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**Implementation of Project Management Knowledge Areas by Project Managers** Pini Davidov1 , Inessa Ainbinder2, Nadine Ayoubi3 , Batel Avivi4 , Lital Eliyahu5,

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**Abstract:** Academic and professional literature records main points of interest across time however, it does not always keep up with the on-the-ground practical needs of different industries. This article discusses Project Management Body of Knowledge (PMBOK) areas and their implementation among active Project Managers (PMs). The PMBOK guide, defines terms, guidelines, and knowledge areas of project management. A survey was conducted among 117 active PMs who were asked to rate their level of implementation of PMBOK areas. PMs reported integration, cost, and procurement as mostly implemented by them, while quality, scope, and stakeholders were not reported. This points out the need of requiring reinforcement among PMs. After a comparison between the degree of implementing additional knowledge among PMs and the coverage degree of the knowledge areas in the last generation of textbooks, no correlation was found. Textbooks do not match the PMs implementation in their working fields. The study identified gaps between the degree of application of the knowledge areas of project management and the importance that the authors of the textbooks attach to the above areas of knowledge. The research findings may contribute greatly to reducing these gaps. The research findings can also contribute to the training programs of project managers.

**Keywords**: PMBOK knowledge areas, Textbooks, Project Management

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1. Introduction

Project mmanagement applications have existed since ancient time, from the pyramids of Egypt, through the Great Wall of China, and the Roman Colosseum, aqueducts, and roads. In the early 19th century modern project management was born. The first management consultant, Frederick Taylor, was a initiator of modern business practices. He introduced the management theory that includes a set of tools, rules, and guidelines to administer organizations. Later, Henry Gantt, an associate of Frederick Taylor, developed planning techniques and created the famous Gantt tool in 1915 to transfer a project into effective visualization, control the project schedule, and break it down into prioritization of tasks. Subsequently, project management was defined as a method of directing and coordinating manpower and other tangible resources, throughout the life of a project, by utilizing up to date techniques of management to achieve the desired targets of scope, cost, time, quality, and the gratification of all participants (PMI Standards Committee, 1987). Project management is a branch of management science that aims to ensure that projects are completed, and goals are achieved. Project management is about reaching that endpoint at a predictable point in the future, which usually means within a given financial frame and a planned amount of time (Newton, 2016).

In recent years project management has been widely recognized due to the wide-ranging advantages and benefits in organizational environments that are characterized by a rapid and changing environment (Abdessamad and Ibrahim, 2019). Project management applications take place in a wide range of fields such as construction, engineering, science, and software development. It involves tools and techniques that help to define the project plan, evaluate progress, provide better communication, collaboration, and managing of budgets (money, time, and resources). The success of project management is dependent on the application of suitable project management tools (Kostalova and Tetrevova, 2014). Until the turn of the 20th century many organizations chose not to have any model of management in their projects or processes. Today not only do they have complex and unique project management systems, but their survival also depends on the successful implementation and execution of those project management models that were once not even an option (Sändig, 2016). Projects not managed properly and professionally can cause many problems. Therefore, having an appropriate project methodology helps the project achieve its objectives.

A Project Management methodology has been defined as “an application of knowledge, skills, tools, and techniques to meet or exceed the project requirements” (Project Management Institute, 2017). The main aim of project management methodologies is to control the management process by making effective decisions. The aims have increased and been improved over the years since the revolution of the information age. Different types of methodologies are suited for certain projects. The best-known tools and methodologies are Agile, Scrum, Kanban, Lean, PRINCE2, and PMI's PMBOK.

Selecting the right methodology depends on factors such as the project type, scope, flexibility of time, budget, industry, customers, and stakeholders. This implies that specific methodologies should be defined for some groups running similar projects (Jovanovic and Beric, 2018). PRINCE2(PRojects IN Controlled Environments) and PMBOK are the most popular methodologies among organizations and companies, and studies have examined them to provide managing recommendations for the next generations.

