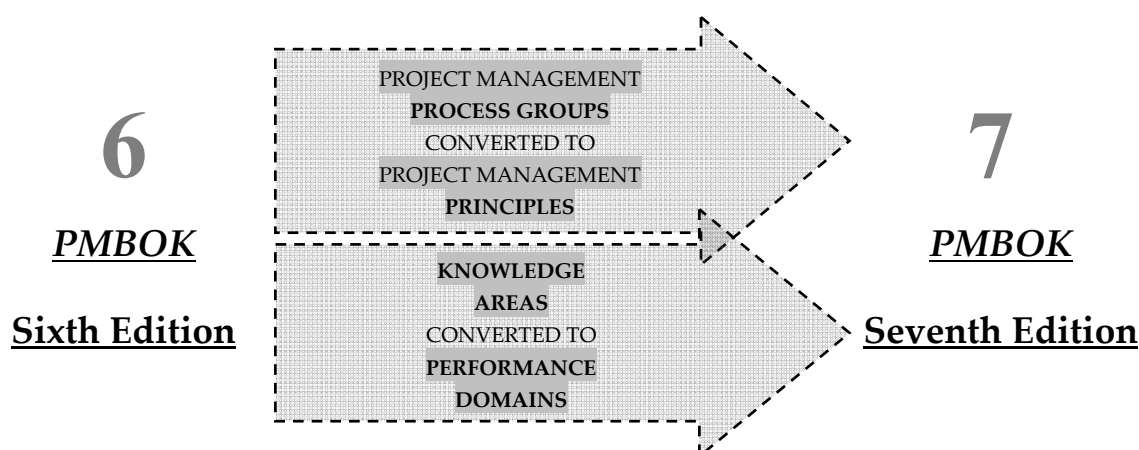


Figure 1. Shift of framework from PMBOK 6th edition to PMBOK 7th edition.

Table 1. Comparative evolution of PMBOK from 1996 to 2021 through 7 diverse editions [30–33].

Version	Year of Publication	Number of Knowledge Areas/Page s	Number of Process Groups/ITTO s *	Number of Processes (+Added-Subtracted)	Description of Some Major Changes	Methodology
PMBOK 1st Edition	1996	9/176	5/358	37	-	
PMBOK 2nd Edition	2000	9/211	5/434	39 (+2)	<ul style="list-style-type: none"> ▪ Glossary improved; ▪ New and revised processes. 	
PMBOK 3rd Edition	2004	9/390	5/592	44 (+7-2)	<ul style="list-style-type: none"> ▪ Glossary improved; ▪ New processes; ▪ Process name changes; ▪ Describing the difference between project and product; ▪ More definitions on stakeholders and the project team; ▪ Discussion of the role of the PMO; ▪ Introduction of the concept of project management system; ▪ Expansion of the focus on “process groups” and “knowledge areas”; ▪ Expansion of the coverage of integration and initiation processes. 	Hierarchical functional decomposition of project management knowledge
PMBOK 4th Edition	2009	9/467	5/517	42 (+3-1)	<ul style="list-style-type: none"> ▪ Glossary improved; ▪ Clearing the interaction between processes using several images; ▪ Demonstrating knowledge areas with flow diagrams; ▪ More explanations on project charter ▪ Detailed descriptions on statement elements; ▪ Detailed focus on earned value management. 	

PMBOK 5th Edition	2013	10/589	5/619	47 (+5)	<ul style="list-style-type: none"> ▪ Glossary improved; ▪ Revised processes; ▪ Introduction of new knowledge area named “project stakeholder management”; ▪ More detailed descriptions on some knowledge areas; ▪ Enhancement of many terms and phrases; ▪ Improvement in the planning process group. 	
PMBOK 6th Edition	2017	10/976	5/667	49 (+3-1)	<ul style="list-style-type: none"> ▪ Glossary improved; ▪ Novel sections for agile concept; ▪ Improvement of knowledge areas with the agile approach; ▪ Descriptions on project manager roles and responsibilities; ▪ Time management area renamed to schedule management; ▪ Human resource management re-named to resource management. 	
PMBOK 7th Edition	2021	8 Performance domains	-	-	<ul style="list-style-type: none"> ▪ The ontology and methodology fundamentally have been changed. ▪ Supporting full range of development approaches (predictive, traditional, adaptive, agile, hybrid, etc.) ▪ Adding new section for tailoring methods and processes ▪ Devoting entire new section to tools, techniques and artifacts; ▪ More focus on value creation and project outcomes; ▪ Introducing the PMIstandards+™. 	Comprehensive principles-based approach

* Inputs, tools and techniques, outputs.

3. Research Methodology

To respond to the questions of the research and to establish a proper insight around project management standards, firstly, the literature about standards and PMBOK has been reviewed, the findings about standards have been examined and previous utilized methodologies and techniques have been surveyed. The basic context of the current study was decomposition of the novel presented text, it can be called a newly emerged paradigm, to comprehend the new trends and governing thought principles on project management. Therefore, the philosophy of research was adopted considering the body of text as the main source of data. Accordingly, a three-step methodology has been designed and followed to answer the question of applicability and compatibility of the latest issue of PMBOK in 2021.

Given that experts of project management have no thorough cognition about the novel presented framework of PMBOK, in the first step, data acquisition, use of a text mining method was adopted. Thereby, using a text mining tool, Voyant online text processor, each performance domain was fed to the system and studied separately and related concepts were extracted from the standard. Extracted raw data were delivered to the experts to analyze the two available challenges through a semi-closed questionnaire, the first exploring undercover connections between new performance domains and pre-

vious knowledge areas. This step was essential because concealed concepts in the newly presented domains can be revealed more easily by having experienced information of the previous version of PMBOK. Secondly the covert relationships between the performance domains themselves were explored. For the first problem, quantitative closed questions for a percentage-based questionnaire were designed, while for the second area of study, open questions that pointed to the domains in a pair-wise comparison form were considered. To measure applicability and compatibility of the newly introduced concepts within the field of construction management, in the second major step, characteristics of the construction industry in the form of project typology and various phases of project lifecycle have been surveyed through experts' opinions. To this end, and to reduce the effect of subjective judgments of the experts on the final results, an iterative method of Delphi was adapted. As the result of this stage, which was conducted through 4 rounds of the Delphi method, a novel typology of construction projects has been proposed for the first time and, based on this categorization, the lifecycle of these project types and the role of each of performance domain in them have been studied. Finally, in order to have a broader and, at the same time, clearer understanding of the presented principles of project management in relation to the performance domains, the effectiveness of these 12 principles on performance domains in the construction industry has been estimated (Figure 2). Table 2 summarizes the demography of 14 experts involved in the current investigation. These experts were selected based on their expertise in a project management context, the area of experience and educational level. Though, in the data gathering stage, 23 experts were identified, their availability for participation decreased this number to 14.

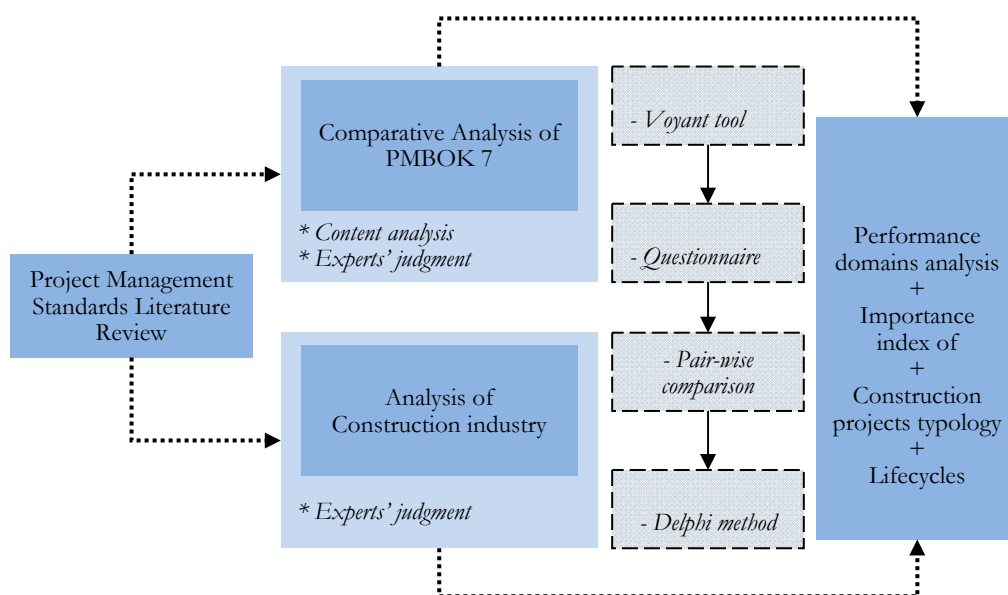


Figure 2. Schematic illustration of the research.

