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PREFACE

This book constitutes the proceedings of the Third International Conference on Research and Education in Project Management (REPM 2020). This scientific event was held in Bilbao (Spain) on February 20-21 2020.

Project Management (PM) is recognized as one of the best tools to create successful developments. The objective of REPM 2020 was to bring together practitioners and academics who wish to discuss and agree on the best practices in both research and education in the field of PM. The conference had close to 60 participants from academia and industry, so it finally contributed to bridge the gap between the two environments.

Continuous effort into research is the only guarantee to develop advanced techniques and tools. The PM community is being increasingly recognized through their Scientific Journals. Moreover, PM professionals feel the need of deepening in their knowledge when they face daily problems, and the University is the main instrument to educate professionals. Besides, the World needs PMs to be aware of the importance of their role into sustainable development projects. Taking the previous aspects into account, those three thematic areas were chosen for this third Conference: Research in PM, Education in PM, and Sustainability and PM. Moreover, a special slot was dedicated to Women in PM.

This publication includes 13 papers selected by the scientific committee of REPM 2020.

We eagerly look forward to REPM 2021.

April 2020 Jose Ramón Otegi

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The impact of women on Project Management: The emotional intelligence competences perspective

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Abstract:

Nowadays, more and more women are discovering the field of project management as a way to become project management professionals. The challenges, faced by project management, require not only field knowledge, but also ability to respond and manage it adequately. Today's embedded scientist Emotional Intelligence (EI) introduce as one of the most important factor in helping manage various challenges of the project management area.

A women perspective was taken in this research by analysing EI competencies in the project management area with a special focus on the challenges of EI competencies and how to overcome these challenges. The paper presents results of quantitative and qualitative research that was conducted in Lithuania. The research discovered that the sense to common idea or goal is the key driver of women emotional intelligence in the project management.

Keywords: women; project management; emotional intelligence.

1. Introduction

Number of projects is rapidly increasing. Projects become a key tool to implement strategical aims and deliver value for public and business organizations. A successful project requires the right combination of performance management and people leadership. In accordance to KPMG, AIPM and IPMA Project Management Survey 2019 [1] report 74% of respondents think that, in the future, project management skills will be more important than today. Moreover, Industry 4.0 is based on innovative technology that creates changes and preconditions for economic growth [2]. Projects become the key tool to implement changes of new industrial revolution. Traditionally, project manager responsibilities cover the coordination and completion of projects on time within budget and within scope. Industry 4.0 requires new competencies, such as flexibility, fast and efficient communication and decision-making, dealing with complex problems, leadership, delivering value.

Jordan and Lindebaum [3] highlight emotional intelligence (EI) as crucial factor of successful project management. More twenty years ago Goleman [4] presented the term emotional intelligence. Since then, EI has been widely analysed. The research on the EI contributed to the analysis of emotional intelligence as sociodemographic variables gender, age, etc. [5, 6, 7]. Moreover, the results of EI research mostly offered the understanding how EI functions in individuals [8]. EI in the area of project management presents relevant benefits of the emotional intelligence impact on the leadership style [9] [10].

Traditionally male dominated as a project manager. In addition, managerial careers in the past have traditionally been male oriented. Women continue to be minority in the field of project management [11]. Consequently, researchers [12] and have become interested in the role of women by managing different projects. However, understanding women emotional intelligence competency in the project management area seems limited at a present.

The aim of paper is to reveal the impact of women in project management focusing on the emotional intelligence competencies as important factor for project success.

2. Literature review

2.1. Gender differences

The APM Salary and Market Trends Survey 2019 [13] reports the gender gaps in the project manager profession. The survey presents situation in UK. In 2019 males earned 24% more than female. A larger proportion of female coming in to project manager profession, as 49 % have up to five years project management experience compared to 32% of men, was revealed. OECD study [14] reveals gender difference in the business environment – "More women than men value work-life balance as a motivation for starting their business". Proportionally, more women than men start a business out of 'necessity', i.e. they become entrepreneurs because they do not see other, more attractive, options (including salaried employment) to enter the labour market.

Bernice G. and Jebaseelan [15] reveals relation of EI and women entrepreneurs. Studies indicate that EI is an integral part of any leadership. Women capable of handling risky tasks take up challenging assignments and play a pivotal role in handling business affairs. Women by nature are great listeners and born with an innate sense of care giving, empathy and intuition. Women are always considered as better than men in terms of handing the issues, taking criticisms, confronting the situation and passive over tough predicaments.

Rodríguez et al. [16] argues that women have better interpersonal communication, teamwork and Influence and sensitivity skills.

In overall, this research contributes to the project management field focusing on women EI competencies as key factor for managing the challenges of project management.

2.2. Emotional intelligence and project management competencies

The emotional intelligence plays key role for success of the project [15] and positively affects the ability of the project manager to organise and coordinate project activities, motivate the team and manage conflicts [3], manage stakeholders [16], ensure smooth team collaboration [17]. In accordance to Obradovic et al. [19], the ability to control emotions shows project managers' maturity. Such competencies as empathy, transparent behaviour, self-confidence, leadership and ability to act, understand theirs strengths and weaknesses, to be able to recognise the emotions of other people, understand their needs and manage interpersonal relations significantly contribute to the project success [20] and enable to inspire the team and lead it towards a common goal [19].

Definition of emotional intelligence was made famous by Daniel Goleman in 1995. Emotional intelligence broadly understood as person abilities to communicate effectively due to the ability to understand people emotions and ability to react to their emotional condition [21]. According to Salovey [22] "Emotional intelligence is the ability to perceive emotions; to access and generate emotions so as to assist thought; to understand emotions and emotional knowledge, and to reflectively regulate emotions so as to promote emotional and intellectual growth." This ability is essential to survive in fast changing environment, be a leader in business environment. There are large number of competencies models that involves components of emotional intellect. EI models proposed by Mayer et al [23], Bar-On [24] and Goleman [4] are most popular and analyzed in scientific works and applied in practice. EI competencies as important elements of project managers' competencies models are mentioned in Kerzner [25] and Dzekonsky [26] works.

Kerzner [25] emphasized features of project managers such as initiative, leadership abilities, ambition, creativity, flexibility and adaptability, personal commitment, vision, creating trust, ability to persuade, effectiveness, ability to make decisions, ability to identify problems, ability to organize work to subordinates. Dzekonsky [26] developed a model of key competencies that are needed for construction project managers'. Project management competencies are divided in to four clusters and represents such groups of competencies: managerial skills, personality characteristics and interpersonal abilities, emotional intelligence characteristics and complementary elements of competency profile

Daniel Goleman who has elaborately researched on the concept identifies 5 elements such as. self-awareness, self-regulation, self-motivation, empathy, and social skills [4]. Bar-On [26] model reflects holistic approach. The model distinguishes five components of emotional intelligence: Personal abilities, Interpersonal communication, adaptability, Stress management and general mood. The model offered by Mayer et al [22] analyses four dimensions of emotional intelligence such as perception, assimilation, understanding, and regulation of emotions.

3. Methodology

Following this theoretical analysis, the methodology for development of emotional intelligence skills for women is created. The combination of quantitative and qualitative research approach was applied in to phases.

I phase: quantitative data research for the women emotional intelligence competency identification was collected via questionnaire, which was shared online. Bar-On [26] methodology was chosen as the core perspective of this research. The questionnaire was based The questionnaire was filled by project managers representing different fields such as information technology, engineering, education, energy, communication services, real estate, manufacturing and other in Lithuania. 31 project managers as experts were invited to complete questionnaires. Professional experience in project management was the main criteria for selection experts for research.

II phase: after identification, the key competencies of women in the area of project management the qualitative research design within the interview method was completed. The interview was completed in October – November 2019. The interview sample was fulfilled with 5 women in the field of project management. All interviewees were project management professionals working in the project management area for more than 5 years.

All interview was recorded and transcribed. The interview data were analysed by the 10th most meaningful emotional intelligence areas identified during quantitative research.

4. Results

I phase: quantitative data research. The expert research was conducted in order to explore the most frequent practice of applying emotional intelligence competencies in PM different situations. The questionnaire was spread to 31 expert who are working in project manager position for longer than 5 years. In order to reveal gender differences in applying PM practices both female and male completed the questionnaires. Female experts made up 58 percent of the sample. Approximately 30 percent of experts are certified professionals.

For experts' evaluation 39 statements representing different EI practices in PM were provided. the calculated Cronbach's Alpha for statements is 0,749, which is adequate for social science research, and indicates the internal consistence of questionnaire. The Kendal concordance test (parameter W) was processed in order to assess the homogeneity in experts' opinions regarding the statements.

Calculated Kendall's Coefficient of Concordance W is quite low (0.332) although significant with the probability of 99 percent (p (sig.) is 0.000), which is sufficient and it means that experts concede with the statements, although the agreement parameter is low.

The results show that the most important practices in PM for experts are presented in table 1.

