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ISO 21500:2012 and PMBoK 5 processes in information systems project management

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ABSTRACT

The purpose of this research is to contribute to a better understanding of information systems (IS) project management practice, by investigating the ISO 21500:2012/PMBoK 5 processes implemented by project managers in this kind of projects. Responses to an international web-based survey, representing 472 projects in total, showed that processes from knowledge areas as, for instance, scope management, cost management, and time management, are frequently implemented. However, there are processes from important areas as, for instance, quality management and risk management, that are being relegated to a second plane, what is a matter of concerning. Since IS projects do not have a very good reputation concerning success, these results can be of outmost importance to help researchers and practitioners to improve project management performance.

1. Introduction

A process can be defined as a "set of interrelated or interacting activities, which transforms inputs into outputs" [13]. In the past decades many guides of good practices, comprising processes and techniques, have been developed, covering all aspects of managing projects from their initiation to their closing [47].

Nevertheless, Project Management (PM) remains a highly problematical endeavor. Projects still fail to live up to the expectations of stakeholders as they continue to be disappointed by projects' results [9,10,12,36,48]. In the particular case of information systems (IS), the projects continue to show lower levels of success [8, 19,33,34,42,43,7] due to several reasons [5]: project underestimates; inadequate requirements when the delivery decision is made; changes in scope; risks not re-assessed, controlled, or managed through the project; unrealistic expectations; inappropriate methodology; etc.

A common feature of failed projects is the lack of effective project management [2,18]. The proper implementation of PM processes best practices should improve PM performance, thus resulting in improving the speed and quality, fewer mistakes, lower cost because of less rework, fewer delays and snags, better use of time, and customer satisfaction [23].

Several guides can be used by organizations in selecting the most appropriate processes and techniques to improve PM in a given context, being ISO 21500:2012 and PMBOK good examples of standards. ISO 21500:2012 provides guidance for project management and can be used by any type of organization, including public, private or community organizations, and for any type of project, irrespective of complexity, size or duration [14]. ISO 21500:2012 is aligned with PMBOK 5. PMBOK 5 (A Guide to the Project Management Body of Knowledge – Fifth Edition) provides guidelines for managing individual projects and defines project management related concepts. It also describes the project management life cycle and its related processes, as well as the project life cycle [32].

On one hand, it has been recognized over the last decades that project management is an efficient tool to handle novel or complex activities [28]. On the other hand, practice shows that IS projects continue to not achieve the most desirable results [42,43]. So, it is important to investigate to what extend the PM standards are actually used, to identify opportunities of improvement. As we can observe in the literature, there is only limited evidence on the standards implementation in PM practice, being the research of [30] one of the few available studies, however it is not focused in the particular case of IS projects. Other efforts include partial implementations like the one provided in the work of [46], which pictures an effort to combine ABC analysis with PM standards or efforts conducted in the field of, for instance, risk analysis [16,21].

The purpose of this paper is to identify which ISO 21500:2012 and PMBoK 5 processes are being implemented in IS projects. Our study, part of a wider international study seeking to characterize several

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dimensions of IS projects success, complements existing research by providing a richer understanding of IS project management practice.

This research addresses the gap in the literature by examining the following research questions:

1) Are the ISO 21500:2012 and PMBoK 5 processes being implemented in IS project management?
2) Are the project management standards (ISO) and Bodies of Knowledge suitable to characterize the IS project management processes?

To answer these questions, we conducted an international survey with 107 experienced IS project managers. We asked each of them to identify the frequency of implementation of a list of processes in the last projects they participated.

This paper is organized as follows. The following section summarizes the relevant literature on project management processes. The research design and methodology are described next. Then, the key findings and results are presented. This is followed by the discussion of results. Finally, we conclude with implications from this study for practice and research and some highlights for further research.

2. Background

2.1. Information systems

Information Systems (IS) play an extremely important role in modern organizations, since they are present in almost every aspect of business [44,45]. IS are nowadays a business core asset, essential to improve productivity [44], reduce operational costs, improve the managerial decision making, and gain competitive advantages, just to mention a few benefits.