PRINCE2 was initially developed and announced in 1989. It is a process-based approach that focuses on the organization and control throughout an entire project. It was developed in the United Kingdom by OGC (Office of Government Commerce), and it has been used worldwide. This methodology insists on good communication and on including clients in the project management process, on dividing the projects into phases, and on the orientation towards the expected project outcomes (Jovanovic and Beric, 2018). The structure of PRINCE2 consists of seven principles that make a project compliant and scaled, seven themes that can be overlapped, and work in parallels like Business Case, Organization, Quality, Risk, Planning, Change, and Progress (PRINCE2). The seven processes are broken into forty activities that define what needs to be done and by whom (Ghosh et al., 2012).

Project Management Body of Knowledge (PMBOK) was first published in 1996 by members of the Project Management Institute (PMI), an international non-profit organization founded in 1969 by a group of NASA graduates who decided to institutionalize the knowledge they had accumulated within the world of project management. PMI works towards developing and disseminating best practices, carrying out research, offering training, testing, and certification (Dos Santos and Cabral, 2008). The PMBOK repository has a more comprehensive framework in the project management field in that it encompasses both standards, methods and, processes, as well as established practices (Errihani et al., 2015). It recognizes five process groups (initiating, planning, executing, monitoring and controlling, and addition closing) and ten knowledge areas that define the processes that have aspects in common. Each knowledge area is an essential component that contributes to project success.

Several types of research have compared PRINCE2 and PMBOK (Wideman, 2002; Siegelaub, 2004; Rehman and Hussain, 2007; Yeong, 2007; Chin and Spowage, 2012; Ghosh et al., 2012; Sánchez et al., 2013; Singh and Lano, 2014; Waheed, 2014; Jamali and Oveisi, 2016). There is an elemental difference between PMBOK and PRINCE2. PMBOK is a knowledge-based project management methodology incorporating widely proven practices. PRINCE2, however, provides a more prescriptive or process-oriented approach that can be applied to projects by the project or team manager (Yeong, 2007). The conclusions of Wideman (2002) were that PRINCE2 provides a robust methodology for running projects where the objectives are clear , while PMBOK takes the best approach for purposes of teaching the subject content of each knowledge area, but is not so eeffective when it comes to providing guidance for running a particular project. On the other hand, regarding the coverage by PRINCE2 of PMBOK knowledgeareas, it seems that PMBOK has a complete integration mechanism. It is stronger in Human Resources (HR) and stakeholder management. It has a more detailed concept of communication management. Procurement management is covered only by the PMBOK (Karaman and Kurt, 2015). McGrath and Whitty (2020) concluded that PRINCE2 cannot claim to be generic in the engineering infrastructure space and therefore, cannot reasonably claim to be considered best practice for it. The current work does not focus on a specific type of project, but on those involved in project management in general, and therefore PMBOK's areas of knowledge were chosen as the basis for the work.

As mentioned above, there are ten areas of knowledge, and each one is an essential component that helps the project succeed (Project Management Institute, 2017). We shall explain each in brief.

* *Project Integration Management (ING)* includes first identifying and then integrating the processes required to ensure that the correct coordination of the various elements of the project is achieved.
* *Project Scope Management (SCP)* includes a set of processes that ensures a project’s scope is accurately defined and mapped. The techniques that it contains validate the managers in the assigning of the correct amount of work to successfully complete a project.
* *Project Schedule Management (SDE)* includes all the processes needed to manage the timely completion of the project. It involves schedule management, defining activities, sequencing activities, estimating activity resources and durations, developing, and controlling the schedule.
* *Project Cost Management (CST)* involves all the processes that are involved in the planning, estimating, budgeting, financing, funding, managing, and controlling costs, so the project can be completed within the confines of the approved financial budget.
* *Project Quality Management (QLY)* involves all the processes to achieve quality deliverables. Quality is maintained throughout the project. It includes three main processes: quality planning, quality assurance, and quality control.
* *Project Human Resource Management (RSS)* involves the processes necessary of the identification, acquisition, and management of the resources needed for the successful completion of the project.
* *Project Communications Management (CMS)* involves the processes that are required to ensure timely and appropriate planning, collection, creation, distribution, storage, retrieval, management, control, monitoring, and the ultimate disposition of project information.
* *Project Risk Management (RSK)* all processes involved in this area are connected to risk identification, regulation, and negotiations of a project. The objective is to increase the probability of positive risks (opportunities) and decrease the likelihood of negative risks (threats).
* *Project Procurement Management (PCT)* involves the processes necessary for the purchasing or acquiring of products, services, or essential results that originate from outside the project team.
* *Project Stakeholder Management (SKL)* involves the processes required to identify all entities that the project could impact upon, or that could impact the project. These will consist of individuals, groups or organizations. The information obtained will enable the analysis of stakeholder expectations and their impact on the project, and managerial development of appropriate strategies.