II phase: qualitative research. Thus it was decided to take those practices and analyze in depth in interviewing experts. Interviewees were asked about the challenges of implementing competencies of emotional intelligence and how to overcome these challenges.

	Ranks	Mean Rank
1	When solving the problem, I analyse every option and then choose the best.	28,85
2	I am excited by the team s enthusiasm to achieve a common goal	28,6
3	It is important for me to maintain good relations with others	27,6
4	If necessary, I take the initiative myself	26,81
5	I am always ready to exploit the opportunities	26,15
6	I try to find solutions that are useful for all sides	26,13
7	I like my work	25,6
8	Most often, I hope that everything will end well, despite the episodic failures	24,61
9	If I saw a crying colleague, I would try to calm him immediately, even if it was very urgent at that time.	24,45
10	I give people feedback	24,26

Table 1. Key women project management emotional intelligence competences.

Analyse every option and then choose the best

Concerning the challenges of the analysis of every option and choosing the best one “lack of the time” (R1, R2, R3) was highlighted. As the best practice to deal with a time lack respondents R3 and R5 suggested to “develop decision-making skills and to use cost-effectiveness analysis”.

Encourage the team to achieve a common goal

The challenges regarding the team encouragement to achieve the goals are related with: “lack of trust” [R1], “lack of delegation” [R5, R3, R2], “lack of building collaboration” [R4, R5]. To overcome these challenges [R1] suggest establishing a “common goal by inviting everybody into the discussion and trying to create a common sense atmosphere” [R4]. [R3] encourage “to remind the team the value of working together towards a common goal”.

Maintain good relations with others

The challenge to have a good relationship are indicated by saying “I’m very busy” [R1], “I do not have anything to say” [R3], “I don’t want to bother you” [R4] mostly it relates to the “lack of self-confidence” [R5].

“Good working relationships can create more enjoyable work relations” [R4]. “Do not forget to emphasize or to show the effort in making other ideas real” [R1]. “Create a mutual respect atmosphere” [R2]. To maintain a good relationship with others “is important to get to know each other better and communicate honestly and professionally” [R5].

One of the best ways to maintain a good relation with others “is to let others know who you are” [R2].

Take the initiative

“The lack of self-confidence” [R1, R2, R3, R4, R5] is the key challenge of the possibility and trust to take an initiative.

It is not very easy to become self-confident. However, to gain more self-confidence project managers should “point the bad decisions rather than wait for the bad thing to happen” [R4]. To define “what it means to you to be proactive” [R1].

Exploit new opportunities

The process of finding new opportunities relates to the sense of the entrepreneurship [R5]. An entrepreneur should be a person despite obstacles, opposition, and failure to become a flagman of the project idea realization [R2]. The project manages should learn how to confront with unknown challenges, risks and learn from failures [R4]. The process of finding new opportunities could be related to a project manager’s capability to map the client/user or customer strategy and project results [R2].

Find solutions that are useful for all sides

There is no right or wrong answers [R2]. Everyone runs into obstacles along the way [R1]. Project manages should learn how to clarify the problem [R5], how to analyse the nature of the problem [R3] and how to find the solution [R4].

Like what are you doing

The most challenging to reflect on the questions: why are you here and what are you doing [R1]? The challenge is in line with the insights of new opportunities exploitation. As a good practice “project managers should create requirements for the project in user stories” [R3]. Also, the project manager should immerse in the output of project discovery and ask strategic questions about the user [R5]. The project manager could “write a statement of work” [R2] and “keep the project structure clear for documents” [R3].

Hope that everything will end well, despite the episodic failures

Project management is a complex game to play in. In the project management “an optimistic project manager performs better” [R1]. The project manager “should learn how to deal with failures” [R4] and at the same moment “how to stay motivated with your team and project results” [R2].

To gain empathy (to calm down your colleague; understand the feelings of other people)

Empathy means the ability to understand and share the feelings and experiences of another person. Empathy is very important for a project manager. It helps the project manager to “understand the level of competence required for project task completion" [R2]. Empathy helps to "share the responsibility" [R4], and it helps to adjust to your level of responsibility in terms of delegating duties [R1].

Give feedback

The feedback procedure of the project manager faces with a project's manager "*lack of a culture of communication*" [R2]. Another reason for a lack of project management practices on giving feedback relates to a "*comfortability*" [R1]. If project managers do not feel comfortable with one another, projects could have problems. Sometimes the project managers "do not to value communication" [R3].

The recommendation for the project manager relates to the simple rules. Project managers should be positive and "*focus on the project expert body language" when giving feedback"* [R1]. The project manager should "*be specific and not only criticize*" [R4] and always "*consider what are you going to say*" [R5].

5. Conclusions

The research was dedicated to indicate the importance of women emotional intelligence in the project management area. Though, significant gender differences were not find out. More investigation is needed mainly to wider the sample of experts in order to get significant results. This research was conducted in Lithuania, however international perspective would improve the results of research.

Mostly all emotional intelligence competences related to the feelings, encouragement and taking care of the project management team. At the same time the sense to common idea or goal is the key driver of women emotional intelligence in the project management.

In terms of the women emotional intelligence challenges, the dominant perspectives how to overcome challenges of women emotional intelligence competences are related to the knowledge and practice of a different methods in order to have an appropriate solution for different situations.

References

[1] KPMG, AIPM and IPMA Project Management Survey 2019 report. The future of project management: Global outlook 2019. https://www.ipma.world/assets/PM-Survey-FullReport-2019-FINAL.pdf

[2] A. Cerezo-Narvaez, et al., Development of professional competences for industry 4.0 project management, *7th IESM Conference, October* 11 – 13, 2017, Saarbrücken, Germany

[3] D. Lindebaum, & P. J. Jordan, Relevant but exaggerated: the effects of emotional intelligence on project manager performance in construction, *Construction Management and Economics*, 30(7), 2012, pp. 575-583.

[4] D. Goleman. Emotional intelligence Bantam Books, New York, 1995.

[5] A. L. Day,& S. A. Carroll, Using an ability-based measure of emotional intelligence to predict individual performance, group performance, and group citizenship behaviours, *Personality and Individual differences,* 36(6), 2004, pp. 443-1458.

[6] K.Kafetsios, Attachment and emotional intelligence abilities across the life course, *Personality and individual Differences*, 37(1), 2004, pp. 129-145.

[7] B. R. Palmer, et al., A psychometric evaluation of the Mayer–Salovey–Caruso emotional intelligence test version 2.0. *Intelligence*, 33(3), 2005, pp. 285-305.

[8] P.Fernández-Berrocal, R. Cabello, R. Castillo, & N.Extremera, Gender differences in emotional intelligence: The mediating effect of age, *Psicología Conductual*, 20(1), 2012, pp. 77.

[9] R. Y. Sunindijo, B. H.Hadikusumo & S. Ogunlana, Emotional intelligence and leadership styles in construction project management. *Journal of management in engineering*, 23(4), 2007, pp.166-170.

[10] N. Clarke, Emotional intelligence and its relationship to transformational leadership and key project manager competences, *Project Management Journal,* 41(2), 2010, pp. 5-20.

[11] Rodríguez et.al,, Gender influence in project management: analysis of a case study based on master students, *Procedia Computer Science*, 121, 2017, pp. 461–468

[12] J. Varga, Á.Csiszárik-Kocsir, Women in the project management. *Project Management Development–Practice and Perspectives*, 2017, pp. 355.

[13] APM Salary and Market Trends Survey 2019. https://www.apm.org.uk/media/33475/apm_salary_and_market_trends_survey_2019.pdf

[14] OECD study (2012). Gender Publication - Closing the Gender Gap: Act Now.

[15] G. Ranjitha Bernice, A Umesh Samuel Jebaseelan, Emotional Intelligence – Women Entrepreneurs' Secret Weapon – A Conceptual Study, *Research on Humanities and Social Sciences*, Vol.7, No.17, 2017 – Special Issue

[16] A. Rezvani, A. Chang, A.Wiewiora, N. M. Ashkanasy, P. J. Jordan, & R. Zolin, Manager emotional intelligence and project success: The mediating role of job satisfaction and trust, *International Journal of Project Management*, 34(7), 2016, pp. 1112-1122.

[17] A.K.Mazur, A.Pisarski, A.Chang, N. Ashkanasy,. Rating defense mega-project success: the role of personal attributes and stakeholder relationships, *Internaional Journal of Project management*, 2014.

[18] J. Vierimaa, Emotional Intelligence and Project Leadership, Unpublished MA Thesis. Göteborg, Sweden: Chalmers University of Technology, 2013.

[19] V. Obradovic, P.Jovanovic, D. Petrovic, M. Mihic, Z. Mitrovic,. Project managers' emotional

intelligence–a ticket to success, *Procedia-Social and Behavioral Sciences*, 74, 2013, pp. 274-284.

[20] S. Hobbs, H.Smyth, Emotional intelligence in engineering project teams. *In Proceedings of the CIB Research to Practice Conference*, 2012, June.

[21] S. P. Derevyanko, The role of emotional intelligence in the process of social-psychological adaptation of students, *Innovative education technologies*, 1, 2007, pp. 92-95.