In a rapidly changing business and technological environment, the ability to develop and deploy new systems is an important asset that can differentiate one organization from another [31]. Moreover, organizations must continuously innovate in terms of product, process, market and business model in order to remain sustainable [29]. The sustainable success of any organization is strongly associated with the success of the IS projects [7]. However, the success of IS projects is far from the desirable and the establishment of effective and efficient project management practices still remains a challenge [19].

Companies currently use multiple IS solutions to support their activities at all management levels and few of them try to conduct their businesses without seeking to exploit the advantages of IS. Due to the increasing complexity of organizations, the projects are also becoming more complex [20,41] and currently an IS project can assume many sizes and forms, including ERP (Enterprise Resource Planning system) implementation, CRM (Customer Relationship Management system) implementation, SCM (Supply Chain Management system) implementation, BI (Business Intelligence system) implementation, ERP module implementation, custom system implementation, systems improvement, process improvement using information technology, systems migration, infrastructure enhancement, consultancy, and others. The development/implementation type can also vary, from customized development up to COTS (Customer of the Shelf)/packaged software implementation (or both).

2.2. Project management bodies of knowledge

A PM body of knowledge is the sum of knowledge within the profession of PM. The complete PM Body of Knowledge includes proven traditional practices that are widely applied, as well as innovative practices that are emerging in the profession [38]. The attempts by the Bodies of Knowledge to systematize the knowledge required to manage projects are largely based on the underlying assumption that there are identifiable patterns and generalizations, from which rules, controls and guidelines for best practice can be established that are replicable, even if not on absolutely every circumstance [22]. PM Bodies of Knowledge have been published by the professional PM associations in the last decades. There has been an emergence of multiple Bodies of Knowledge, such as: PMBOK from Project Management Institute [24]; APM BOK from Association for Project Management [39]; ICB from International Project Management Association [25]; and P2M from Project Management Association of Japan [40]. These Bodies of Knowledge are used by practitioners as 'Best Practice' guides to what the discipline comprises [35]. The PMBoK®, APM BOK and P2M are of the most influential publications on what constitutes the knowledge base of the profession [48]. The research is progressing in order to find if the PM practices are dependent on the organizational context (e.g. industry, size, project type and geographic location) [12].

2.3. PMBoK 5 and ISO 21500:2012

The PMBOK contains the globally recognized standard and guide for the project management profession. A standard is a formal document that describes established norms, methods, processes, and practices. As with other professions, the knowledge contained in this standard has evolved from the recognized good practices of project management practitioners who have contributed to the development of this standard [32].

PMBOK 5 has the following process groups: initiating; planning; executing; monitoring and controlling; and closing. It identifies 10 "knowledge areas" for organizing processes: integration; stakeholder; scope; human resources; time; cost; risk; quality; procurement; and communication. ISO 21500:2012 is based and aligned with PMBOK.

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization. International Standards are drafted in accordance with the rules given in the ISO/IEC Directives [14].

ISO 21500:2012 provides guidance on concepts and processes of project management that are important for, and have impact on, the performance of projects. It provides high-level description of concepts and processes that are considered to form good practice in project management. Projects are placed in the context of programmes and project portfolios, however, this International Standard does not provide detailed guidance on the management of programmes and project portfolios. Topics pertaining to general management are addressed only within the context of project management [14].

ISO 21500:2012 identifies the following process groups: initiating; planning; implementing; controlling; and closing. It also identifies 10 "subjects" for organizing processes: integration; stakeholder; scope; resource; time; cost; risk; quality; procurement; and communication.

The differences between ISO 21500:2012 and PMBOK 5 are minimal concerning the process groups and subjects/knowledge areas. The main difference is in the description of tools and techniques, because ISO 21500:2012 do not provide it.

3. Method

Our method involved a web-based survey of information systems project managers. The data was analyzed using descriptive statistics and reliability estimates. This approach was chosen because the study of project management processes is well enough advanced that a

Table 1
Project Management processes.