PMBOK provides a valuable source of information for Project Managers (PMs). They will be more effective if they are familiar with the ten knowledge areas and the various tools related to project management (Schwalbe, 2015). The performing organization will assign the PMs to this challenging, high-profile role. The role carries with it significant responsibility and shifting priorities that are needed in order to achieve the project objectives. The characteristics required to fulfil such a task include strong leadership, flexibility, good negotiating skills as well as good judgment, and of course solid knowledge of effective project management practices. PMs will need to utilize and apply tools and techniques that enable them to effectively adapt the PMBOK processes and principles to the pragmatic project management world.A PM should identify the relevant criteria for success, from determining appropriate factors for success that would increase the chance of achieving those criteria that are essential for success. Only then can project management methodology that delivers those success factors be selected (Crawford et al., 2005). The latest version of PMBOK (PMBOK 7th edition) has, in comparison to the previous editions, brought changes: the function of process groups using ten knowledge areas has been transferred to a series of principles applying eight performance domains. Each of the ten areas of knowledge is covered by at least two domains of PMBOK7, therefore ten knowledge areas are relevant to study (Faraji et al., 2022).

PMs manage the constraints (knowledge areas) of individual projects, while the Project Management Officer (PMO) focuses on the standards, methodologies and overall risks, or opportunities at the enterprise level of projects. Together they form a team in the area of project management. This is then an organizational entity that is established in order to offer assistance on matters of strategy and functional entities (Ward, 2000). The PMO has attained popularity in organizations as it assists the maintaining of the delivery of projects that fit appropriately with the schedule, avoids cost overruns, and generates the required specifications of the project according to the specified quality levels (Wedekind and Philbin, 2018). Darling and Whitty (2016) summarized the PMBOK guide to PMOs and observed that the second edition of the PMBOK was the first to discuss the PMO while the third edition stated that PMOs are varied but used to coordinate the organizations business objectives through projects. The fourth edition has similar descriptions while the fifth edition includes a general description of three PMO typologies: supportive, controlling and directive.

After examining hundreds of articles in Google Scholar with the key words “10 areas of knowledge PMBOK” between the years 2020-2021, we found that 373 articles addressed the areas of knowledge. From the 373 articles, only 27 mentioned the word PM/PMO in the title/abstract along with knowledge areas of the PMBOK. The findings of the researches were: (1) Managers should consider integration and scope planning and not simply rely on resources, communication, and cost planning on virtual teams (Gallego et al., 2021); (2) PMs already have sufficient competence in the project quality management unit. There are, however, still deficiencies in the project HR management and cost management unit that require attention (Sitohang et al., 2020); (3) Most PMs have difficulties in HR Management (Nobre, 2020); (4) PMs should understand that multiple factors contribute to the success of construction projects (Ali Khan et al., 2021); and (5) Implementing a PMO in a company assist in the improvement in the rates of project performance in terms of cost, time, and scope; the cross-cutting axis of all the processes will be quality (Meléndrez et al., 2021). We conclude from the review that not many studies (6.9%) have dealt with the knowledge needs of PMs. We could not determine which PMs need resultant and implementation. We set out to study and explore these information gaps. Table 1 summarizes the review of the 373 articles that addressed the PMBOK knowledge areas.