[22] P. Salovey, J. D. Mayer, D. Caruso, P. N. Lopes, Measuring emotional intelligence as a set of abilities with the Mayer-Salovey-Caruso Emotional Intelligence Test, 2003.

[23] D.Mayer, P. Salovey, D. Caruso, TARGET ARTICLES:" emotional Intelligence: theory, findings, and implications", *Psychological inquiry*, 15(3), 2004, pp.197-215.

[24] R. Bar-On, The Bar-On model of emotional-social intelligence (ESI). *Psicothema*, 18, 2006.

[25] H. Kerzner Project Management. 9th ed. New Jersey: John Wiley & Sons, 2005.

[26] K. Dziekoński, Project Managers' Competencies Model for Construction Industry in Poland, *Procedia Engineering*, 182, 2017, pp.74 – 181.

[27] T.Galvin, M.Gibbs, J.Sullivan, C.Williams, Leadership Competencies of Project Managers: An Empirical Study of Emotional, Intellectual, and Managerial Dimensions, *Journal of Economic Development, Management, I T, Finance, and Marketing*; Beverly Hills Vol. 6, Iss. 1, 2014, pp. 35-60.

Women project managers: a literature review

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Abstract: Literature presents project management as a male dominated profession, mainly due to the culture of traditional project-based industries such as construction. The purpose of this paper is to explore the state of the art on women working in the project management field, in order to understand the reasons why women are under-represented in this profession as well as know the challenges women face in this profession. Masculine project work practices, presenteeism and long working hours, as well as "filtering of personnel" in recruitment and promotion practices, appears as some of the most important barriers to keep women out of the profession.

Keywords: women project manager; gender perspective.

1. Introduction

Traditionally, occupations were gendered depending on the feminine or masculine skills considered to be required [1]. Nowadays, there are more legal and cultural mandates for gender equality in the workplace than ever before in history. But, after decades of efforts to create opportunities for women, inequity remains firmly established [2]. According to Eurostat [3], men generally occupy higher positions than women. For example, around a third (34 %) of managers in the EU in 2018 were women. Moreover, when comparing hourly earnings for different professions, in all groups of professions women earned less than men on average in the EU in 2014. The profession with the biggest differences in hourly earnings were managers (23% lower earnings for women than for men). Women in general management are not reaching higher positions, in the same way as women working in project management are not breaking into the role of project manager [4].

The main objective of this paper is to explore the state of the art on women working in the project management field, in order to understand the reasons why women are still under-represented in this profession.

2. Literature review

A bibliographic search was carried out in Scopus, a leading scientific database. "Project Management", "Women" and "Gender" were used as basic search words. The search words were applied to the titles, abstracts and keywords. In order to analyze the most homogeneous set of publications approved by a peer review system, only scientific articles were selected obtaining 191 documents. *Figure 1* shows the temporal distribution of the publications, which reveals a growing evolution from 1977 to 2019, similar to the evolution of project management literature, although "women/gender" represents only a 0,51% of these publications.

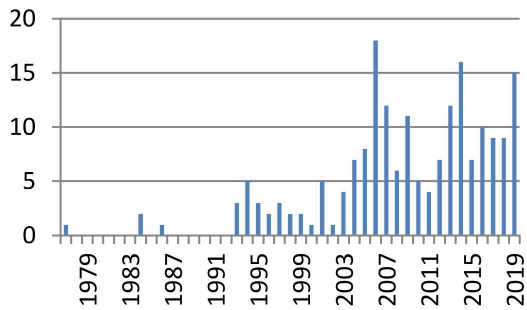

Figure 1. Articles on women, gender and project management.

Based on the group of articles identified, content analysis was used to assure that the articles address the topic of the research.

Topic	**Articles**	
Women project managers	60	31%
Study about project managers	45	24%
Women as project user/gender perspective	78	41%
Other	8	4%

Table 1. Classification of articles by topic.

41% of the articles study women as project users, sometimes analyzing the gender perspective of the project. 24% of the articles are studies about project managers where gender is one of the factors to analyze. And 31% of the articles address the topic of women working in project management field, which is the focus of this paper.

2.1. Project management: a male-dominated profession

The first articles on women project managers found were published in the middle 90s. According to [5], women encounter problems gaining entry and acceptance in the project environment because the culture of traditional project-based industries like construction, heavy engineering, process and petrochemical, power, utilities, transport and defense, is "masculine" in orientation. This is the reason why during the first months in an organization, females experience a cultural mismatch more acutely than males, involving higher levels of anxiety, that may be caused, according to the authors, by a lack of female role models and peer group support during the early socialization process. [6] identified socialization of the project environment as central to the topic of women in project management. Based on several previous studies, [5] emphasize that women who progress in organizations are those who learn to fit in, prove a hard-nosed business approach and are seen as having characteristics, attitudes and temperament more like men than women. Many women in male-dominated industries see themselves as in a strong position because they are fairly rare, ensuring that people will remember them, and so, some of them prefer not many women to join the same male-dominated firm because this would introduce too much competition.

Also in the mid 90s, several articles on women in project management working in information technologies and software development were published. Based on an empirical study with software professionals from German and Swiss projects, [7] showed that women were not under-represented among subteam leaders in software development but among team leaders. Besides, women in subteam and team leading positions experienced a less complex work situation than their male colleagues. The same idea was argued by [8] in her paper about sexism in the software industry workplace. This industry creates a differential in types of work, distinguishing between “pure” and “messy” jobs. Men seem to be gravitating towards the pure whereas women towards the messy. Some studies ([9]; [10]) developed in the undergraduate level were aimed at encouraging women to continue in the computer science curriculum and reinforcing women’s role in the computer science field. According to [9], many women in undergraduate and graduate school and industry feel a cold environment when working with a majority of men, so men and women have to learn to communicate professional and socially in order for both genders to feel comfortable in a working environment, and starting this process while they are in training should minimize the tension in the professional world.

More than 20 years after the publication of this firsts articles, [11] present their study about structural barriers to career progression and the gender role stereotyping women project managers experienced in construction and property development project-based organizations. They argue the normative isomorphism, understood as the process whereby individuals in corporate environments tend to think and behave in similar ways [12], may contribute to the reproduction of female underrepresentation in those organizations. The culture of constant availability, long working hours and presenteeism are limiting the career progression of women project managers who due to their family responsibilities are perceived as not meeting these expectations. In construction industry there are also gendered divisions in tasks. According to [13], female project managers are primarily found at headquarters or in special functions, such as environmental or quality positions, while only a few women work on constructions sites. Moreover, female project managers and team members are more likely to manage and work on smaller projects and dispersed project teams comprised of other women [4].

Long working hours (often unpaid) are also the most important barrier facing women in IT's workforce and can explain their scarcity, according to [14]. Authors demonstrate that project management in the IT sector, despite the claims of creative autonomy at work for skilled workers, actually set quite strict controls through the rhetoric of professionalism, which becomes a powerful device to rationalize, justify and promote unpaid overtime. In these conditions, anyone who asks to work different hours, to work at home or who asks for any other measures to balance work and family life is considered as less committed and therefore less appropriate for a promotion, and these “ones” are more often women. As an end result, it is considered that women cannot meet the defined "professional" standards of project management.

Theoretical constructs	Associated terms
Masculine Field independent Separation from environment, others Performance orientation Active Linear-sequential Hierarchical authority Control over Analytical/impersonal problem solving Impersonal task focus	*Avoid, Categories, Closure, Conflict, Constrain, Control, Correct, Efficiency, Efficient, Execute, Expectation, Formalize, Get, Getting, Hierarchical, Hierarchy, Impose, Influence, Initiate, Logic, Manage, Measure, Organize, Outside, Perform, Plan, Risk (+Uncertain/ Threat/Unknown), Sequential, Structure, Technique, Template, Terminate, Tool, Uniform*
Feminine Field dependent/context sensitivity Connection to environment, others Improvisational Receptive/responsive Non-linear Lateral-democratic authority Shared power/Control with focus on situational and emotional gestalts Interpersonal relationships	*Affect, Care, Connect, Consider, Coordinate, Devote, Discover, Disseminate, Emerge, Estimate, Feedback, Generate, Informal, Lead, Link, Receive, Relate, Relationship, Respond, Response, Share, Unexpected, Unplanned*

Table 2. Work language associated with gender constructs (adapted from [12]*).*

2.2. Masculinity and femininity in project management isomorphism

As explain [15], the terms “sex” and “gender” are often confused. Sex is a biological type whereas gender is socially constructed and learned, so individuals may tend to be more male or female in a gendered sense. In this direction, [12] try to make visible the gendered discourse operating within the profession of project manager. With this objective, authors examined the PMBOK (2000 edition), which is considered as an important socialization document that identifies the ‘‘generally-accepted’’ body of project management knowledge. In this way, PMBOK is one of the isomorphic forces whereby individuals in the emerging project management profession tend to think and behave in highly similar ways. [12] show a table (Table 2) collecting a synthesis from literature on the gendered nature of work that identify terms and constructs associated with masculinity and femininity. Examining the symbolic language the PMBOK used to indicate ‘‘appropriate’’ project management behavior, it became evident that masculine modes of thought and action dominated the ‘‘best practice’’ recommended in this book while feminine logics were represented less often, i.e. bodies of knowledge tend to overemphasize masculine project management skills and underemphasize feminine skills [16]. This could explain why important feminine work activity such as team building and conflict resolution become “non-work” in highly technical, male dominated work environments [12]. However, project management profession is evolving from a discipline based on technology and control to a focus on interactions and learning, which appears to correlate with the increasing acceptance of feminine strengths. Besides, both men and women are capable of masculine- and feminine-gendered ways of knowing and behaving. Moreover, [16] argues that both feminine and masculine modes of behavior contribute importantly to the successful managing of projects. For example, successful project managers reported several feminine capacities that they used to address project risks, such as stakeholder analysis, information sharing, and monitoring the internal and external project environments.