ISO 21500:2012 [14]	**PMBOK 5** [32]
Integration (IM):	**Integration (IM):**
Develop Project Charter	IM: Develop Project Charter
Develop project plans	IM: Develop project management plan
Direct project work	IM: Direct and manage project work
Control project work	IM: Monitor and control project work
Control changes	IM: Perform integrated Change Control
Close project phase or project	IM: Close project or phase
Collect lessons learned *(related to "close project or phase" in PMBOK)*	
Scope:	**Scope (SM):**
Define scope *(related to "collect requirements" and "define scope" in PMBOK)*	SM: Plan Scope management SM: Collect requirements
Create Work Breakdown Structure	SM: Define scope
Define activities *(related to "define activities" of "time" in PMBOK)*	SM: Create WBS (Work Breakdown Structure) SM: Validate scope
Control scope	SM: Control scope
Time:	**Time (TM):**
Sequence activities	TM: Plan Schedule management
Estimate activity durations	TM: Define activities *(related to "define activities" of "scope")*
Develop schedule	TM: Sequence activities
Control schedule	TM: Estimate activity resources *(related to "estimate resources" of "resources")* TM: Estimate activity duration TM: Develop schedule TM: Control schedule
Cost:	**Cost (CM):**
Estimate costs	CM: Plan Cost management
Develop budget	CM: Estimate costs
Control costs	CM: Determine budget CM: Control costs
Resource:	**Human Resources (HRM):**
Establish project team	HRM: Plan Human Resource management
Estimate resources *(related to "estimate activity resources" of "time" in PMBOK)*	HRM: Acquire project team
Define project organization *(related to "plan human resource management" in PMBOK)*	
Develop project team	
Control resources *(related to "monitor and control project work" of "integration" in PMBOK)*	HRM: Manage project team
Manage project team	HRM: Develop project team
Quality:	**Quality (QM):**
Plan quality	QM: Plan Quality management
Perform quality assurance	QM: Perform quality assurance
Perform quality control	QM: Control quality
Risk:	**Risk (RM):**
Identify risks	RM: Plan Risk management
Assess risk *(related to "perform qualitative risk analysis" and "perform quantitative risk analysis" in PMBOK)*	RM: Identify risks RM: Perform qualitative risk analysis RM: Perform quantitative risk analysis
Treat risks	RM: Plan risk responses
Control risks	RM: Control risks
Stakeholder:	**Stakeholder (StM):**
Identify stakeholders	StM: Identify stakeholders
Manage stakeholders	StM: Plan stakeholders management StM: Manage stakeholders engagement StM: Control stakeholders engagement
Communication:	**Communication (CmM):**
	CmM: Plan Communications management
Plan Communications	CmM: Manage communications
Distribute information	CmM: Control communications
Manage communications	
Procurement:	**Procurement (PM):**
Plan procurements	PM: Plan Procurement management
Select suppliers	PM: Conduct procurements PM: Control procurements
Administer contracts *(related to "control procurements" and "close procurements" in PMBOK)*	PM: Close procurements

(continued on next page)

qualitative approach was deemed unnecessary and because others (*v.g.* [14]; [32]) have already identified a comprehensive list of general processes that can be used as a basis to study the information systems project management.

3.1. Measurement instrument

Based on ISO 21500:2012 [14], on PMBOK 5th edition [32], and on the literature review, a survey instrument was used to measure the implementation of information systems project management processes. The questionnaire contained a list of forty seven processes (as presented in Table 1, column 2), organized in ten knowledge areas (integration, scope, time, cost, quality, human resource, communications, risk, procurement, stakeholder). All of the items used a Likert scale ("Never", "Occasionally", "Often", "Always"), concerning the frequency of implementation in practice. It was used the nomenclature proposed by [32], since the processes of ISO 21500:2012 and PMBOK are quite similar, and PMBOK has a more detailed list of processes. As can be seen in Table 1, many processes have the same names in ISO 21500:2012 and in PMBOK 5 (e.g., "Develop Project charter" [14] and "Develop Project Charter" [32]); others have different names but are similar (e.g., "Control changes" [14] and "Perform integrated Change Control" [32]); and others are grouped (e.g., the process "Administer contracts" [14] is related to the processes "Control procurements" [32] and "Close procurements" [32]). The data was collected at organizational level.