Table 2. Descriptive data and demography of the selected experts.

Demographics		N	Percentage
Age	35–45	5	35.7
	45–55	8	57.1
	>55	1	07.1
Educational level	Bachelor	3	21.4
	Master	4	28.5
	Ph.D.	7	50.0
Years of experience	0–8	3	21.4

	8–20	6	42.8
	>20	5	35.7
Field of experience	Academic	8	57.1
	Professional	6	42.8
Sector type	Public	9	64.2
	Private	5	35.7

4. Content Analysis of Performance Domains

Extracting concepts from the terms and phrases of a given text can be a tough task that even two experts can hardly agree on. To tackle this challenge, some text mining and content analysis tools have been developed to assist in the process of meaning derivation. Thus, in the first step, to have a primary perception and a realistic insight of the performance domains, using online Voyant Tools, the text of each domain was analyzed distinctly. According to the Voyant Tools webpage (<https://voyant-tools.org/>; 10/2021), “Voyant Tools is a web-based text reading and analysis environment. It is a scholarly project that is designed to facilitate reading and interpretive practices for digital humanities students and scholars as well as for the general public”. However, using the above online tools to reveal the keywords of content and to explore probable relationships between different sections, each of the eight performance domains was scrutinized. This inspection provided objective statistics to figure out each of the section objectives, their interconnections and intersections. In addition, supplementary illustrations, as a part of the outputs of the text analysis, have been used to enhance perception of roles of various phrases as textual factors in the presented standard framework. To this end, all headers, footers and figures were removed and plain text of each section was prepared for participants to examine.

According to the text analytical study, the most frequent words in the *Stakeholder* section are “project” (75), “stakeholders” (56), “stakeholder” (29), “team” (14) and “engagement” (13) among the total number of 1567 words of this section. If two words of “stakeholders” and “stakeholder” are considered as same, the term “team” has the third rank, with a powerful role throughout the text (Figure 3). The results of the analysis of the *Team* domain revealed that words “project” (176), “team” (125), “members” (46), “leadership” (29) and “work” (24) are the most frequent words among 4183 total words of this section. Phrases “leadership” and “work” are applied in the text without obvious links to the other keywords. Although the term “stakeholder” was not identified in the top ranking words, it is still a strong factor in the content of this section, with a frequency of 10 and a powerful connection with the term “team” (Figure 4). In the performance domain of *Development Approach and Life Cycle*, as expected, the most repeated words are “project” (100), “approach” (94), “development” (74), “life” (48) and “cycle” (47) out of 4411 total words. Again, the term “team” exists as a main phrase alongside expressions of “development” and “delivery” (Figure 5). The most frequent words in the *Planning* section are “project” (122), “planning” (68), “work” (46), “estimates” (28) and “information” (28) in the 4264 words. The word “team” still has a significant role in this text and has a considerable link with other catchwords (Figure 6). The words “project” (91), “work” (42), “team” (24), “knowledge” (22) and “process” (20) are the most frequent phrases in the 2639 words of the *Project Work* section. Interestingly, the word “team”, alongside phrases of “changes” and “processes”, can be considered as a pivot point of the text here (Figure 7). The most frequent words in the *Delivery* section are project (58), requirements (50), quality (36), scope (24) and product (23) in the total 3184 words. It is obvious that the delivery section is deeply dependent on the quality and scope of work and also the project constraints, like time and cost, with frequent use of the word “requirements” (Figure 8). It is noteworthy to mention that this section frequently refers to the higher levels in the organizational pyramid, deduced from words like “business” and “deliverable”. In the *Measurement* section, “project” (102), “performance” (82), “work” (48), “value” (46) and “measures” (45) are the five top ranking words in the 1144. Still, the concept of “team”

working has the focal point in the text and, naturally, the “measurement” of “progress” and “completed” “work” can be considered as the main stream of the text (Figure 9). The phrases of “project” (70), “risk” (40), “uncertainty” (34), “team” (23) and “ambiguity” (19) are the main words in total 3194 words of the *Uncertainty* section. Surprisingly, here again, the concept of “team” plays the axial role beside the phrases “risk” and “ambiguity” (Figure 10).

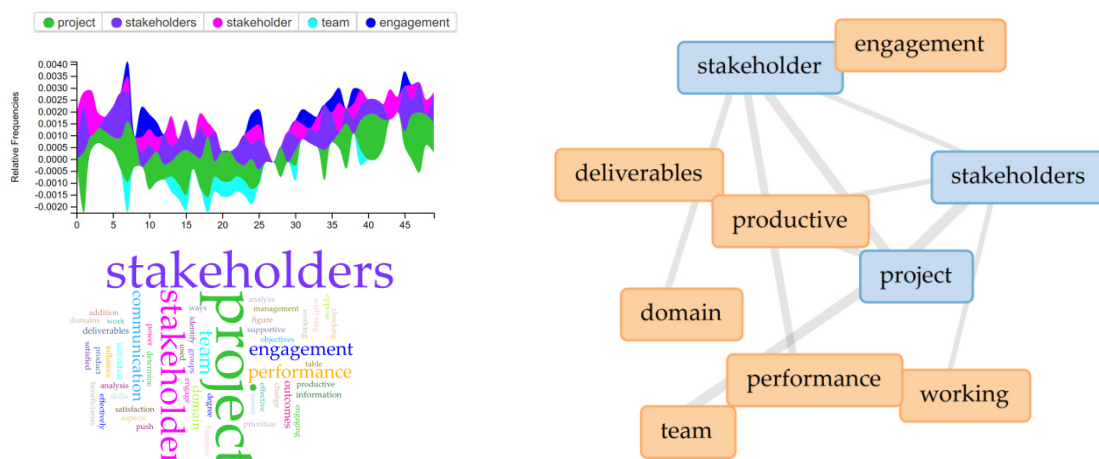


Figure 3. Stream graph, word cloud and words links in the Stakeholder section.

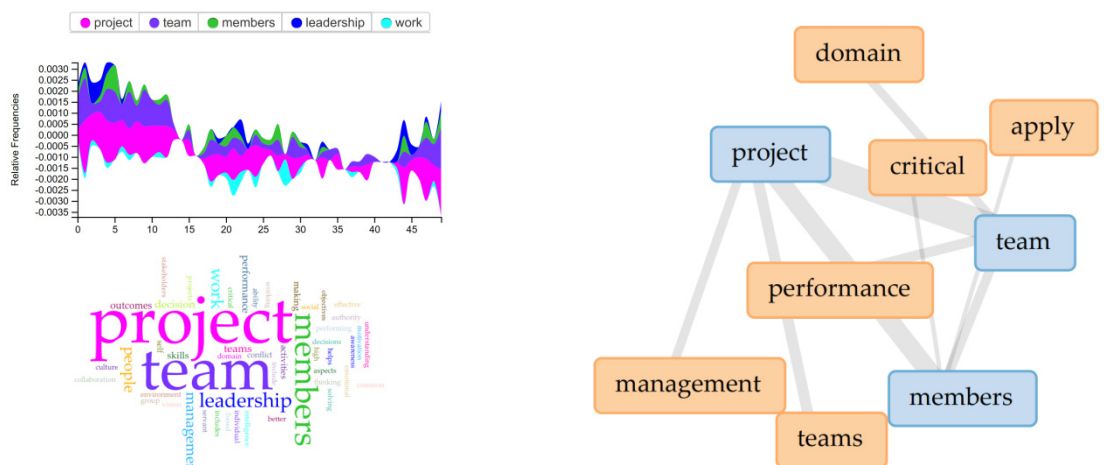


Figure 4. Stream graph, word cloud and words links in the Team section.

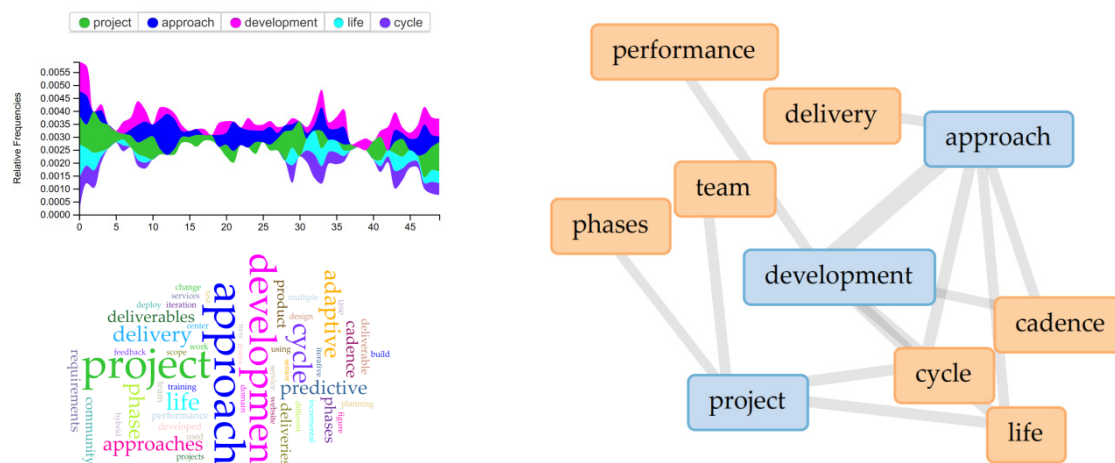


Figure 5. Stream graph, word cloud and words links in the Life Cycle section.