The project management discipline is based on theory and practice (Angolia and Reed, 2021; Marcelino and Domingues, 2022). Practice is very important and is based on learning. For this reason, it is important that project management courses, learning games and simulations, be based on the topics that PMs need. Therefore, textbooks which forms the fundamental bases for building the complementary tools that have been mentioned before, must contain complete information about the field.

Table 1 - The frequency of knowledge areas appearance in the research

|  |  |
| --- | --- |
| Keywords | Knowledge Areas |
| ING | SCP | SDE | CST | QLY | RSS | CMS | RSK | PCT | SKL | %of mentions |
| Project Management | 11 | 32 | 61 | 78 | 48 | 38 | 37 | 129 | 8 | 64 | 64.9% |
| Methodologies | 5 | 5 | 12 | 14 | 10 | 3 | 7 | 10 | 1 | 8 | 9.6% |
| PMBOK | 4 | 6 | 6 | 11 | 6 | 5 | 6 | 15 | 2 | 6 | 8.6% |
| PMs/PMOs | 1 | 8 | 9 | 11 | 3 | 4 | 5 | 6 | 2 | 5 | 6.9% |
| PMI | 0 | 2 | 2 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0.9% |
| Implementations | 2 | 4 | 9 | 11 | 6 | 8 | 5 | 11 | 3 | 12 | 9.1% |

In this paper, the main goal is to understand the survey observations of PMs in different industries and recognize PMBOK knowledge areas implementation among active PMs, as well as the degree of knowledge area coverage in the third-generation textbooks in the field of project management.

1. Methods
	1. Research Questions

Q1. Is there a significant difference in the degree of implementing different knowledge areas among PMs?
For each separate knowledge area separately we shall check whether there is a significant difference in the degree of implementing the knowledge area depending on the different categories such as gender, age, level of education, number of organizations managed, and project management seniority.

Q2. Is there a correlation between the degree of Implementing different knowledge areas among PMs and the degree of knowledge areas covered in the textbooks (third-generation)?

* 1. Questionnaire Design and Survey

The study area focuses on active PMs from different working fields, gender, age range, educational level, and seniority. Using the survey method, we shall obtain insights into our research interest, answer research questions, examine the intensity of the phenomenon, and report the main findings and recommendations.

We aimed to collect data that lead us to identify the observations of PMs from different perspectives. The database is based on a survey distributed among active PMs. We wanted to know how well a PMs implements a particular area of knowledge. The survey was built in Google Forms and consists of two parts: Introductory Questions and  Knowledge Areas Questions. The Introductory Questions are based on the independent variables such as gender, employment sector, level of education, age range, project management field, seniority in the current work, seniority in project management, and the organizations in which the PM works (See Appendix 1.a). The Knowledge Areas Questions ask to what extent a PM implemented tools there from. Each PM was required to rank response from 1 to 6 for the question “What extent do you apply tools from any of the following areas of knowledge?” (1=to a very small extent, 6=to very a large extent). Each of the respondents answered ten questions in this part of the survey (See Appendix 1.b).

One hundred and seventeen anonymous PMs answered the survey (66% male, 34% female, with an age range for the majority of 30-50), from different working fields, and different educational levels as shown in Fig. 1 and Fig. 2. Table 2 shows the results of the survey by working fields of the respondents. As will be recalled, the respondents gave weight between 1 and 6 according to the degree of application of the knowledge area in their work. Each of the areas of knowledge is applied in the professional work and the lowest average weight is 3.18 and the highest is 4.37.