Although our study used items identical to those in PMBoK 5 [32], thus taking advantage of previous validation, the context validity of the questionnaire was examined prior to starting of the survey. Two professors of IS and project management and nine IS project managers pilot-tested the surveys. The results indicated a few minor refinements that were made to the final questionnaire.

3.2. Data collection

Our sample of IS project managers was primarily drawn from the worldwide community of LinkedIn users. A discussion topic with a link to the online survey was posted in several groups of project management and IS. In addition, it were sent initial and follow-up emails to project managers and chief information officers, with information about the survey and a link to the survey. The data was collected from

November 2014 to January 2015. In total, 111 surveys were obtained. Since four of the surveys were unusable due to incomplete responses, a final number of 107 complete surveys, representing 472 projects in total, were used in our analysis, yielding a total of 96.4% valid responses.

Table 2 summarize the demographics of participating project managers. The respondents consisted mainly of project managers (52.3%) and chief information officers (19.7%). With respect to age, the majority has more than 40 years old (71.1%). Regarding years in project management the majority has more than 10 years of experience (58%) and 18.7% has more than 20 years of experience. Finally, 93.5% of the respondents indicated that they held graduate or postgraduate degrees.

Table 3 summarizes the characteristics of the respondents' companies. Respondents came from organizations of varying sizes (small, medium and large). Many of the companies have their PM methodology aligned with PMBoK (37.4%) and only 12.1% uses a PM maturity model to improve their PM practices. The sample is split evenly in several of the contextual variables (e.g., total employees and turnover), which renders the analysis more reliable. The majority of companies have headquarters in Europe (62.6%) and North America (23.4%), and international presence (60.7%).

To sum up, the respondents are experienced project managers, representing a variety of company sizes and project management approaches.

Table 2
Profile of respondent project managers.

	Frequency	Percent
Gender		
Male	85	79.4
Female	22	20.6
Age		
27–40	32	29.9
41–50	48	44.9
> 50	27	25.2
Education		
Undergraduate	7	6.5
Graduate	40	37.4
Postgraduate	60	56.1
Education area		
Informatics	20	18.7
Information Systems	39	36.5
Business Management	27	25.2
Other	21	19.6
Training or certification in project management		
Yes	70	65.4
No	37	34.6
Current position		
Project manager	56	52.3
CIO / IT Director	21	19.7
Director / Manager	15	14.0
Other	15	14.0
Average years in position		
1–10	23	21.5
11–20	45	42.1
> 20	39	36.4
Average years in project management		
1–5	13	12.1
6–10	32	29.9
11–20	42	39.3
> 20	20	18.7
Number of projects as project manager		
< 11	25	23.4
11–30	42	39.2
> 30	40	37.4

Table 3
Profile of respondents' companies.

	Frequency	Percent
Total employees		
1–200	33	30.8
201–500	20	18.7
501–2000	22	20.6
> 2000	30	28.0
Do not know/Do not answer	2	1.9
Turnover		
< 1.000.000	15	14.0
1.000.000–10.000.000	19	17.8
10.000.001–250.000.000	24	22.4
> 250.000.000	23	21.5
Do not know/Do not answer	26	24.3
Headquarters		
North America	25	23.4
Europe	67	62.6
Other	15	14.0
Number of countries where is present		
1	42	39.3
2–10	36	33.6
> 10	29	27.1
Certifications		
Yes	50	46.7
No	57	53.3
Project management approach/methodology		
PMBoK or Custom (based on PMBoK)	40	37.4
Custom (based on various methodologies)	26	24.3
It is not used a formal methodology	22	20.5
Other	19	17.8
Uses a project management maturity model		
Yes	13	12.1
No	94	87.9
Main software used in project management		
MS Project	55	51.4
MS Excel	20	18.7
Custom	13	12.1
Other	19	17.8

4. Results and discussion

Cronbach's Alpha was computed to test the reliability and internal consistency of the responses. Cronbach's Alpha is .967 (47 items), which is considered excellent [6], indicating a high degree of internal consistency in the responses.