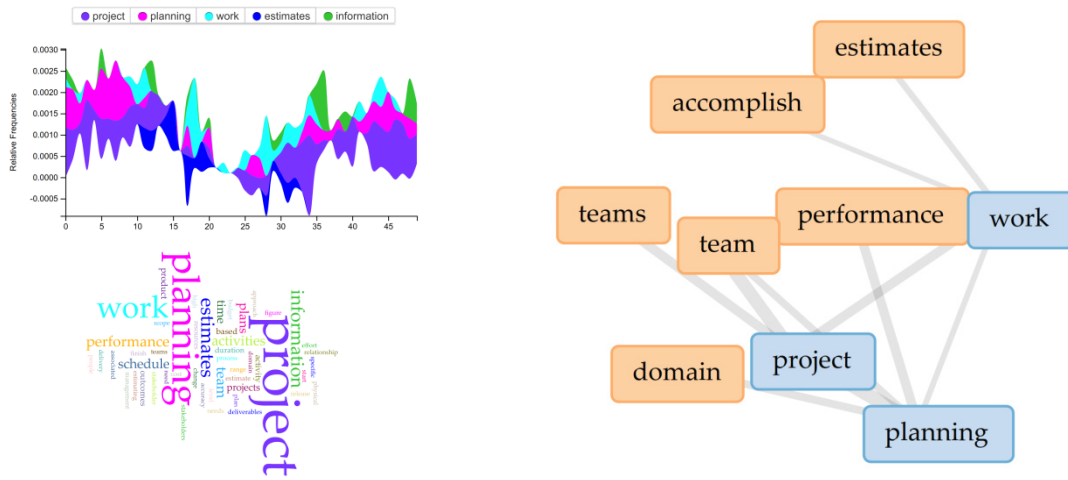


Figure 6. Stream graph, word cloud and words links in the Planning section.

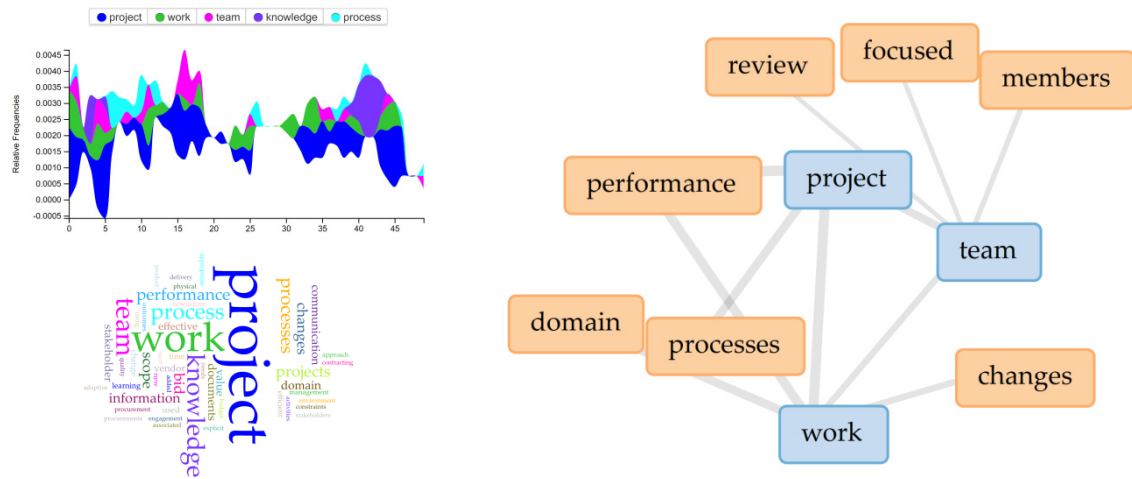


Figure 7. Stream graph, word cloud and words links in the Project Work section.

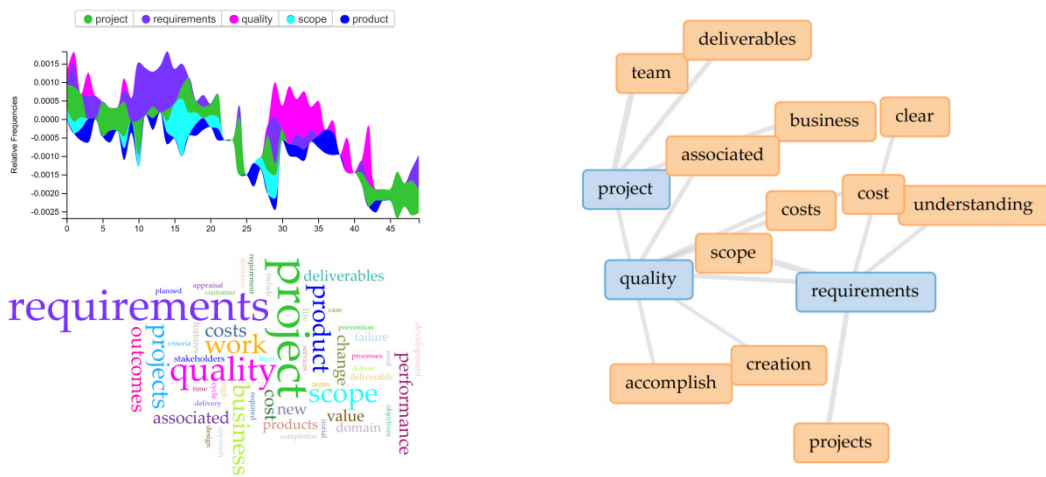


Figure 8. Stream graph, word cloud and words links in the Delivery section.

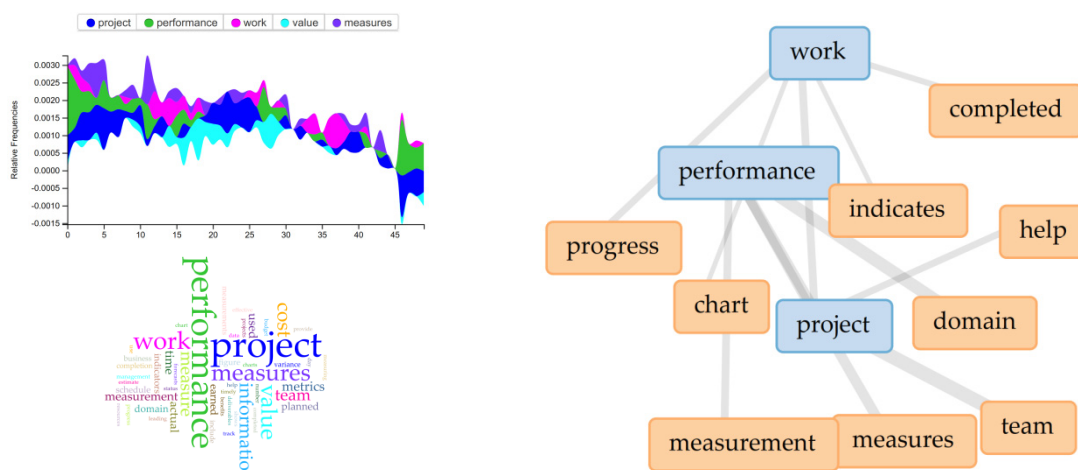


Figure 9. Stream graph, word cloud and words links in the Measurement section.