2.3. Challenges for women in project management

Literature review shows several aspects that can be considered as challenges for women working in project management, starting with the selection process for a project manager job. The research developed by [17] shows that female project manager candidates were viewed as less competent and less likely to be hired compared to their male counterparts, but only when perceived technical skills are low. When women are able to demonstrate task-specific or task-related expertise, many gender biases tend to disappear.

Once in the workplace, according to [11], the barriers facing women in construction and property development project-based organizations include:

- masculine project work practices;
- limited access to flexible work practices, what causes many women to have to take a reduction in their status into office-based and administrative roles, and abandon their career advancement when returning from maternity leave;
- presenteeism: long working hours and organizational expectations for total work commitment;
- reliance on career self-management, with limited career planning and restricted access to social networks;
- and “filtering of personnel” in recruitment and promotion practices, to exclude those who are different or need different work practices.

Regarding masculine project work practices, [13] explain that, as a consequence to being a woman, negotiations and discussions with sub-contractors in a male-dominated work environment may suppose handle with discriminatory expressions. To be accepted in this masculine context, a woman project manager must balance doing entrepreneurial masculinity well and finding ways to do it differently. Beyond managing complex projects, women face the added challenges of having to prove their credibility many times over and in multiple ways or to disconfirm negative stereotypes about their authority [4].

On the other hand, regarding to presenteeism, [14] claims that a logic causing a serious impact on women is present in the projectified workplaces:

- Women, more than men, want to limit their working hours, often in order to take care of their children.
- But working hours and presenteeism are considered indicators of job commitment.
- And commitment is an important factor in promotion.

Nevertheless, some authors (such as [13]) suggest that there could be opportunities in entrepreneurial organizations to do gender well and to do it differently in multiple ways, for example, questioning the traditional masculine culture in the construction industry and complain that long working hours are unacceptable for parents with small children.

Regarding women access to social networks, their marginalization reduces the avenues available for effective socialization, which is critical in the development of social capital [4]. As a woman, she is an outsider in relation to the informal power networks that are apparent in the management of the infrastructure project. This position limits her possibilities with respect to performing her work, and therefore, she must constantly make plans and determine how to maneuver in this masculine territory [13].

3. Conclusions

This literature review offers a first important conclusion that is the lack of published research on women in project management. In spite of the low female representation and slow progression of women to leadership roles in project-based organizations, limited studies exist considering those issues [11]. Although literature presents project management as a male dominated profession, mainly due to the culture of traditional project-based industries, the expansion to other

types of industry such as health, education, etc should open the profession to more and more women.
Several studies on isomorphism had shown that both masculinity and femininity are presently – and appropriately – part of the reality of the project management profession [16], and competent project management practice is evolving and expanding to include both soft (feminine) and hard (masculine) skills. As this profession evolves, scholars are noting a shift from a discipline based on technology and control to a focus on interactions and learning. This trend towards accepting the ''softer'' side of project management appears to correlate with the increasing acceptance of feminine strengths legitimized [12].

However, the continued absence of women from project management teams means that the variety of approaches to the project management process is limited and the pool of project management talent half what it could be [6], losing important feminine work practices such as teamwork, absence of hierarchies and collaboration.

Masculine project work practices, presenteeism and long working hours, as well as "filtering of personnel" in recruitment and promotion practices, appears as some of the most important barriers to keep women out of the profession. Traditional gendered patterns are reproduced in the projectified workplace, where the ideal worker still appears to be a young man fully dedicated to his job [14]. Therefore, women are thus excluded from the "projectification" of society, with its highly paid, prestigious jobs. While men play the card of flexibility and consent to unpaid overtime, they reinforce the professional norms of project management; women unwilling to work overtime do not achieve a high score in the evaluation of commitment and tend to abandon in higher proportion [14].

References

[1] R. Vázquez-Carrasco, M. E. López-Pérez, and E. Centeno, "A qualitative approach to the challenges for women in management: Are they really starting in the 21st century?," *Qual. Quant.*, vol. 46, no. 5, pp. 1337–1357, 2012.

[2] N. M. Carter and C. Silva, "Women in management: Delusions of progress," *Harvard Business Review*, 2010. [Online]. Available: https://hbr.org/2010/03/women-in-management-delusions-of-progress. [Accessed: 28-Dec-2019].

[3] Eurostat, "Gender pay gap: How much less do women earn than men?" [Online]. Available: https://ec.europa.eu/eurostat/cache/infographs/womenmen/bloc-2d.html?lang=en. [Accessed: 28-Dec-2019].

[4] L. S. Henderson, R. W. Stackman, and C. Y. Koh, "Women project managers: the exploration of their job challenges and issue selling behaviors," *Int. J. Manag. Proj. Bus.*, vol. 6, no. 4, pp. 761–791, 2013.

[5] A. Gale and S. Cartwright, "Women in project management: entry into a male domain?," *Leadersh. Organ. Dev. J.*, vol. 16, no. 2, pp. 3–8, 1995.

[6] S. Cartwright, A. Gale, and S. Cartwright, "Project management: different gender, different culture?," *Leadersh. Organ. Dev. J.*, vol. 16, no. 4, pp. 3–8, 1995.

[7] S. Sonnentag, "Team leading in software development: a comparison between women and men," *IFIP Trans. A Comput. Sci. Technol.*, no. A-57, pp. 379–391, 1994.

[8] F. Grundy, "Women in the computing workplace: some impressions," *IFIP Trans. A Comput. Sci. Technol.*, no. A-57, pp. 349–363, 1994.

[9] J. A. Polack-Wahl, "Group projects: woman and men can work together in the computer science realm," *Int. Symp. Technol. Soc.*, pp. 245–248, 1999.

[10] D. R. Bernstein, "Computing, diversity and community: Fostering the computing culture," *SIGCSE Bull. (Association Comput. Mach. Spec. Interes. Gr. Comput. Sci. Educ.*, vol. 29, no. 1, pp. 101–105, 1997.

[11] M. Baker and E. French, "Female underrepresentation in project-based organizations exposes organizational isomorphism," *Equal. Divers. Incl.*, vol. 37, no. 8, pp. 799–812, 2018.

[12] P. Buckle and J. Thomas, "Deconstructing project management: A gender analysis of project management guidelines," *Int. J. Proj. Manag.*, vol. 21, no. 6, pp. 433–441, 2003.

[13] G. Olofsdotter and L. Randevåg, "Doing masculinities in construction project management: 'We understand each other, but she…,'" *Gend. Manag.*, vol. 31, no. 2, pp. 134–153, 2016.

[14] M. J. Legault and S. Chasserio, "Professionalization, risk transfer, and the effect on gender gap in project management," *Int. J. Proj. Manag.*, vol. 30, no. 6, pp. 697–707, 2012.

[15] S. Cartwright and A. Gale, "Project management: different gender, different culture?," *Leadersh. Organ. Dev. J.*, vol. 16, no. 4, pp. 12–16, 1995.

[16] J. L. Thomas and P. Buckle-Henning, "Dancing in the white spaces: Exploring gendered assumptions in successful project managers' discourse about their work," *Int. J. Proj. Manag.*, vol. 25, no. 6, pp. 552–559, 2007.

[17] J. K. Pinto, P. Patanakul, and M. B. Pinto, "'The aura of capability': Gender bias in selection for a project manager job," *Int. J. Proj. Manag.*, vol. 35, no. 3, pp. 420–431, 2017.

Mono, mixed or multiple strategy approach: a descriptive study of the latest published articles in the International Journal of Project Management

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Abstract:

To develop a valid and credible research project, it is essential to define in detail the *research design*. It will have a meaningful strategy to answer the research question. While some researchers suggest that there might be some benefits in adopting multiple and mixed strategy approach for conducting the research, some tend to stick to mono-methods. This article tackles a descriptive study that identifies the research strategies followed by top ranked researches, by reviewing the last two years of publications of the International Journal of Project Management, the leading journal for the field of project management and organization studies. The results suggest that most researchers stick to mono-methods, predominantly with qualitative techniques. Also, there is a higher trend to use case study strategies in the field.