Answering to the research question ("Are the ISO 21500:2012 and PMBoK 5 processes being implemented in IS project management?"), Fig. 1 shows the computed ranking of IS project management processes. Results show that our population implement all the processes at least occasionally and do not proposed new processes, enabling to answer positively to the research question "Are the project management standards (ISO) and *Bodies of Knowledge* suitable to characterize the IS project management processes?".

All processes have averages between 1.6 and 2.6 in a scale of 0 (meaning "never") to 3 (meaning "always"). The processes overall average is 2.2 (2 means "Often"). The top 5 most frequently implemented processes in IS project management are "CM: Determine budget", "TM: Develop schedule", "SM: Define scope", "SM: Collect requirements" and "TM: Define activities". Whereas the 5 less implemented ones, with averages equal or lower than 1.8, are "RM: Perform quantitative risk analysis", "RM: Plan Risk management", "IM: Develop Project Charter", "RM: Perform qualitative risk analysis" and "RM: Plan risk responses".

The fact that all the processes proposed by ISO 21500:2012/PMBOK 5 are being put in practice by IS project managers is particularly interesting, since more than an half of the survey's participating project managers do not have a certification in PM (53.3%) and they are not using ISO 21500:2012/PMBOK as the main PM approach/methodology (62.6%). Also to note that according to