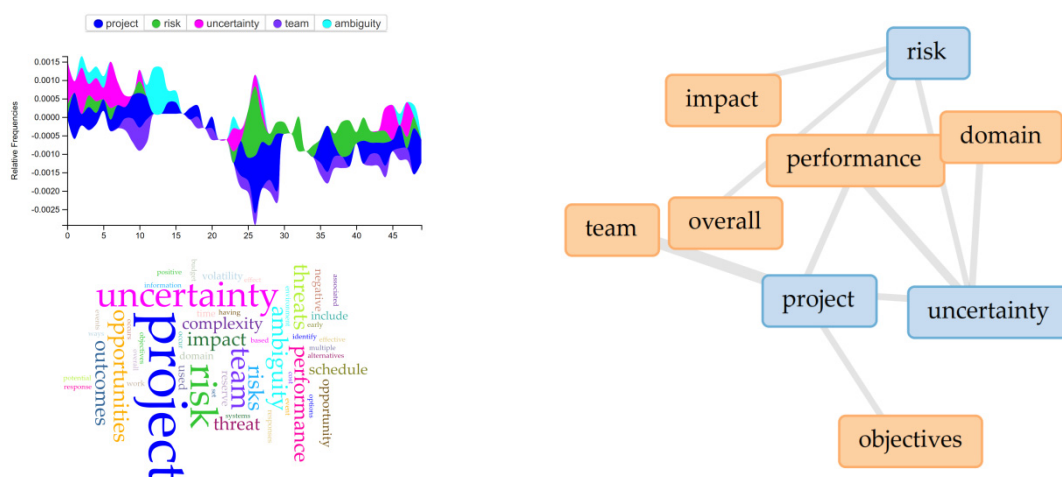


Figure 10. Stream graph, word cloud and words links in the Uncertainty section.

In the next step, employing the extracted catchwords from the text analysis study alongside the review of the original text, aiming to reveal actions and reactions of modules in a bigger picture and to illustrate a compact scene of the novel presented model, the connections and interactions between eight performance domains have been explored. According to the analysis of the text using experts’ judgment, it has been found that all of the eight performance domains can be considered as warp and woof of a net, with tight impacts on each other. Although such connections can be detected in the process-based approaches, classic knowledge areas are functions that hold their independence to a high extent. Hence, to have a sense of function and relation between previous knowledge areas and current performance domains, the experts who were provided with outcomes of the text analysis of previous step were asked to determine which of performance domains theoretically cover the concepts of each knowledge area and to what extent. Table 3 shows that, except the two knowledge areas of risk and stakeholder which entirely covered the two performance domains of uncertainty and stakeholder, the content of the others are scattered in more than two categories. The findings also indicate that the four domains of planning, project work, delivery and measurement cover the majority of knowledge areas, probably because knowledge areas are rooted in the semi-sequential management process groups of initiating, planning, executing, monitoring and controlling and closing. However, scrutinizing the performance domains revealed the connections between the performance domains themselves (Table 3). For instance, direct and indirect actions and reactions of the stakeholder domain with the team

domain determine the key criteria for team building and, on the other hand, the team domain itself ascertains the quality of leadership and the communication system with stakeholders. In practice, when the project becomes more complicated, the project manager and other administrative personnel cannot assume and employ the performance domains as a single, distinct and abstract concept; therefore, having insight and comprehension about undercover interactions between various performance domains can improve the effective application of them in the project (Table 4).

Table 3. The coverage extent of each project management knowledge area in PMBOK 6th edition against performance areas in PMBOK 7th edition.

Knowledge Areas of PMBOK 6	Performance Domains of PMBOK 7							
	Stakeholders	Team	Life Cycle	Planning	Project Work	Delivery	Measurement	Uncertainty
Integration	0%	22%	28%	41%	9%	0%	0%	0%
Scope	0%	0%	0%	52%	0%	48%	0%	0%
Schedule	0%	0%	0%	29%	33%	21%	17%	0%
Cost	0%	0%	0%	28%	32%	21%	19%	0%
Quality	0%	0%	0%	28%	32%	22%	18%	0%
Resource	0%	0%	0%	28%	28%	26%	18%	0%
Communications	28%	31%	0%	29%	12%	0%	0%	0%
Risk	0%	0%	0%	0%	0%	0%	0%	100%
Procurement	0%	0%	23%	0%	55%	22%	0%	0%
Stakeholder	100%	0%	0%	0%	0%	0%	0%	0%

Table 4. The main counter-interactions of performance domains.

Performance Domains	Performance Domains							
	Stakeholders	Team	Life Cycle	Planning	Project Work	Delivery	Measurement	Uncertainty
Stakeholders	-	Defining and prioritizing the requirements and scope for the project team	Determines the way deliverables should be handed over (partially or completely)	Shapes the planning	Engaging and communicating with stakeholders	Determines acceptance and quality criteria for the project deliverables	Focuses on measures of performance	Assists in lowering the amount of uncertainty
Team	Demonstrates leadership qualities and communication skills throughout the project	-	Communicating the project vision and benefits to stakeholders while planning and throughout the life cycle is one example	Influences plans for working effectively	Employing critical thinking, problem solving and decision making while engaging in project work	Deliverables are the results of team working	Accountability of team for outcomes is demonstrated throughout the Planning and Measurement performance domains	Planning and administration of risks
Life Cycle	Way and	Comes to	-	Impacts the	Determines	Has	Define the	Can reduce

Performance Domains	Performance Domains							
	Stakeholders	Team	Life Cycle	Planning	Project Work	Delivery	Measurement	Uncertainty
	cadence of working and delivering	project team capabilities and project team leadership skills and project manager's style		way in which planning is undertaken and plan may be adjusted to reflect the actual environment	different phases and methods of execution	significant overlap with the Delivery performance domain	deliverables of each phase and the measurement indices	<i>uncertainty on projects</i>
Planning	Establishes objectives and measures of progress and success	Shapes the team formation and expertise structure	Determines the main phases and whole life cycle	-	Guides the project work	Guides the delivery of outcomes	Guides the business value performance compared to plans	<i>Uncertainty and Planning interact to address risks</i>
Project Work	Provides stakeholder engagement to be effective; affects the quality	Provides the environment for project team and impacts its formation	Balances their impacts with the project constraints	Supports efficient and effective planning	-	Defines and results in the deliverable	Determines the indices for measurement	<i>Supports navigating uncertainty, ambiguity and complexity</i>
Delivery	Influences the realization of project outcomes	Determines the team requirements	The way work is structured	How the work should be done and how the deliverables should be handed over	Enables the deliveries by establishing processes	-	The control methods should support Delivery	<i>Navigates uncertainty</i>
Measurement	Controls the predefined quantity and quality	Interacts as project team members develop the plans and create the deliverables	Approves or disapproves project phases	The basis for comparing the deliverables to the plan	Presenting up-to-date information	Measures of performance	-	<i>Assess the impacts of risks on outputs</i>
Uncertainty	Supports the stakeholders' objectives	Changes project team structure	Impacts on phases and their cadence	Determines the plan and provisional plans	Determines the way work will be carried out	Determines the way outputs will be delivered	Indicates controls to check the risks regularly	-

* Some wordings are adapted from PMBOK 7th edition.

5. Results: Value Creation of PMBOK 7 in the Construction Industry

5.1. Typology of Construction Projects

Through four rounds of application of the Delphi method, four different main categories of projects and 12 subcategories have been recognized by their nature and com-

plexity based on the experts' judgment. It is worthwhile to mention that the presented categories and subcategories of construction projects in this study were developed considering three inherent characteristics of magnitude of budget/schedule, risks and engaged stakeholders and with the aim to analyze the applicability of introduced performance domains (Figure 11).

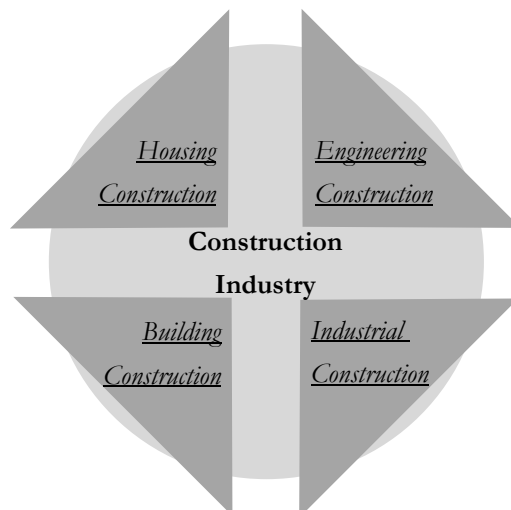


Figure 11. Four main sectors of the construction industry.