Keywords: research strategies, mono-strategy, mixed-strategy, multiple-strategy

1. Introduction

In research projects, it is key to develop a design of the research according to the objectives of the search. The research design is the detailed plan of how the researcher is going to answer the research question(s). It involves some considerations like how to collect the data, from which source will be collected, how it will be analysed and, of course, to take into account the barriers and constraints one may find in all steps. That is why it is important to consider research strategies, options and time horizons as a whole [1-4].

To understand the nature of this article it is necessary to note the difference between design and tactics. The former is concerned with the overall plan for your research; the latter is about the finer detail of data collection and analysis [5]. This article focuses on the design rather than the tactics, with a spotlight in the strategies followed by researchers.

The main research strategies identified by Saunders et al.'s are experiment, survey, case study, action research, grounded theory, ethnography and archive research. They can be used in combination in the same research project to provide better opportunities to answer research questions.

In this context, the research design process is an area of vital importance and interest to researchers responsible for delivering meaningful outcomes to their studies. Therefore, this paper aims to investigate used research strategies in project management, considering the following research questions:

1) Which strategies do project management researchers apply mostly in their studies?
2) Do project management researchers use mono-strategy approach or do they use multiple or mixed strategies?

Therefore, we present the results of a systematic literature review of the strategies followed by project management researchers by evaluating all published papers from 2018 and 2019 in the International Journal of Project Management (IJPM), the leading journal for the field of project management and organization studies. After analysing these articles, we also discuss directions for future research [6, 7].

The paper is structured as follows: Section 2 describes the methodology, and undertakes a categorization of the research strategies. Section 3 presents the results of evaluating the material. Finally, Section 5 presents the conclusions and indicates future directions of the study.

2. Research Method

The systematic literature review has been used so as to offer an overview of the current understanding of the research topic under study [8, 9]. A systematic literature review identifies, selects and critically appraises research in order to answer a clearly formulated question [10-12]. The review builds on a method that follows three steps: material collection, category selection and material evaluation.

The material collection component is described in Section 2.1. A discussion on how the categories were selected is offered in Section 2.2, while the material is evaluated in Section 3.

2.1. Material Collection

Considering the nature of the study, it was decided to base the research on the leading journal on project and organizational management issues, the International Journal of Project Management. This Journal has an Impact Factor of 4.694 and a citation score of 6.1 in the year 2018, therefore, it is assumed that this journal publishes the best rated and more relevant articles in the field.

For this purpose, the material of all the issues published by the journal from 2018 to 2019 was collected. The search resulted in 163 articles, which were filtered to 127 excluding corrigendum or erratum articles, editorial boards, and a special issue from 2018 dedicated to essays in honour of J. Rodney Turner researcher's work.

2.2. Category selection

As mentioned in the Introduction, the objective of this paper is to identify what criteria and strategies are the most widely used ones in project management environments. There is a wide variety research strategies one may employ, therefore, by following Saunders et al.'s (2007) research strategies categorization, papers were classified into seven categories: experiment, survey, case study, action research, grounded theory, ethnography and archive research [13]. A brief description of the type of criteria to classify into each of the categories is given hereafter (see *Figure 1*).

3. Results or material evaluation

Once the material has been collected, a systematic analysis of the content has been carried out. In order to do this, the following steps have been taken. First, a matrix table has been generated indicating the main research strategies and the articles under study.

Then, each of the articles have been analysed by reading the sections referring to the research design, research method, methodology or data collection and analysis. Next, the articles have been classified into one or more of the categories mentioned in the previous section.

The results of the Systematic Literature Review are presented in the following topics: (1) identification of the used strategies, (2) analysis of the use of multiple and mixed strategies, (3) the combination of used strategies.

3.1 Identification of the used strategies

From the 127 articles that were analysed, a total of 161 main strategies were identified (see *Figure 2*).

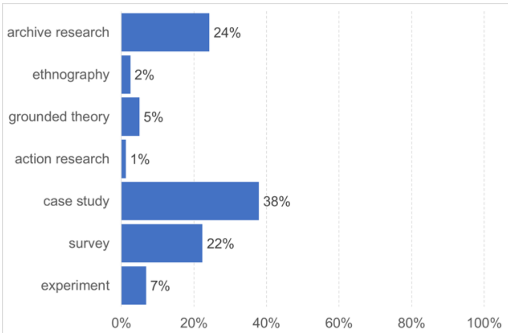

Figure 2: Distribution of the research strategies used in the IJPM in 2018 and 2019

Research strategy	Description
Experiment	Experiment is a classical research where the researcher manipulates one variable, and control/randomizes the rest of the variables. It has a control group, and the researcher only tests one effect at a time. In this case, also the strategies that involve the selection of a sample and the study of the effect of interaction to a certain process, model or any other experimental approach that can lead to useful insights are included.
Survey	Survey research is a quantitative approach that features the use of self-report measures on selected samples. It is a flexible approach that can be used to study a wide variety of basic and applied research questions. Articles that mention using a survey strategy are included in this category.
Case Study	Robson (2011) defines case study as 'a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real-life context using multiple sources of evidence'. Articles that mention using a single or a multiple case study approach are included in this category.
Action research	Action research involves actively participating in a change situation, often via an existing organization, whilst simultaneously conducting research. Only articles that claimed to be applying action research are included in this category.
Grounded theory	Grounded theory is a research method concerned with the generation of theory, which is 'grounded' in data that has been systematically collected and analysed. In grounded theory, data collection starts without the formation of an initial theoretical framework. Theory is developed from data generated by a series of observations.
Ethnography	Ethnographic research is a qualitative method where researchers observe and/or interact with a study's participants in their real-life environment. Articles that mention using ethnography approach or that imply a long-term observation are included in this category.
Archival research	Archival research, makes use of administrative records and documents as the principal source of data. Literature reviews and other use of documentation as the main source of information are included in this category.

The case study approach is the predominant strategy used by the published researchers with a representation of the 38%. Followed by a 24% and 22% of the archive research and survey, respectively. The less used strategies are the action research which has been identified in only 2 articles as the main research strategy and ethnography strategy with 4 articles.

The fact that ethnography and action research strategies are not so widely used is not related to their effectiveness. They are very useful strategies when the researcher has a very high time horizon and accessibility to the field of study, which is not usual due to lack of resources.

3.2 Analysis of the use of strategy approach

Taking into account the categorization of the strategies mentioned in Section 2.2, and their main qualitative or quantitative approach, a second analysis was undertaken. Depending on the use on mono-strategy when only one strategy was used, mixed strategy when mainly qualitative and quantitative strategies were used, or multi-strategy when more than one mainly qualitative strategies or more than one mainly quantitative strategies are used. It is important to note that some of the strategies, might have qualitative and quantitative approaches within them, like in the case study, but at this stage only the main categorization was taken under consideration.

As shown in **Figure 3**, from the 127 articles, 96 were identified as mono-strategy, 19 as multi-strategy and 12 as mixed-strategy. This indicates that researchers on the field stick to a mono strategy approach.

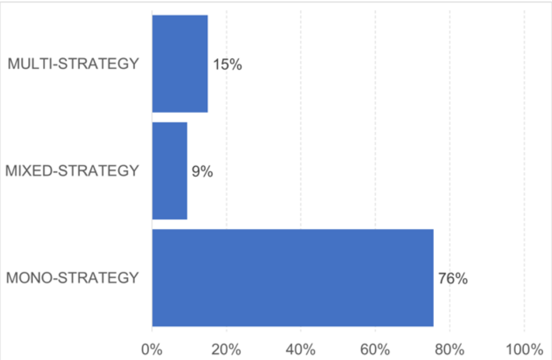

Figure 3: Distribution of the articles depending on the combination of strategies

Even though the mono-strategy is the most widely used, certainly, articles were identified that use mixed or multiple methods of data collection and analysis, like interviews and questionnaires in a different stages of a case study.

3.3 Analysis of the combination of strategies

An analysis of the types of strategies used in the different strategy approaches was conducted.

In *Figure 4* we can see the distribution of the strategies when tackling a mono-strategic approach. Here, case studies, archive research and surveys are main strategies tackled.

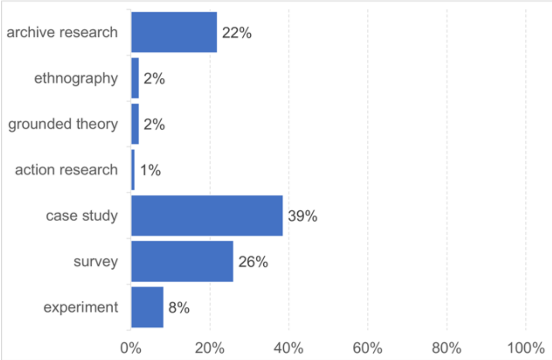

Figure 4: Distribution of the strategies when using mono-strategy approach

The case study strategy has been the most used because of its accessibility and as it is usually more relevant for the parties involved due to the direct observation of the entities engaged.