**Fig. 1.** Working Fields Distribution among the PM Respondents

**Fig. 2.** The Distribution of the Educational levels among the PM Respondents

**Table 2 -** The knowledge areas weights and rank according to respondents obtained from the PMs

|  |  |
| --- | --- |
| Working Fields | Knowledge Areas |
| ING | SCP | SDE | CST | QLY | RSS | CMS | RSK | PCT | SKL |
| High-tech and Digital | 3.75 | 3.88 | 4.38 | 3.59 | 3.69 | 3.03 | 3.75 | 3.31 | 3.41 | 3.88 |
| Security and Information | 3.84 | 4.20 | 4.32 | 3.12 | 3.84 | 3.16 | 3.20 | 3.84 | 3.04 | 3.16 |
| Other | 3.50 | 2.89 | 3.94 | 3.61 | 3.44 | 3.22 | 3.06 | 3.39 | 2.67 | 2.78 |
| Construction | 3.93 | 4.14 | 4.71 | 4.14 | 3.29 | 2.86 | 3.36 | 3.86 | 3.57 | 3.43 |
| Industry | 3.55 | 3.91 | 4.36 | 3.64 | 3.00 | 3.27 | 2.27 | 4.09 | 3.82 | 2.55 |
| Supply and Operation Chain | 4.33 | 4.22 | 4.67 | 4.22 | 2.44 | 3.11 | 3.11 | 4.56 | 4.22 | 4.22 |
| Water and Infrastructure | 3.33 | 3.67 | 5.00 | 4.00 | 4.00 | 4.67 | 3.33 | 3.33 | 2.67 | 3.67 |
| Education | 4.00 | 4.00 | 4.00 | 4.50 | 3.50 | 4.00 | 3.50 | 3.00 | 4.00 | 4.00 |
| Marketing | 3.50 | 3.50 | 5.00 | 4.00 | 3.50 | 4.00 | 2.50 | 4.00 | 3.00 | 3.50 |
| Entrepreneurship | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 4.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Average weight  | 3.76 | 3.84 | 4.37 | 3.64 | 3.47 | 3.18 | 3.25 | 3.68 | 3.32 | 3.38 |
| Rank | 3 | 2 | 1 | 6 | 5 | 10 | 8 | 4 | 9 | 7 |

* 1. **Textbook data collection**

In order to answer the second research question, we had to collect data about project management textbooks. Data was collected from 12 textbooks from the third generation, i.e. textbooks published during the period 2011-2020 (Allan, 2017; Badiru, 2019; Badiru et al., 2018; Dobson and Dobson, 2012; Kerzner, 2017; Lester, 2017; Lock, 2017; Maley, 2012; Meredith and Mantel, 2011; Patzak and Rattay, 2011; Richardson and Jacks, 2018; Zwikael and Smyrk, 2019). The following is the description of the stages used for the data collection:

1. Searching the project management third-generation textbooks.
2. Identifying lists of topics included in each of the textbooks.
3. For each book, counting the total number of pages devoted to each knowledge area. When a knowledge area appeared in a few places, all space was added up.
4. Expressing, as a percentage, the number of pages devoted to each knowledge area, in each textbook relative to the total number of pages in the textbook, to allow comparison. Davidov and Globerson (2020) proposed to express the importance of the various topics in textbooks by calculating the percentage of coverage of the topics. The percentage of coverage is calculated as the ratio of the number of pages that the topic occupies in the textbook to the total number of pages in the textbook.

Table 3 shows the degree of coverage of each area of knowledge in each of the 12 sources. There are areas of knowledge that are not explained at all in a considerable number of the textbooks. For example, SKL does not appear in 50% of the sources and PCT, CMS does not appear in about 42% of them. In contrast SCP appears in all textbooks and SDE, QLY, RSS appear in about 92% of the books.

To compare the two databases (PMs’ answers and textbook coverage), each with itsunique values, we used rankings of the knowledge areas (1-10), where 1 expresses the highest value obtained. As a result, SDE received a rank 1 (highest) and RSS received a rank 10 (lowest) among PMs (see Table 2). QLY received a rank 1 and SKL received a rank 10 among textbooks (see Table 3).