1. **Housing construction.** Designing and building residential buildings was recognized as the first, and probably the greatest, section in the construction industry. Those projects that are defined as developing any habitat or accommodation for the dwelling of people are placed in this category. Obviously, the housing projects produce architectural spaces and their landscape, are identified as low-cost, low-time and low-risk efforts, which can be set off in both public and private sectors. The contractors, consultants and material supplier companies engaged in these projects generally are small-sized companies. Two main categories of housing projects are:
 - 1.1. Mass housing
 - 1.2. Private/single housing
2. **Building construction.** The second major category of construction projects has been identified in this study as the conventional buildings in a civil space except the housing ones. Therefore, all other buildings and construction projects in the urban areas fall into this building category. The building projects also produce architectural spaces, require medium to high costs/time and are relatively low risk in planning and can be considered in both public and private sectors. The building projects in the urban regions commonly are designed and implemented by small- to medium-sized companies. These projects include the following subsections:
 - 2.1. Commercial buildings
 - 2.2. Educational buildings (university/schools)
 - 2.3. Healthcare buildings
 - 2.4. Public spaces
3. **Engineering construction.** The third main category of construction projects is known in the current study as the non-conventional civil structures and/or constructions. These projects may be implemented in urban or suburban areas or in the sites out of the city boundary. The engineering constructions do not produce almost any architectural spaces and instead it depends more on the engineering aspects, are categorized as medium- to high-cost/time projects with medium risks. Almost all of these projects are defined by the governmental agencies or the public sector and are im-

plemented by the medium- to large-sized companies. The engineering projects can be distinguished into the following:

- 3.1. Traffic/transportation (roads, bridges and harbors)
- 3.2. Energy/water infrastructures
- 3.3. Dam
- 3.4. Power networks/pipelines/telecommunications facilities
4. Industrial construction. The fourth and final section of the construction industry has been recognized as industrial construction, which is generally located in the non-residential regions. These projects produce limited architectural spaces; they are highly dependent on the industrial processes and require different expertise. The industrial constructions are the most expensive and long-lasting projects in the construction industry and face high levels of risks and various uncertainties of the market. These projects are normally defined with the support of governmental sector or financial entities and are mostly designed and executed by large-sized companies and deep-pocket firms. Two main types of industrial construction are:
 - 4.1. Factories/chemical plants
 - 4.2. Petroleum refineries/gas processing;

5.2. Applicability Analysis of Performance Domains in Regards to Construction Projects

To examine the compatibility of the presented performance domains with different types of projects in the construction industry, pair-wise comparison of domains versus each project type has been adopted. Thus, firstly, the weights of the performance domains have been estimated (Table 5) and then the relative importance index for each performance domain of various sectors of the construction industry categorized in previous section, using a five-point spectrum (0 to 5 for without any importance to very high importance, respectively), have been calculated (Table 6).

Table 5. Pair-wise comparison matrix of importance of the performance domains in the housing sector of the construction industry.

Housing Projects	Stakeholders	Team	Life Cycle	Planning	Project Work	Delivery	Measurement	Uncertainty
Stakeholders	1	0.85	0.23	0.25	0.32	0.92	0.63	0.52
Team	-	1	0.45	0.75	0.92	0.87	0.58	0.46
Life Cycle	-	-	1	0.95	0.90	0.85	0.63	0.58
Planning	-	-	-	1	0.89	0.75	0.72	0.95
Project Work	-	-	-	-	1	0.89	0.91	0.89
Delivery	-	-	-	-	-	1	0.89	0.92
Measurement	-	-	-	-	-	-	1	0.56
Uncertainty	-	-	-	-	-	-	-	1

Table 6. Relative importance index of the performance domains in the construction industry.

Type of Construction Project	Importance Index of Performance Domains							
	Stakeholders	Team	Life Cycle	Planning	Project Work	Delivery	Measurement	Uncertainty
Housing	4.83	3.92	3.75	4.17	4.67	4.83	3.50	3.67
Building	4.25	3.92	3.67	3.92	4.75	4.92	3.83	3.67
Engineering	4.33	4.08	3.58	4.25	4.67	4.92	3.92	4.00
Industrial	4.67	4.17	3.33	4.33	4.75	4.92	3.92	4.67

As is obvious in the applicability analysis of the performance domains against various project types, the *Delivery* performance domain plays the most important role in project management in the construction industry overall. Whereas, in the housing and building sectors, *Stakeholders* and *Project work* stand in second and third importance ranks, respectively, the functions of *Team* and *Planning* become more important in the engineering and industrial projects. Furthermore, considerable outgrowth of the importance of the *Uncertainty* performance domain in the industrial and engineering projects of the construction industry utterly makes sense, because risk management in these sectors of the construction industry is vital for project success. However, Figure 12 illustrates the average importance index of all performance domains in the construction industry. In addition, a summary of the content analysis of the received questionnaires, which can be supposed as the core axes of performance domains in the four categories of projects in the construction industry, is presented in Table 7.

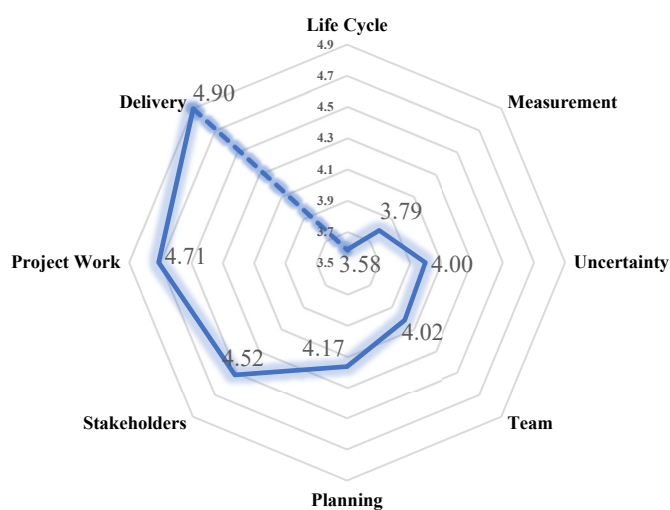


Figure 12. The overall importance index of performance domains in the construction industry.

Table 7. The types of construction industry projects can be affected by performance domains.

Performance Domains	Construction Industry			
	Housing	Building	Engineering	Industrial
Top 5 recognized key Stakeholders	<ol style="list-style-type: none"> 1. Client/ Land owner 2. Final user 3. Architect 4. Contractor 5. Codes regulator body 	<ol style="list-style-type: none"> 1. Owner 2. Final users 3. Customers 4. Neighbors 5. Architect 	<ol style="list-style-type: none"> 1. Governmental agencies 2. Local people 3. Client 4. Consultant engineer 5. Contractor 	<ol style="list-style-type: none"> 1. Owner 2. Environmental agencies 3. Financer 4. Insurance body 5. Final user
Considerations for Team building	<ol style="list-style-type: none"> 1. Building Information Modeling (BIM) 2. Architecture as a pivot point 	<ol style="list-style-type: none"> 1. Building Information Modeling (BIM) 2. Architecture as a pivot point 	<ol style="list-style-type: none"> 1. Building Information Modeling (BIM) 2. Engineering as a pivot point 3. Needs more integration between design team and implementation team 	<ol style="list-style-type: none"> 1. Building Information Modeling (BIM) 2. Engineering as a pivot point 3. Many disciplines engaged 4. Strong communication system 5. Needs more integration between design team and implementation team

Major phases of project <u>Life Cycle</u> (For details, look at Figure 17)	1. Design 2. Build Or 1. Design-Build	1. Feasibility study 2. Design-Build	1. Conceptual Design 2. Feasibility study 3. Design-Build	1. Conceptual Design 2. Feasibility study 3. Design-Build 4. Operation
Main axes of project <u>Planning</u>	1. Client's design approval 2. Client's approval on material 3. Client's approval on quality of implemented work	1. Construction in urban area 2. Recognition and meet real clients' needs 3. Design and architecture considerations	1. Engineering design 2. Possession method the permanent and temporal land 3. Construction phase considerations 4. Environmental concerns	1. Engineering design 2. Possession method the permanent and temporal land 3. Construction phase considerations 4. Environmental concerns 5. Selling methods of final product
Main aspects of <u>Project Work</u>	1. Project quality accordance to client's needs 2. Project cost and time	1. Project cost and time 2. Project quality accordance to client's needs 3. Safety concerns	1. Project quality accordance to client's needs 2. Project cost and time 3. Safety concerns 4. Engineering specific considerations 5. Procurement management	1. Project quality accordance to client's needs 2. Project cost and time 3. Safety concerns 4. Engineering specific considerations 5. Procurement management 6. Long Lead Items (LLI) advanced orders 7. Project hand over to Operation
Final <u>Delivery(ies)</u> of project	1. Main facility(ies) 2. Landscape	1. Main building 2. Landscape 3. Supportive buildings	1. Main facility(ies) 2. Infrastructures 3. Supportive buildings 4. Access roads	1. Main facility(ies) 2. Infrastructures 3. Supportive buildings 4. Access roads 5. Final product
Major needed <u>Measurements</u> for project control	1. Client's satisfaction 2. Budget 3. Schedule	1. Client's satisfaction 2. Budget 3. Schedule 4. Safety	1. Client's satisfaction 2. Budget 3. Schedule 4. Health, Safety, Environment (HSE) 5. Situation of buying items	1. Client's satisfaction 2. Budget 3. Schedule 4. Health, Safety, Environment (HSE) 5. Situation of buying items and LLIs
<u>Uncertainty</u>	Very low; Mainly about quality, cost and time	Low; Mainly about quality, cost and time + Market situation	High; Mainly about quality, cost and time, Market situation + Health, Safety, Environment (HSE)	Very high; Mainly about quality, cost and time, Health, Safety, Environment (HSE), Market situation + Supply and demand of product