Figure 5 shows the combination of strategies used in the mixed-strategy approach. In the 50% of the cases, surveys have been accompanied by case studies as main strategies in the research project. In addition, 25% of the analysed articles, surveys are complemented with archive research.

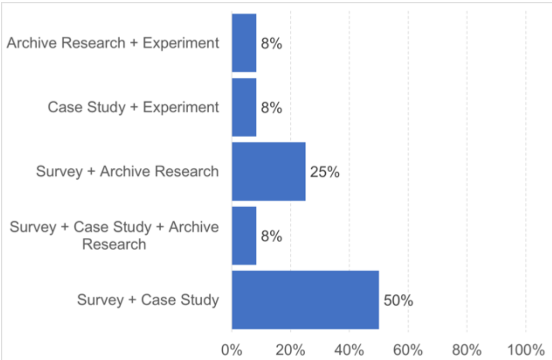

Figure 5: Distribution of the strategies when using mixed-strategy approach

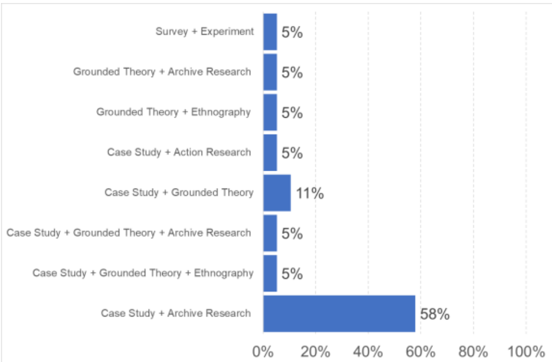

Figure 6: Distribution of the strategies when using multiple-strategy approach

Likewise, *Figure 6* shows the combination of strategies used in the multi-strategy approach. In the 58% of the cases, case studies are reinforced with an archive research strategy, for example, when a case study is preceded by a in depth documentation of the situation and context. The rest of the cases are residual and alternative.

Both *Figure 4* and *Figure 5*, shows that the case study is the most widely used because of the versatility and complementarity it gives to other types of strategies, specially archive research. They require an in depth analysis of the documentation of the case under study, like companies results, historical data, situation and other relevant data to the project.

4. Conclusions and further studies

Since the research design is critical for the success of the research project, the decision of the chosen strategy is very influential. The choice of research strategy is not only guided by research objectives, but to the extent of existing knowledge, the amount of time and available resources.

Thus, this paper leads to a further investigation on the criteria and strategies to select and evaluate research strategies. In this context, a literature review was undertaken, covering publications from 2018 and 2019 in the IJPM.

This paper has contributed to the literature by integrating knowledge from strategy selection and strategy approach in project management.

The results from this study provide insights to explore the issues raised here. These observations show some opportunities for future research.

First, a deeper analysis of the qualitative and quantitative nature of the methods used in each strategy of the analysed research projects is needed. Additionally, a broader analysis in terms of number of articles or sources could be tackled. By exploring in the methods of research, it would be possible to identify their relationship with specific cases of application, or disruptive or innovative techniques that would allow the acquisition of knowledge that would not be possible otherwise.

Moreover, a comparison of the mono, multi and mixed methods, with the relevance of the paper could be dealt in order to understand if the use of one or another approach is more valuable.

Finally, it would be useful to conduct exploratory studies on the perception of the importance of the strategy approach for the researchers on the field.

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References

[1] J. Söderlund, "Building theories of project management: past research, questions for the future," *International journal of project management,* vol. 22, no. 3, pp. 183-191, 2004.

[2] O. Bentahar, and R. Cameron, "Design and Implementation of a Mixed Method Research Study in Project Management," *Electronic Journal of Business Research Methods,* vol. 13, no. 1, 2015.

[3] D. J. Bryde, "Project management concepts, methods and application," *International Journal of Operations & Production Management,* vol. 23, no. 7, pp. 775-793, 2003.

[4] J. R. López-Robles, J. R. Otegi-Olaso, H. Robles-Berumen, H. Gamboa-Rosales, A. Gamboa-Rosales, and N. K. Gamboa-Rosales, "Visualizing and mapping the project management research areas within the International Journal of Project Management: A bibliometric analysis from 1983 to 2018," in Research and Education in Project Management - REPM 2019, Bilbao (Spain), 2019.

[5] M. Saunders, P. Lewis, and A. Thornhill, "Research methods," *Business Students*, 2007.

[6] J. R. López-Robles, J. R. Otegi-Olaso, and I. Porto-Gómez, "Bibliometric analysis of worldwide scientific literature in Project Management Techniques and Tools over the past 50 years: 1967-2017," *Research and Education in Project Management (Bilbao, 2018)*, pp. 49, 2018.

[7] J. R. Otegi-Olaso, J. R. López-Robles, and N. K. Gamboa-Rosales, "Responsible Project Management to face urgent world crisis and regional conflicts," in Birzeit University - Project Management, Birzeit, Palestine, 2019.

[8] M. Sartor, G. Orzes, G. Nassimbeni, F. Jia, and R. Lamming, "International purchasing offices: Literature review and research directions," *Journal of Purchasing and Supply Management,* vol. 20, no. 1, pp. 1-17, 2014.

[9] A. T. de Almeida, J. A. de Almeida, A. P. C. S. Costa, and A. T. de Almeida-Filho, "A new method for elicitation of criteria weights in additive models: Flexible and interactive tradeoff," *European Journal of Operational Research,* vol. 250, no. 1, pp. 179-191, 2016.

[10] A. Dewey, and A. Drahota, "Introduction to Systematic Reviews: Online Learning Module Cochrane Training," 2016.

[11] J. R. López-Robles, J. R. Otegi-Olaso, I. Porto-Gómez, and M. J. Cobo, "30 years of intelligence models in management and

business: A bibliometric review," *International Journal of Information Management,* vol. 48, pp. 22-38, 2019.

[12] J. R. López-Robles, J. R. Otegi-Olaso, I. Porto-Gómez, N. K. Gamboa-Rosales, H. Gamboa-Rosales, and H. Robles-Berumen, "Bibliometric Network Analysis to Identify the Intellectual Structure and Evolution of the Big Data Research Field." pp. 113-120.

[13] C. Robson, *Real world research*: Wiley Chichester, 2011.

Building Cooperation between Innovation Clusters Based on Competences Requirements. Case of CFAA and ruhrvalley

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Abstract: The paper presents results of the joint research between CFAA (Spain) and ruhrvalley (Germany) innovation clusters regarding the competence profiles description based on the demands of R&D projects. Both research bodies are based on the triple helix model involving participation of higher education institutions: CFAA is the part of the University of the Basque Country (UPV/EHU), and Dortmund university of Applied Sciences and Arts (FH Dortmund) and Westphalian University are ones of partner universities involved in ruhrvalley project. Research lines of these innovation clusters have different focuses but several elements in common. A current cooperation between those innovation ecosystems works on the level of universities mostly thanks to the funding possibilities to support mobility activities of master and PhD students. Considering previous experiences with exchange students, further it will be reflected how this cooperation can be improved and extended on the level of involved innovation clusters. Analysis of semi-structured interviews with researchers and managers of research bodies will contribute to description of competence profiles required to work on joint R&D projects.

Keywords: competence; innovation cluster; research collaboration; triple helix model

1. Introduction

Innovation clusters CFAA (Aeronautics Advanced Manufacturing Centre) and ruhrvalley are located in the Basque country of Spain and in the Ruhr region of Germany, respectively. Both innovation ecosystems are formed by a triple helix model, which involves a balanced intersection of academia, industry, and state, to create the best environment for innovation in a knowledge society [1]. Namely, ruhrvalley cluster is formed by three large universities of applied sciences, seven of their research institutes, spin off companies and associated project partners [2]. The innovation cluster ruhrvalley covers the research areas of electro-mobility, energy system technology and geothermal energy, information and communication technology, IT security and all areas of economic and social sciences and applied innovation research. CFAA is a research centre within the University of the Basque Country (UPV/EHU) and a consortium of companies, with the aim to deliver final applications and to generate new know-how in advanced manufacturing technologies [3]. Both research bodies if cooperated, could improve innovation processes by enhancing the "collaborative" sum of capabilities that none of the participants had before. One of these capabilities is competence capacity of researchers.

In order to sustainably strengthen the research priorities at universities and the development activities of SMEs within the ruhrvalley network, a structured concept for human resource development is planned to be developed and implemented. This intends to provide scientific support for personnel qualifications in the partner companies, especially for start-ups and spin-offs. At the same time, efforts are being made to increase staff qualifications in the research institutes (including project management, social skills). Transfer via heads will revitalize teaching and provide universities with attractive offers for graduates and doctoral candidates.

Previously, four master students from FH Dortmund have already accomplished their internships and research stays on the base of CFAA, what was possible due to existing agreements between UPV/EHU and Dortmund university of Applied Sciences and Arts (FH Dortmund). Two of these master students had a background in applied mathematics and industrial engineering, what helped to contribute significantly to research in evaluation of success factors of R&D projects. Other two master students were experienced in quality management and mechanical engineering subjects.