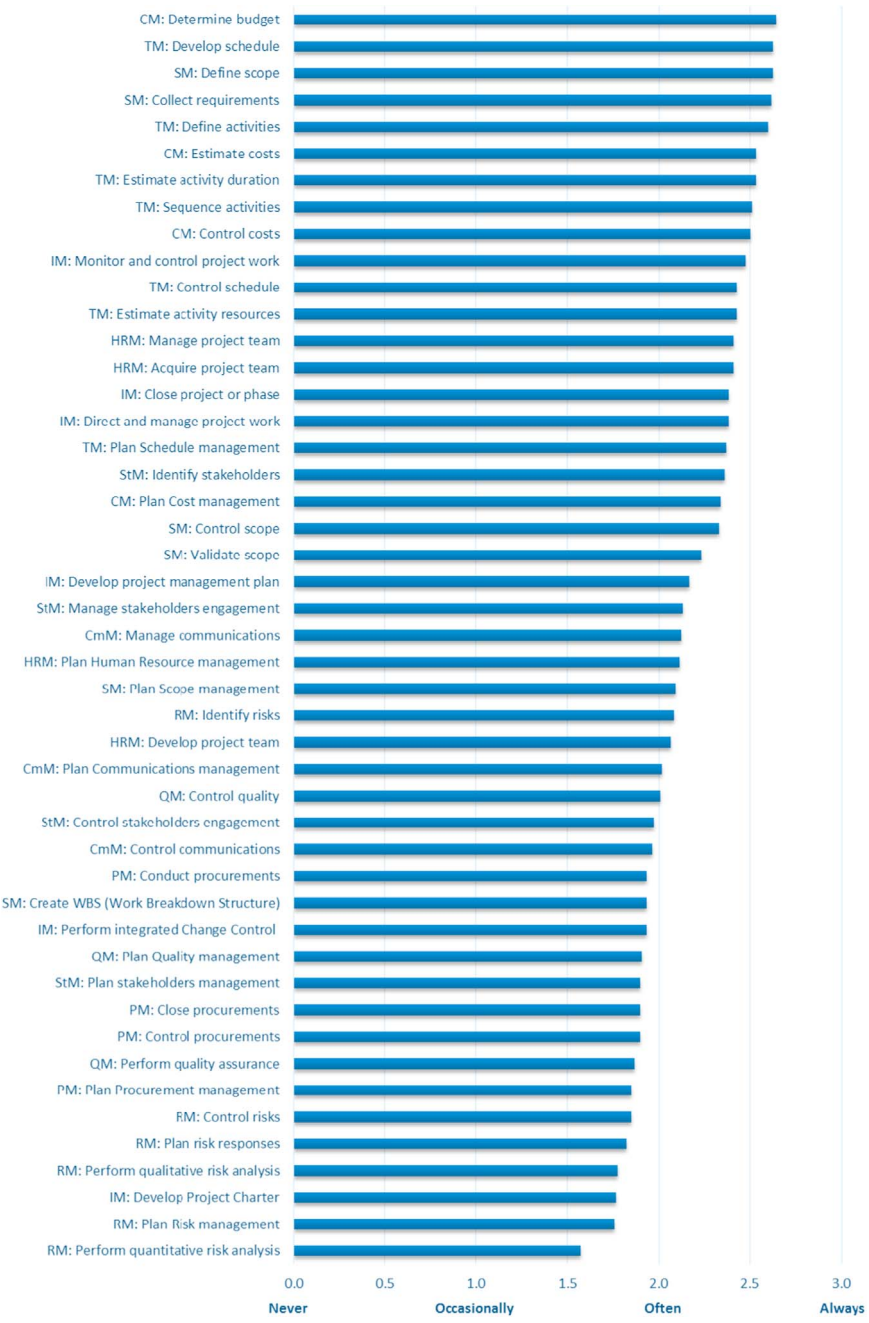

Fig. 1. Ranking of IS project management processes.

[27], certified project managers perform better on high performing projects (but not for all kind of projects). Given that IS projects are normally high performing projects, the difference in the view of the project, project management, its results and insights, seem to be important in the case of IS project managers. To investigate whether project managers who have *specialized training in project management* and those that *do not have it* differ on the *implementation of project management processes*, it were used Mann-Whitney tests. Although the importance of certification for the community is still moderate [4,37], it was found a significant difference ($p < 0.05$) in the case of the processes: IM: Develop project management plan ($p=0.12$); SM: Create WBS ($p < 0.001$); TM: Define activities ($p=0.35$); TM: Estimate activity resources ($p=0.31$); TM: Estimate activity duration ($p=0.32$).

Considering the ranking position of the processes from *primary* knowledge areas such as scope management, time management, and cost management, there are not reasons for concern in these processes, since all, without exception, are between the "often" and "always" levels of implementation. Notwithstanding the focus on these processes, the results of cost, scope and time compliance in IS projects are not very positive. For instance, delays are very common in IS projects [42,43]. So, we can conclude that the processes from time, cost and scope management are of course very important, but they are not sufficient to guarantee the time, cost and scope compliance in projects. Processes from other areas, although not being considered *primary*, are of central importance for PM performance.

Looking at the processes at the bottom of the ranking, we find, for instance, many processes from quality management (considered also a *primary* area) and from risk management. Quality Management includes the processes and activities of the performing organization that determine quality policies, objectives, and responsibilities so that the project will satisfy the needs for which it was undertaken. Works to

ensure that the project requirements, including product requirements, are met and validated [32]. Risk Management comprises the processes of conducting risk management planning, identification, analysis, response planning, and controlling risk on a project. The objectives of project risk management are to increase the likelihood and impact of positive events, and decrease the likelihood and impact of negative events in the project [32]. From these definitions, it become clear that these are important areas of PM and the low usage of these processes can be a strong reason for the chronic problems in IS projects. To mention the particular case of risk management processes, since results show that these processes are well below the recommendable levels of usage, what is a matter of concerning.