5.3. Compatibility Analysis of Management Principles in Regards to Construction Projects

To study the compatibility of the presented 12 principles of project management, the influence of them on each performance domain, in the context of construction projects, has been surveyed. For this purpose, using a five-point spectrum (0 to 5, indicating without any importance to very high importance, respectively), experts were asked to determine the impact of each principle per performance domain. It should be noted that the universal principles that are introduced in the seventh edition of PMBOK can be

considered constant for all project types and, hence, estimation of such impacts were fulfilled without considering four different categorizations. However, overall, *Team*, *Complexity* and *Value* are recognized as the most effective principles on project performances in the construction industry, while the *Planning*, *Delivery* and *Project Work* can be considered the most effective domains in the construction industry (Table 8). The charts presented in Figure 13 demonstrate the impact coefficient of principles “Be a Diligent, Respectful, and Caring Steward” and “Create a Collaborative Project Team Environment” on eight project performance domains. Obviously, in these cases, the correlation of “Team” and “Stakeholder” with the “Stewardship” principle is considerable, and “Team”, “Delivery” and “Project Work” have strong relationships with the “Team” principle.

Table 8. The impact coefficient of 12 principles on different 8 performance domains for success in the construction industry.

Principles	Performance Domains								Average
	Stakeholders	Team	Life Cycle	Planning	Project Work	Delivery	Measurement	Uncertainty	
Be a Diligent, Respectful, and Caring Steward	4.88	4.97	1.86	3.46	4.12	4.44	3.75	2.54	3.75
Create a Collaborative Project Team Environment	1.96	4.95	3.93	4.41	4.88	4.92	3.51	3.77	4.04
Effectively Engage with Stakeholders	4.90	2.98	2.62	4.89	3.09	3.98	2.15	2.52	3.39
Focus on Value	4.98	2.08	2.57	4.85	4.84	4.83	4.85	3.20	4.02
Recognize, Evaluate, and Respond to System Interactions	1.06	1.75	4.85	4.90	4.92	3.78	2.14	1.65	3.13
Demonstrate Leadership Behaviors	4.82	4.82	1.88	2.79	3.54	3.64	2.87	2.71	3.38
Tailor Based on Context	4.00	2.76	3.25	4.77	4.80	3.87	3.33	4.89	3.96
Build Quality into Processes and Deliverables	4.82	2.61	3.44	4.23	4.62	4.86	4.79	2.72	4.01
Navigate Complexity	2.13	2.47	4.86	4.73	4.88	4.96	3.36	4.84	4.03
Optimize Risk Responses	3.05	1.26	1.67	4.87	3.24	3.94	3.28	4.79	3.26
Embrace Adaptability and Resiliency	4.84	4.13	3.02	4.89	3.84	3.05	1.57	4.13	3.68
Enable Change to Achieve the Envisioned Future State	2.97	3.30	3.24	3.96	3.08	4.79	3.19	4.87	3.67
Average	3.70	3.17	3.18	4.40	4.16	4.26	3.23	3.55	-

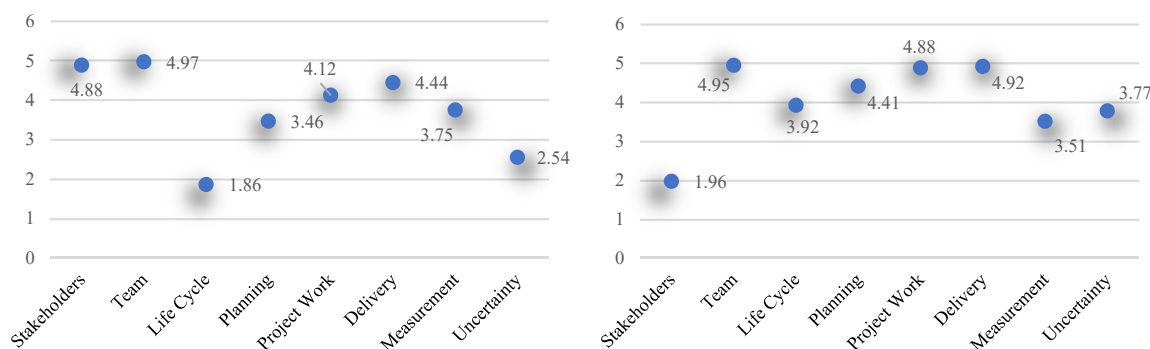


Figure 13. The correlation coefficient of principles 1 (stewardship in the left) and 2 (team in the right) on eight performance domains.

6. Discussion

Combined analysis of applicability and compatibility of novel presented principles and performance domains in the PMBOK seventh edition through experts' judgments provides new insights about prospective capacities available for construction project management. It is clear that the process-based approach has not been entirely replaced with the novel performance domains and is obviously concealed beneath the conceptual cover of principles and domains (Figure 14). For this reason, it seems that the departure from the existing framework towards an emerging one probably can be fulfilled using known process-based methods. However, in the next two sections, distilled inferences of the results based on the data analysis of experts' thoughts have been summarized.

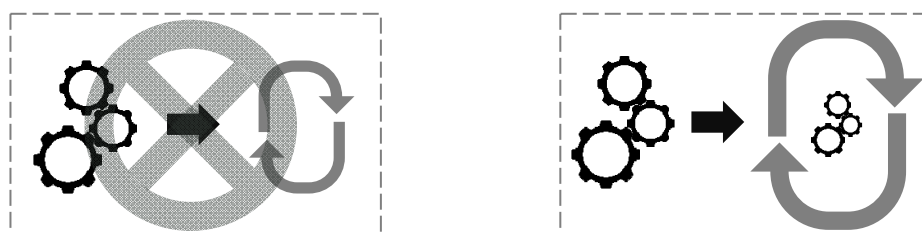


Figure 14. The new approach does not negate the classic process tools and techniques (**left**) but encompasses them by raising the principles and highlighting the performances (**right**).

6.1. Interpretation of Eight Performance Domains in Relation to Construction Projects

1. *Stakeholders.* Construction projects in comparison to projects of other industries have vaster stakeholders, especially in the external section. Although other parties may stand as key stakeholders of projects, such as financier or insurance company, internal stakeholders in construction projects often include the traditional triangle of client, consultant/architect and contractor/constructor. External stakeholders of a construction project can be defined in some surrounding tiers from local people, governmental agencies, regulatory, various NGOs, environment activists and many other organizations and authorities. These stakeholders can have direct or indirect, positive or negative impacts on the project and their roles must be taken into account in any project planning.
2. *Team.* The nature of a construction project that leads to physical buildings and constructions through fulfillment of studies in diverse areas of expertise, make team working completely distinct from other projects, such as information and communications technology (ICT), development of industrial products or research works. Indeed, in a construction project, several teams may build up and dissolve throughout the project life cycle; also, it is not unusual to form several distinctive teams at the same time, such that each of them has their own project manager in the organization. The issue stemming from this fact is that each party engaged in a construction project in itself is usually a subsection of a large entity with complicated bureaucracy. Therefore, the creation of an interconnected team in construction projects creates many obstacles and complexities, which usually is addressed through contract legal tools and techniques. Consequently, the team formation in a construction project utterly depends on the type of project delivery system, including conventional method, design-build, engineering-procurement-construction (EPC), finance-based methods (e.g., build-operate-transfer (BOT)) or other practicable contractual methods. It is worth mentioning that the highest level of team working in a concentrated manner and form in construction projects can be found in an integrated project delivery (IPD) method, which is empowered by utilizing building information modeling (BIM) technology (Figure 15).

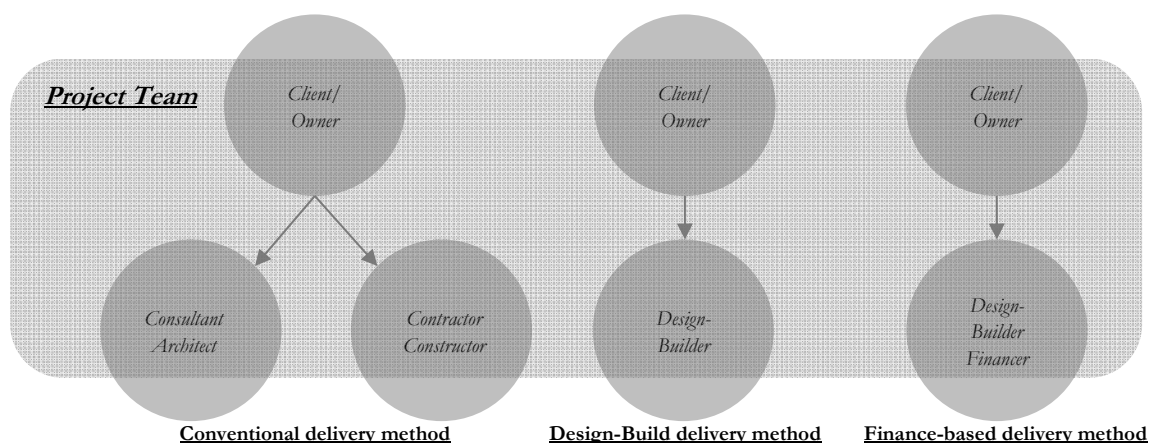


Figure 15. The project team in a construction project is a function of the project delivery system.