**Table 3 -** The knowledge areas coverage and rank in the third generation of the Textbooks

|  |  |
| --- | --- |
| Working Fields | Knowledge Areas |
| ING | SCP | SDE | CST | QLY | RSS | CMS | RSK | PCT | SKL |
| Meredith and Mantel (2011) | 0% | 8% | 6% | 6% | 13% | 11% | 3% | 0% | 0% | 0% |
| Patzak and Rattay (2011) | 7% | 31% | 4% | 0% | 8% | 16% | 0% | 0% | 0% | 2% |
| Maley (2012) | 16% | 13% | 10% | 0% | 0% | 0% | 0% | 9% | 10% | 3% |
| Richardson and Jacks (2018) | 9% | 3% | 7% | 5% | 15% | 8% | 2% | 6% | 3% | 4% |
| Lock (2017) | 15% | 7% | 9% | 16% | 7% | 9% | 0% | 10% | 7% | 0% |
| Lester (2017) | 7% | 1% | 11% | 6% | 2% | 3% | 1% | 6% | 8% | 1% |
| Dobson and Dobson (2012) | 13% | 16% | 6% | 0% | 12% | 6% | 0% | 6% | 0% | 0% |
| Kerzner (2017) | 0% | 7% | 5% | 10% | 9% | 4% | 4% | 7% | 4% | 3% |
| Allan (2017) | 15% | 11% | 0% | 8% | 11% | 18% | 8% | 0% | 0% | 0% |
| Badiru et al. (2018) | 0% | 12% | 7% | 12% | 10% | 11% | 11% | 5% | 10% | 0% |
| Zwikael and Smyrk (2019) | 18% | 4% | 1% | 3% | 10% | 3% | 0% | 12% | 0% | 5% |
| Badiru (2019) | 0% | 8% | 11% | 11% | 24% | 14% | 0% | 0% | 7% | 0% |
| Avg. % Coverage | 8.38% | 10.13% | 6.33% | 6.45% | 10.20% | 8.45% | 2.43% | 4.96% | 4.03% | 1.44% |
| Rank | 4 | 2 | 6 | 5 | 1 | 3 | 9 | 7 | 8 | 10 |

**3. Results**

According to a Kruskal-Wallis test, there is a significant difference in the degree of implementing the knowledge areas. Among the tested group the knowledge area that was implemented the most is SDE (p<0.05). In addition, for each separate knowledge area the same test was applied to check whether there is a significant difference in the degree of implementing a knowledge area depending on:

* Gender – A significant difference was obtained in CST and RSK, which means that these knowledge areas are used by male PMs more than female PMs (p<0.05).
* Age – The Spearmen Correlation test was applied to see whether there is a significant difference in the degree of implementing each knowledge area by age. It was determined that the older a PM is, the more he/she implements ING, CST and PCT (p<0.05, a positive correlation coefficient).
* Educational level – A significant difference was also obtained in the degree of implementing knowledge areas depending on the educational level. Managers with a Master's degree use CST more than those with a Bachelor's degree (p<0.05).
* Number of organizations managed – The more a PMs manages organizations, the more he/she implements knowledge areas like ING, CST, RSS, CMS, PCT and SKL (p<0.05, a positive correlation coefficient).
* Project management seniority – PMs implement tools more in ING, CST, CMS, PCT, and SKL (p<0.05; a positive correlation coefficient) when they have higher seniority in managing projects. The opposite is also true for those lower seniority, the result is a negative coefficient.

To compare the textbooks studied we examined whether there is a correlation between the degree of implementing knowledge areas among PMs and the coverage degree of the knowledge areas in the textbooks (third generation). See Fig. 4 for rank comparisons It can be seen that four of the knowledge areas (SCP, CST, PCT and CMS) received the same ranking but the most important knowledge area among PMs, SDE, received a rank of 6 (relatively low) and QLY, which received the highest rank in the textbooks received a rank of 6 among PMs.



**Fig. 3.** The comparison of the knowledge areas ranks both in Survey and Textbooks

According to the Spearmen Correlation test, there is no correlation between the two ranks, thus there is no correlation between the level of coverage in the textbooks and the rank of implementation that was applied from the questionnaire. The textbooks do not match the PMs implementation in their working fields.

**4. Conclusions**

In the present study, we successfully analysed the survey responses obtained from the 117 active PMs. We intended to investigate the degree of implementation in the various fields of knowledge areas. We were able to find out from the perspective of the PMs whether and how the PMBOK knowledge areas from a basis or an anchor for them. The results concentrate on PMs needs and examine the gaps between the PMBOK knowledge areas as a project management methodology and the PMs in real applications.