As the outcome, five research papers were delivered and accepted for further publication, as well as three project theses were developed on the next topics:
- new methodology for R&D and innovation project management,
- decision making based on qualitative data,
- evaluation of the maturity of the planning processes related to the scheduling and estimation of the projects in the context of multi-project management.

For the CFAA, the exchange of ideas, different approaches to research problems solving, high quality of the results obtained, the knowledge

acquired, and cultural exchange are seen as valuable inputs to pursue sustainable outcomes of that collaborative research work.
Based on previous experiences with the exchange students, semi-structured interviews with the manager, coordinator of research projects and technicians / researchers of CFAA, and coordinator of ruhrvalley will highlight which competences are required to collaborate on joint R&D projects.

2. Research Methodology

In the current research, we applied a bottom-up research strategy to reflect the collective view towards individual competences [4]. Technicians and researchers at CFAA were interviewed regarding one of three specific technologies, for which they were responsible (group 1). Those three technologies are: additive manufacturing, advanced machining of integral rotary components, and validation of digital X-ray technology for aeronautical components. Interviewees of this group presented an experience within CFAA as of one till three years, and in similar positions – between one and 1eleven years.

Coordinator of research projects in all three domains was asked to provide the overview of the required skills for working on projects (group 2). Experience of this group counts three years at CFAA, and thirteen years in similar positions.

Further, the manager of CFAA and coordinator of ruhrvalley provided their expert opinions (group 3) as an overview of demanded competences including those required to manage R&D projects. Manager of CFAA has five years of experience in the actual position and more than ten years in similar positions, whereas the ruhrvalley' coordinator's experience counts for two years in experience in the actual position and more than six years – in similar. An overview of research methodology is presented in the *Figure 1*.

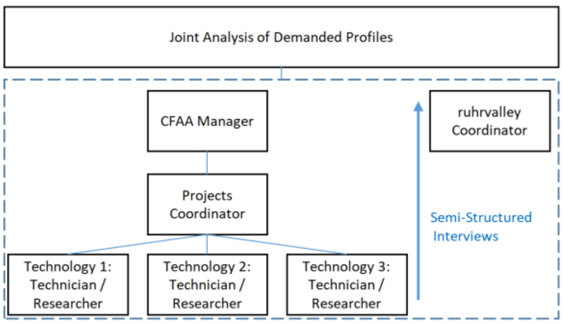

Figure 1. Research methodology.

Moreover, with the help of literature research next questions attempt to be replied:
- what is meant by collaborative competences on organizational and individual levels?
- which competences will be required for future engineers in general and, particularly, to work with mentioned above technologies?

3. Literature Research

3.1. Competences to Collaborate

In 1998, [5] identified three types of competences: common, complementary, and collaborative, which is required to collaborate between organisations. [6] proposed that a collaborative advantage could be achieved through linked competencies, which help to build and maintain "network-based intellectual, human, social, political, and cultural capital". These competencies considered on the level of organization authors categorize as distinctive (difficult to be replicated by competitors), core (crucial to company's success), and core distinctive (important for reaching stated goals and long-term company's success).

On the level of individual competencies, [7] identifies twelve collaborative competencies which then form a competency model of effective executive collaborators. The scholar claims that the most critical collaboration factor is interpersonal understanding "which only comes through time and experience" [7, p. 118].

Since we consider prospective cooperation, it is interesting to highlight competences required for future engineers. It is claimed by [8] that for being competitive, tomorrow graduates would need to demonstrate technical, professional and global competences (*Figure 2*).

Adapted from Y. Chang, D. Atkinson, and E.D. Hirleman, "International Research and Engineering Education: Impacts and Best Practices," *Online Journal for Engineering Global Education*, Vol. 4, Issue 2, 2009.

Figure 2. The 3-D engineering professional [8].

Moreover, [9] provides next attributes of the global competence:
- exhibit a global mindset,
- appreciate and understand different cultures,
- demonstrate world and local knowledge,
- communicate cross-culturally,
- speak more than one language including English,
- understand international business, law, and technical elements,
- live and work in a transnational engineering environment,
- work in international teams.

3.2. Technologies Description

Additive Manufacturing (AM) is a technology that allows manufacturing of physical components from virtual 3D computer models, with a different range of materials in a layer-by-layer approach, until the part is complete [10]. The thickness of the layer depends on the technology used or the aim of the piece, with more thickness, better surface quality can be achieved. One of the most important technologies of AM is a Selective Laser Melting (SLM), which uses laser as a power source to sinter powdered metals for producing solid structures. The application in aerospace industry is being tested due to the needs of reducing fuel consumption and emission of CO2 and NOx, and manufacturing of light weight components for engines and structural parts of aircrafts [11].

Advanced machining of integral rotary components is an important step in production, which is needed to achieve the final shape of the piece; through it, demanded dimensional and surface tolerances can be obtained. It is a complex process, which can be reached through a correct combination of right machining processes, cutting tools and conditions, and the machine tool that will facilitate the high speed needed to machining a difficult-to-cut rotary components of aero-engines [12]. Mainly, three advanced machining processes are: thermoelectric, mechanical, and electrochemical or chemical machining. None of these processes is the best under all machining situations, hence, the selection of the proper process becomes very important [13].

X-ray industrial computed tomography (CT) is the method of using X-ray radiation to take a number of 2D images of an object in different positions around a rotation axis. Next, a 3D model of the object's external as well as internal structure is reconstructed and can be analysed trough a proper software. This allows detecting flaws such as voids and cracks, and particular analysis in materials. So far, this is the only technology able to represent visually the inner and the outer geometry of a component without the need to cut it through. Over the past decade, CT has become the only technology for industrial quality control of work pieces having non-accessible internal features or multi-material components [14].

4. Results and Discussion

Conducted interviews highlighted the next elements in common. The whole group 1 stated that they require only those skills, which are needed to work with one of three technologies mentioned. Based on the framework proposed by [8] these skills will build technical competence domain.

The coordinator of projects at CFAA (group 2) provided a list of required competences, which are:
- knowledge of technology fundamentals,
- basic knowledge of manufacturing processes,
- computer-assisted design skills,
- R&D and innovation project management,
- social skills,
- critical and creative thinking.

The manager of CFAA grouped required competences as:
- effective communication skills and teamwork,
- planning, organisation and leadership skills,
- problem solving and usability engineering,
- ability to work in multicultural and multispecialty environments,
- curiosity.

Coordinator of ruhrvalley stated that besides technical and professional skills, which are at place, the emphasis should be put to obtain problem-solving skills, project management competences, knowledge and skills to apply scientific and systematic analysis, and social skills in general.
Based on the joint analysis of demanded competences and framework proposed by [8], the next summary can be provided (*Table 1*).

Group / competence		Technical	Professional	Global
CFAA	1	x		
	2	x	x	
	3	x	x	x
ruhr-valley	3	x	x	x

Table 1. Summary of statements on competences.

A bottom-up approach of opinions collection was recommended by [4] to make useful the effect of "wisdom of the crowd", - view of community of involved researchers and technicians on individual competencies. This approach revealed that the higher position of interviewee and the more experience they had, the broader view on competences was presented. Group 1 of interviewed employees described only those technical competences needed to work on the technology and it was claimed, that the social and communication skills were not highly needed since no related issues were faced during R&D projects execution. In its turn, group 2 presented by coordinator of projects at CFAA highlighted the need for social competences and creative/critical thinking, which build a professional dimension of "3D engineering professional" [8]. Whereas group 3 presented by experienced manager of CFAA and coordinator of ruhrvalley projects defined required competences, which definitely cover all three dimensions of the used competence categorization framework.

5. Conclusion

In the age of globalization and particularly for the case of cooperation establishment, global competence would play an important role for formations based on triple helix model. Industry, academia and state parties would require project management staff and multi-skilled engineers capable to successfully implement R&D projects. To achieve that, a broader set of competences would be needed, which cannot be taught only in traditional classroom but would require a learning environment with opportunities to obtain practical experience. Both innovation clusters of CFAA and ruhrvalley provide these opportunities on the R&D projects base. Interviews conducted with different groups of involved parties highlighted various sets of competences required to collaborate on research project but also the skills, which could be trained on the base of the clusters.

Furthermore, the provided list of required competences could play a role of the check-list with an intention to select prospective students and researchers to collaborate of the possible joint projects. In that case, more interviews could be required to describe precisely prerequisites to work on the particular project, as well as assessment measures should be developed to evaluate required competences.

References

[1] C. Wolff and A. Nuseibah, “A projectized path towards an effective industry-university-cluster: Ruhrvalley,” in *2017 12th International Scientific and Technical Conference on Computer Sciences and Information Technologies (CSIT)*, Lviv, Sep. 2017 - Sep. 2017, pp. 123–131.