3. *Life cycle.* Construction projects generally obey a standard sequence of phases, from primary studies and designs to construction and operation, although there are slight differences between diverse project types in this regard (Figure 16). Like the project team, design and formation of the life cycle and phases in a construction project is profoundly hinged upon the project delivery system. The exaggerated conditions can be found in the finance-based methods, like BOT contracts, where the operation phase, a stage which traditionally was supposed out of the project boundary, completely falls into the project scope and the contracted activities. The value creation outlook through project management in the 2021 version of PMBOK is extremely effective for construction projects because it promotes the role of the operation phase as the final ring in the added value chain of the project and will provide more support for the fast tracking of phases to achieve the customer's intended value. This worthwhile point of view is one way of bringing more agile concepts into construction industry, tailored to this industry.

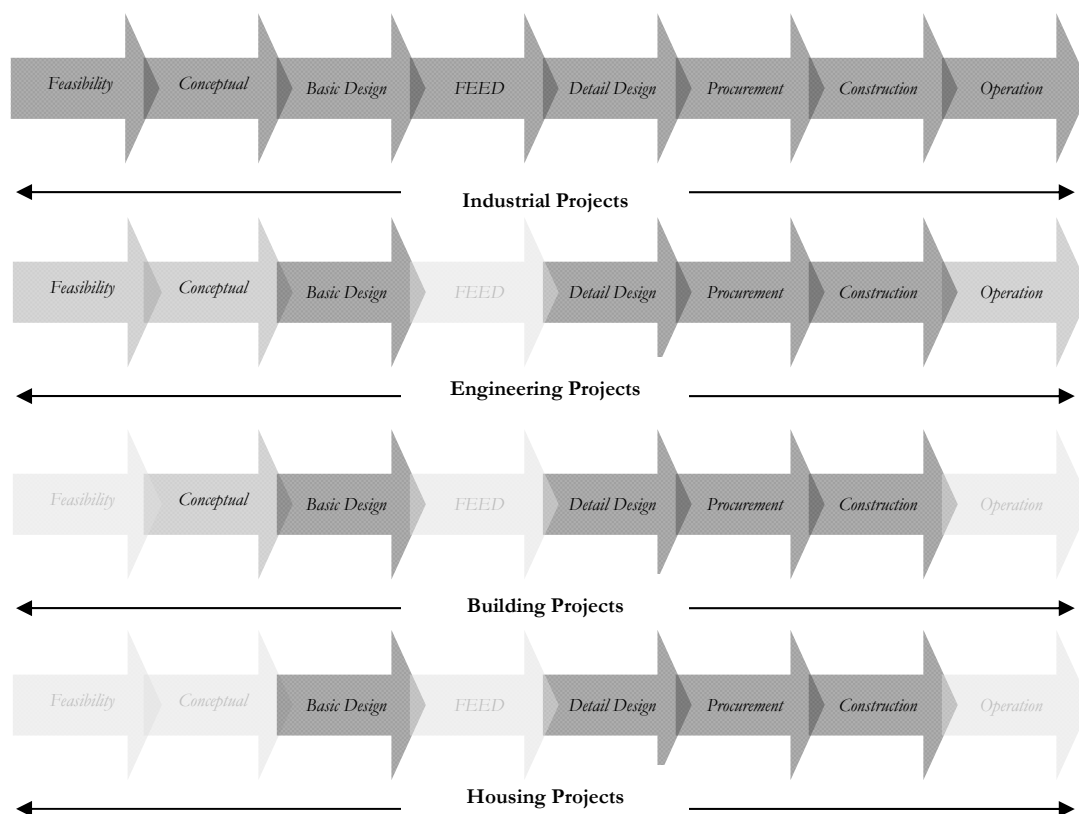


Figure 16. The generic phases in a construction project and relative significance of phases in different project types.

4. **Planning.** Early exact drafting of the gap-bridging scheme between the current condition (as is) and the desirable situation (to be) is vital for a construction project. There are many consumable and inconsumable resources in a construction project, including human resources, machinery, material and equipment, land and, of course, time and money. To use and to apply these costly resources in an effective and productive manner, it is essential to take considerable time for project planning. On the other hand, critical issues such as risks, quality and project control must be embedded in the project planning considerations. Regarding global warming and climate change, it is essential to include environmental issues as a substantial part of the feasibility study in the pre-project phase, especially in engineering projects, like dams, and industrial projects, like oil productions, which potentially can have considerable effects on the surrounding environment and nature. The significance of the planning phase in construction projects makes it necessary to fulfill the basic planning by mostly utilizing the services of the consulting third party, in both public and private sectors.
5. **Project Work.** The construction phase of the project accounts for the largest part of the project's budget and time, and so can be deemed as the most crucial step in the construction industry. Implementation of almost all construction projects combines classic consecutive phases, which are organized based on the plans—design of facilities and preparation of drawings, procurement of resources and goods and services, site preparation and erection of building by adding material. It is worth mentioning that recent technological developments, such as prefabrication, robotics, augmented reality, drones, internet of things (IOT), wearable protective equipment, remote site control, etc., have profoundly impacted the construction methods and techniques. Project contract management, quality control, administration of various

working groups in the form of subcontractors or in-house teams, health, safety, environment (HSE) and knowledge management are the other major considerations in the construction phase.

6. *Delivery.* The phase of handing over the product to the customer in a construction project can potentially turn into a project itself! It is notable to mention that construction projects mostly face a hierarchy of objectives. For instance, take an oil refinery contract between a governmental entity and a contractor, in this project, the contractor is responsible not only for handover of the erected facilities to the client in the mutually agreed time, cost and scope (as the first tier objective), but they must also deliver the final product (gas or fuel) in the desired amount and requested quality (as the second tier objective). All the while, the contractor will still be responsible for the performance of facilities and the quality of the final product for a predefined period of time inserted into the contract. That is why, in the handover phase of industrial projects to the owner, many processes and tests, including pre-commissioning/cold tests, commissioning/hot tests, start-up of the constructed facilities, etc., should be passed to ensure the final acceptance. If the client is engaged in multi-contracts with different contractors, the other problem that should be handled is removing interface issues and solving battery limit constraints.
7. *Measurement.* Control activities, such as schedule and budget monitoring, in construction projects and daily supervisions of the work to ensure compliance with rules and regulations is an indivisible part of the daily tasks. Nevertheless, assessment of the completed work is not a complicated task in construction and tests to check the acceptance indices can be easily performed, but in regards to those parts of the work that will be covered, if there will be no access to them in future, the control is vital. It is worth mentioning that to be in control of the performance of the work continuously, modern technologies, like drones, sensors, camera, image processing, etc., are employed in construction sites. In addition, reporting the project progress to key stakeholders using various tools, such as online applications, is common nowadays.
8. *Uncertainty.* Uncertainties can have profound negative impacts on the objectives of construction projects and so administration of them can be considered as one of the main axial activities in the construction industry. Risks in the construction industry can be evaluated from different points of view, including those of the government, client and contractor; at various levels of the organization, including owners, senior managers and site works; and in several areas, including economic, political, social and technical, all with both international and national outlooks. The importance of risk management is doubled in the case of projects where the inherent nature of the work itself is a basis for uncertainty, like drilling, digging and excavation, because achievement of the project goals is highly vague and unknown obstacles may have been concealed underground.

6.2. Configuration of Performance Domains in the Construction Industry

Content analysis of the gathered data through experts' opinions in the context of construction management revealed that the eight general performance domains can be divided into two categories of major domains and subsidiary domains. Major and subsidiary domains include Stakeholders, Planning, Project Work and Delivery and Team, Life Cycle, Measurement and Uncertainty, respectively (Figure 17).