Risk management in IS project is a hot topic in recent literature. Several meta-analysis depict the need of such management [1,11], although, according to these studies there is not still enough empirical evidence to pair risk management and project success. More focused studies like, for instance, of [15], lead to some positive evidences, limited in this case to the vendor side. In the paper by [17], some of the of the reasons behind this pale adoption can be found. These authors underline that, in one-third of cases, because of the problem of cost justification, no formal project risk management process was applied. Following this anti-pattern approach, [16] dig deeper into these reasons and stablish some of the reasons behind this disengagement: managers sometimes see risks as fictional pieces of management. In our study the reasons for a poor risk management in IS projects were not explored, being this an opportunity for future research.

To investigate if there was a significant association between the demographic variables of project managers and their companies, it were done several statistical tests. In the major case of variables were not found relevant associations. The exception were the variables *project manager age* (and *experience* in project management) and *PM methodology*, since were found associations between all the risk management processes and these variables.

Correlations were computed using the Spearman rho statistic, to investigate if there was a statistically significant association between the *age of the project manager* and *implementation of project management process*. It were found positive correlations between the *age of the project manager* and the processes: RM: Plan Risk management (rho=.215, $p < 0.05$); RM: Identify risks (rho=.247, $p < 0.05$); RM: Perform qualitative risk analysis (rho=.338, $p < 0.05$); RM: Perform quantitative risk analysis (rho=.272, $p < 0.05$); RM: Plan risk responses (rho=.245, $p < 0.05$); RM: Control risks (rho=.234, $p < 0.05$).

We used nonparametric Kruskal-Wallis tests to compare the four levels of *project management methodology* on the dependent variables *implementation of project management processes*. It was found a significant difference ($p < 0.05$) in the case of the processes: RM: Plan Risk management (p=0.002); RM: Identify risks (p=0.012); RM: Perform qualitative risk analysis (p=0.041); RM: Perform quantitative risk analysis (p=0.042); RM: Plan risk responses (p=0.012); RM: Control risks (p=0.024).

Considering the obtained results, we can conclude that both the project manager's age (and experience) and the adopted project management approach/methodology influence the implementation of processes of risk management; this must be taken on account when structuring the project management team. In other words, an experienced project manager seems to be more aware of the importance of the risk management processes, what can be of major importance for the success of the project, particularly in the case of more complex projects.

5. Conclusion

There is no doubt that information systems are the backbone of today's organizations [3,26], being present in almost every aspect of business [45,44]. Nevertheless its importance, the IS projects continue to show lower levels of success [19,33,34,42,43].

PM standards are important tools to improve PM performance [30], however, until now, there is only very limited evidence on the extent of standards usage. This paper contributes to the literature with new insights on the IS PM practice.

The results of our international web-based survey, showed that, on one hand, processes from knowledge areas as, for instance, scope management, cost management, and time management, are often implemented. Nine processes from these areas are in the top 10 of the most implement processes: “CM: Determine budget”; “TM: Develop schedule”; “SM: Define scope”; “SM: Collect requirements”; “TM: Define activities”; “CM: Estimate costs”; “TM: Estimate activity duration”; “TM: Sequence activities”; and “CM: Control costs”. The only exception in the *top 10* is the process “IM: Monitor and control project work”, from integration management, which is transversal to all the knowledge areas and occupies the 10th position in the ranking. On the other hand, there are processes from other important areas as, for instance, quality and risk management, that are being relegated to a second plane, what is a matter of great concern and can be in the root of many problems of this kind of projects. This is particularly serious in the case of risk management, since all (!) the five processes from risk management occupy the last six positions on the ranking together with the process “IM: Develop Project Charter” from integration management. It were found significant associations between these processes implementation and the variables *project manager age* (and *experience*) and adopted *project management approach/methodology*. Furthermore, results show that the project management standards (ISO) and *Bodies of Knowledge* are suitable to characterize the IS project management processes.

This study has important implications for practice, education and research, by identifying the PM areas that need more attention from researchers and practitioners and that can be a deterrent of higher levels of success. Nevertheless, improvements can be done in further studies by using a larger sample size.

One avenue for future research would be to examine in detail the process implementation of the more neglected areas as, for instance, quality management and risk management.

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