From the analysed data different conclusions emerge depending on the independent variables examined. Looking at the PMs’ responses, it can be seen that there is no overall match between the various knowledge areas. There are differences between the various knowledge areas in terms of implementation. There are more implemented areas by PMs such as integration, cost, procurement, and communication. Other knowledge areas like quality, scope, and stakeholder still require reinforcements among PMs.

Due to the comparison analysis between the degree of implementing additional knowledge among PMs and the coverage degree of the knowledge areas in the last generation of textbooks, we recommend: (1) Adjusting the coverage degree of the knowledge areas to the implementation degree in PMs practice; (2) Consider adding more content to the textbooks in the knowledge areas that are required by PMs’ practice.

The limitations of the present study are in the non-separation between the role of the PM and the role of the PMO in the organization. On the other hand, not every organization has two functionaries. Another limitation is that the survey did not address the size of the organization in which the PM is employed and the nature of the projects that are managed by the PM (development or implementation).

Further research should focus on investigating reasons for partial applications of knowledge areas among PMs, whether there is a difference in the application of knowledge areas in development projects compared to implementation projects and whether there is a relationship between the application of knowledge areas and the size of the organization. In addition, it is important to analyze the degree of application of the principles published in PMBOK7 and the degree of implementing PRINCE2 methodology among PMs and the degree of coverage of these topics in textbooks. The study identified gaps between the degree of application of the knowledge areas of project management and the importance that the authors of the textbooks attach to the above areas of knowledge. The research findings may contribute greatly to reducing these gaps. The research findings can also contribute to the professional training of people who are employed or will be employed in project management, such as engineering students of all kinds.

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Inessa Ainbinder contributed to validation, visualization, analysis, and manuscript editing.

Nadine Ayoubi contributed to data collection, analysis, and draft preparation.

Batel Avivi contributed to investigation, data collection, software, and analysis.

Lital Eliyahu contributed to investigation, data collection, software, and analysis.

Appendix 1.a - Introductory Questions in Survey

|  |
| --- |
| Please indicate which gender you belong to* Male
* Female
 |
| To which employment sector does your organization belong?* Private
* Public
* Non-profit organization
 |
| What age range do you belong to?* 20-30
* 30-40
* 40-50
* 50+
 |
| In what field are you currently a project manager?* Security and information systems
* Construction
* High-tech and digital
* Education
* Electricity
* Marketing
* Industry
* Water and infrastructure
* Supply and operation chain
* Entrepreneurship
* Other
 |
| What is seniority (in years) in the current workplace? \_\_\_\_\_\_\_ |
| What is seniority (in years) in project management in all the workplaces you have worked for? \_\_\_\_\_\_ |
| What is the number of organizations in which you managed a project?* 0-4
* 5-8
* 9-12
* 13-17
* 18+
 |
| What is your education?* BA
* MA
* Phd
* Practical Engineering/ Technician
* Diploma
* No studies
 |

Appendix 1.b - Knowledge Areas Questions in Survey

|  |
| --- |
| Please indicate to what extent (1 to a small extent, 6 to a large extent) do you apply tools from any of the following areas of knowledge. |
| 1. Integration Management (preparation of an initiation document and management plan for the project, directing control and supervision of the project work, performing change control).
2. Scope Management (requirements collection, content definition, work content structure (WBS), validation and control of project content).
3. Schedule Management (preparation, management and control of schedule, definition of activities and activities in sequence, estimation of active resources and estimation of activity durations).
4. Cost Management (cost estimation, budget setting, cost control).
5. Quality Management in the project (quality assurance, quality control).
6. Human Resource management in the project (project staff recruitment, team development and management).
7. Communication Management (communication management and control).
8. Risk management (risk identification, qualitative and quantitative analysis of risks, planning solutions to risks, control).
9. Procurement Management (execution and closing of procurement).
10. Stakeholder Management (identification and planning of stakeholders, management, and control of their involvement).
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