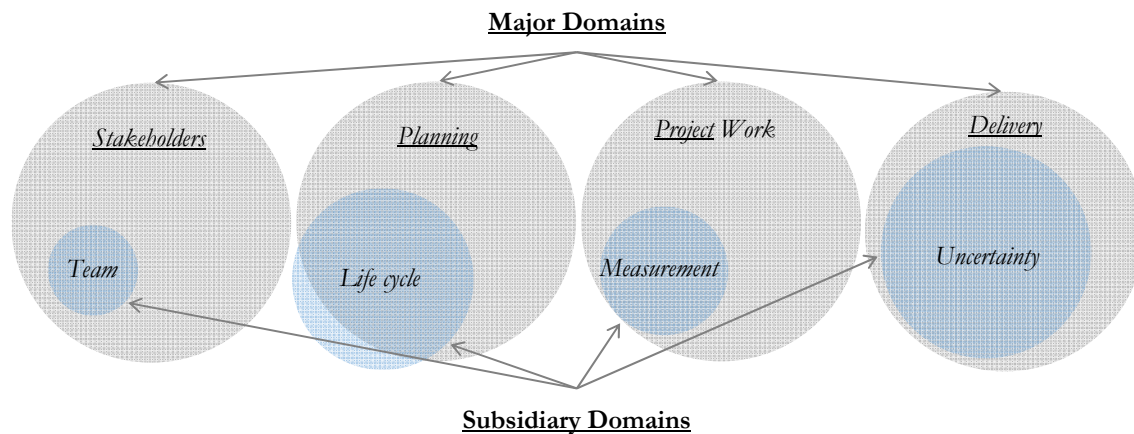


Figure 17. The configuration of performance domains of project management in the construction industry.

1. Although team building can be analyzed under the project human resource management section separately due to its significance and exceptional role in the project's success, obviously administration of the team is a subset of the stakeholder mother set. *Why does this interpretation matter?* Having holistic view regarding stakeholder management and, subsequently, team administration will lead to various aspects of team development in compliance with the results of other in-house and external stakeholders. This means that all team building activities, such as strategy development, alignment with goals, defining members' roles and interface management of sections, should be supported and leveled by the outputs of the analysis of stakeholders in a construction project. Regardless of the construction industry considerations, it is worth mentioning that in almost the entire text of PMBOK 7, two concepts of stakeholder and team have been applied simultaneously using the conjunction "And".
2. Determination of project phases, milestones, deliverables of each phase and the fast-tracking possibility of them, etc., is considered under the schedule section of planning. Therefore, development of the project life cycle conceptually falls under the planning umbrella term for all initial efforts. However, it is noteworthy that it is possible that some stages of the project life cycle may fall outside the conceptual scope of project planning. For instance, in the construction industry, it is not uncommon for a consultant engineer or architect to compose the basic reports of the feasibility study even before project definition, or an operation phase after commissioning of the project is always considered out of the project planning scope, at least in conventional construction contracts. *Why does this interpretation matter?* In a construction project, all vital features, like time and cost estimations and risk analysis, contract type, procurement method, partial delivery of project outputs, etc., strongly depend on the project life cycle framework, which should be determined in the planning phase, named pre-project attempts.
3. Project supervision is one of the core activities in the construction industry, in comparison to the other industries, like information and communications technology (ICT), or maybe healthcare and defense. The main reason for this issue is the need to comply with laws and regulations governed with various watchdog entities in different levels and various distinguished expertise and also requirements to meet the problems that arise from diffused and scattered sites. Therefore, Measurement activities definitely fall into the Project Work section. *Why does this interpretation matter?* The implementation phase in a construction project, including dismantling existing buildings, excavation, erection of structure, finishing works, etc., all require strict data gathering, work monitoring and control of activities to ensure the plan is

met. Therefore, diverse elements of a project control system must be designed in regards to project execution conditions and requirements.

Although the success of a construction project is not a binary concept and it should be viewed from the viewpoint of relative satisfaction of a hierarchy of clients, it is not uncommon to use the label successful or unsuccessful after a project's completion. However, project success is strongly related to the hierarchy of project goals and objectives, and the level of goals achieved, such as time, cost, scope and quality, should be considered as successfulness or unsuccessfulness. Given that achieving project objectives is subjected to risks and uncertainties, it is crucial to assess the potential threats and opportunities and to evaluate their impacts on project objectives. Delivery of project output to the client and evaluation of customer satisfaction are always exposed to many probabilities and prospects and, thus, Uncertainty must be analyzed versus each of the project goals. *Why does this interpretation matter?* A construction project usually faces a series of key stakeholders who are related to the output. For instance, consider a mass social housing project, which is defined by a government sector (first key stakeholder, policy maker). This project is administered by the owner organization (second key stakeholder, client of contract) that will take over the job from a contractor and then will deliver units to costumers (third key stakeholders, final users). Each of the above-mentioned stakeholders, with their own expectations and a certain level of their own interests, will embrace the project output and relative uncertainties must be analyzed related to each of them separately.

7. Conclusions

The twenty-first century has begun with enormous universal challenges, from the main concern of increasing global warming, which has resulted in droughts, floods and extensive migrations, to the currently uncontrollable COVID-19 pandemic, which destroyed many businesses and revolutionized numerous peoples' way of working. Fortunately, like all challenging periods for humanity, science, emerging technologies and new online tools and techniques have come to the aid of mankind and have paved the way to form a new normal in all facets of human life, from academic and educational systems to business management and, of course, new paradigms for building constructions. The latest version of the standard of Project Management Body of Knowledge (PMBOK seventh edition), which is a reflection of the global expert community, from the Project Management Institute (PMI) can be considered as a prompt reaction to drastic and fundamental challenges that have been faced throughout the industry. The current version of PMBOK, in comparison to the previous issues, has brought about considerable changes and the function of process groups using 10 knowledge areas has been transferred to a series of principles applying eight performance domains. In this framework, a performance domain is a set of tasks that lead to project deliverables in an effective way. This edition widens the scope of project management to include the bigger picture, in which it is not enough to just offer deliverables for enterprises, because it is more vital for the organization to create value by fulfillment of their projects. Such a point of view, which pulls and extends the project management system to upper levels in the organizational pyramid, brings to mind the importance of the issue of integrating the two concepts of *"Do right project"* and *"Do project right"*, meaning it is essential to consider organizational strategies for value creation besides project management tools and techniques. Inevitably, this integration highlights the role of the soft side of project management, including stakeholders and team management, in comparison to the hard skills, like cost and schedule management. The other main point in this issue is emphasizing the vital procedure stemmed in the uniqueness aspect of project, named *"Tailoring"*. The tailoring ensures the successful furnishing of processes and emphasizes the adaptation of the presented concepts in a standard to a given organization. It is worthwhile to describe that the PMBOK seventh edition is not a radical paradigm shift but just a change of mindset by differing the viewpoint. The new edition itself declares that:

“Many organizations and practitioners continue to find that approach useful for guiding their project management capabilities, aligning their methodologies, and evaluating their project management capabilities. That approach remains relevant in the context of this new edition.”

At the same time, it asserts that:

“With project management evolving more rapidly than ever before, the process-based orientation of past editions cannot be maintained in a manner conducive to reflecting the full value delivery landscape.”

Although the above-mentioned expressions are not a sign of fundamental contradiction, they may bring a problem to mind that if the stimuli for changes were so strong that they could change the shape and structure of the standard, how can the previous approach still be profitable for some organizations? This can be investigated more in future studies. Nevertheless, in the current investigation, the way that construction industry, with its specific peculiarities, can benefit from this novel framework of project management has been studied and the applicability of the principles alongside the compatibility with performance domains has been investigated. The main findings of the research, which have the capacity to be adapted for practical application in the construction industry, can be summarized as below:

1. The four main sectors and 12 subsections of projects in the construction industry are defined as follows:
 - 1.1. Housing construction (mass housing and private/single housing).
 - 1.2. Building construction (commercial buildings, educational buildings, healthcare buildings and public spaces).
 - 1.3. Engineering construction (traffic/transportation, energy/water infrastructures, dams, power networks/pipelines/telecommunications facilities).
 - 1.4. Industrial construction. (factories/chemical plants and petroleum refineries/gas processing).
2. Measurement of the importance of each performance domain in the PMBOK 7 in regards to the context of the construction industry. In total, Delivery, Project Work and Stakeholders are the main three performance domains, which should be thought out as the pivotal points in the construction industry.
3. Comparison of the significance of management principles of the PMBOK 7. Overall, the *Team*, *Complexity* and *Value* principles are recognized as the most three effective principles on project performance in the construction industry.
4. The eight novel introduced performance domains do not have equivalent roles of effectiveness in the construction industry and can be graded as four major and four subsidiary domains.

The results show that new project management principles and performance domains can be utilized for various types of projects in the construction industry. However, the novel presented approach needs more time to be completely examined, and still can be scrutinized for other project-oriented industries, in regards to both project-specific characteristics and from the philosophical viewpoint.

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