[2] ruhrvalley Management Office, “ruhrvalley Annual Report 2018,” Herne, Apr. 2019. [Online]. Available: https://www.ruhrvalley.de/news/22-ruhrvalley-jahresbericht-2018

[3] L. Sastoque Pinilla, R. Llorente Rodríguez, N. Toledo Gandarias, L. N. López de Lacalle, and M. Ramezani Farokhad, “TRLs 5–7 Advanced Manufacturing Centres, Practical Model to Boost Technology Transfer in Manufacturing,” *Sustainability*, vol. 11, no. 18, p. 4890, 2019, doi: 10.3390/su11184890.

[4] S. Braun, C. Kunzmann, and A. Schmidt, “People tagging and ontology maturing: Toward collaborative competence management,” in *From CSCW to Web 2.0: European Developments in Collaborative Design:* Springer, 2010, pp. 133–154.

[5] H. Barr, “Competent to collaborate: Towards a competency-based model for interprofessional education,” *Journal of Interprofessional Care*, vol. 12, no. 2, pp. 181–187, 1998, doi: 10.3109/13561829809014104.

[6] J. M. Bryson, F. Ackermann, and C. Eden, “Putting the resource-based view of strategy and distinctive competencies to work in public organizations,” *Public Administration Review*, vol. 67, no. 4, pp. 702–717, 2007.

[7] H. Getha-Taylor, “Identifying Collaborative Competencies,” *Review of Public Personnel Administration*, vol. 28, no. 2, pp. 103–119, 2008, doi: 10.1177/0734371X08315434.

[8] S. A. Rajala, “Beyond 2020: Preparing Engineers for the Future,” *Proc. IEEE*, vol. 100, Special Centennial Issue, pp. 1376–1383, 2012, doi: 10.1109/jproc.2012.2190169.

[9] G. M. Warnick, “Global Competence: Its Importance For Engineers Working In A Global Environment,” *Environmental Science*, 2011.

[10] O. Diegel, “Additive Manufacturing,” in *Comprehensive Materials Processing*: Elsevier, 2014, pp. 3–18.

[11] E. Uhlmann, R. Kersting, T. B. Klein, M. F. Cruz, and A. V. Borille, “Additive Manufacturing of Titanium Alloy for Aircraft Components,” *Procedia CIRP*, vol. 35, pp. 55–60, 2015, doi: 10.1016/j.procir.2015.08.061.

[12] E. O. Ezugwu, “High speed machining of aero-engine alloys,” *J. Braz. Soc. Mech. Sci. & Eng.*, vol. 26, no. 1, pp. 1–11, 2004, doi: 10.1590/S1678-58782004000100001.

[13] V. K. Jain, *Advanced machining processes*. New Delhi: Allied Publishers, 2013.

[14] A. Thompson, L. Körner, N. Senin, S. Lawes, I. Maskery, and R. K. Leach, “Measurement of internal surfaces of additively manufactured parts by X-ray computed tomography,” 2017.

Virtual Power Plant: The Portfolio Manager in Power Distributed Generation Networks

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Abstract

In the Power Distributed Generation Networks (PDGN) the Virtual Power Plants (VPP) allow an adequate interaction between the components of Smart Grids (SG), Power Markets (PMk), and Stakeholders. The interactions between the VPP and the SG generate standards, which make easier the power flow monitoring, the supply and demand information controlling, and encourage the production and consumption of renewable energies. Therefore, the key question to address is: What direction model can be applied in VPP to manage and keep reliable governance standards in the SG? According to the PMBOK, the model of Organizational Strategy (OS) offers different sources of value in the governance of Portfolios, Programs, and Projects. Considering this, the authors of this paper propose to apply the features of OS in the governance of VPP over SG and Stakeholders, showing the applied calculations of the proposed model in a small PDGN, their results, and the conclusions according to the transactions balancing obtained.

Keywords: Virtual Power Plants; Smart Grids; Renewable Energies; Project Management; Organizational Strategy

1. Introduction

Smart Grids (SG) are considered as the evolution of the Traditional Electric Power Systems (TEPS) due to the growth in the usage of renewable energies and the technological developments provided by Industry 4.0 [1]. As renewable energy systems evolve and the number of deployed systems in the field also increases, the number of Stakeholders of the systems also grows. These Stakeholders mainly are involved in the production (Producers), in the consumption (Consumers), and in the production/consumption (Prosumers) of power [2]. Currently, the SG have difficulties in achieving the continuous interaction of all its components, preventing the correct communication and coordination of the information for the standardization of governance policies and protocols [3]. Virtual Power Plants (VPP) are a flexible representation of a portfolio of Distributed Energy Resources (DER), allowing the creation of a unique operating profile which facilitates the interaction between the components of the SG, Power Market (PMk), and Stakeholders [4], [5].

TEPS produce power with a unidirectional flow, which travels through the Transmission and Distribution Networks (T&DN) to supply each of the homes, offices, factories, and farms connected to them [6]. On the other hand, the SG produce power with a bidirectional flow traveling through the Distribution Networks (DN) since the Renewable Energy Microgrid (REM) have storage capacity and allow to produce, distribute, store, and consume power dynamically. This last situation allows Consumers, Producers, and Prosumers to make power transactions through VPP in the PMk [4], [7]–[9].

In this paper, the authors argue how a governance structure can be managed from the Project Management (PM) point of view, applying the model of Organizational Strategy (OS) in the SG in order to manage and maintain reliable standards for the optimal operation of the VPP according to the needs of Stakeholders.

The rest of this paper is organized as follows. Section 2 briefly describes the concepts of SG and VPP, and the concept of the OS recommended by PMBOK. In Section 3 the authors describe how to apply the model when the VPP has the role of Portfolio Manager over the Power Distributed Generation Networks (PDGN). Section 4 presents a Case Study where the authors of this paper focus on Photovoltaic Power, due to the fact that Producers, Consumers, and Prosumers of renewal energy are operating mostly with solar Photovoltaic Panels (PVP) in the DER. Finally, the Section 5 contains the conclusions.

This paper seeks to encourage the Stakeholders of the SG to implement VPP using the model of OS for improving the management and governance, contributing to the growth in the use of renewable energies.

2. Contextual framework

VPP leadership optimize and improve the SG performance, through the development of an Organizational Strategy Structure that easies the management for every DER and each Stakeholder.

2.1. Smart Grids (SG):

The idea or concept of the SG is based on the set of technological components (Hardware and Software), which allow the production, distribution, storage, consumption, and trade of power within a network or system. There is not a single definition for SG; the authors of this paper consider the definitions listed below as the most representative ones:

> *Definition by European technology platform is, "A Smart Grid is an electricity network that can intelligently integrate the actions of all users connected to it-generators, consumers and those that do both-in order to efficiently deliver sustainable, economic and secure electricity supplies"* [1].

> *Definition by IEEE is, "The Smart Grid is a revolutionary undertaking entailing new communications and control capabilities, energy sources, generation models and adherence to cross jurisdictional regulatory structures"* [1].

The main objective of SG is to take advantage of power in a smart way, maximizing the benefits in production and distribution, as well as minimizing costs in storage, transfer and consumption. In a global perspective, the SG seek to create the balance between the production and consumption of power within a network or system [10]. In addition, it is important to note that each key point or node interacting within the SG provides information data which must be processed and analyzed in order to define the purchase and sale prices of power made in the PMk [4]. To keep running the system correctly, the SG rely on the Operators (SG Operators) and Sub-Operators (REM Operators), which could be defined as main nodes of support in the management of power. However, the SG Operators and REM Operators do not have the data processing and analysis capability for covering the entire SG [11].

Considering the above, and the fact that the information generated through all the components of SG is increasing exponentially, there is a need to develop a strategic component within the SG, which is more powerful than the SG Operators and REM Operators, and it allows the proper management and administration of information data. This component is known as VPP.

2.2. Virtual Power Plants (VPP):

Since its inception, the concept of VPP has been continuously evolving as a natural consequence of the technological advances and the growth of the supply and demand of renewable energies, but mainly to maintain a continuous and dynamic interaction between the components of SG.

Currently, there is not a single definition for VPP. The authors of this paper consider the follow definition as the most representative one:

> *The Virtual Power Plants are a flexible representation of a portfolio of Distributed Energy Resources (DER), not only aggregating the capacity of many diverse DER, but also creating a single operating profile from a composite of the parameters characterizing each DER and incorporating spatial constraints. Moreover, they rely upon software systems to remotely and automatically dispatch and optimize generation or demand side or storage resources in a single, secure web-connected system* [5].

The VPP direct the administration of the SG, process information for the power flows analysis, monitor and control the behavior of each of the REM, and ideally, provide reliable information for the forecast of prices in the PMk [4].

In order to achieve a correct interaction between the components of the SG, the VPP must establish governance standards that assure good operating policies and protocols, and generate the proper organization and synchronization of them, such as is shown in *Figure 1*. However, nowadays there is neither a standard nor unified management model between them, which would allow the continuous communication and coordination of information data for transferring power [3].

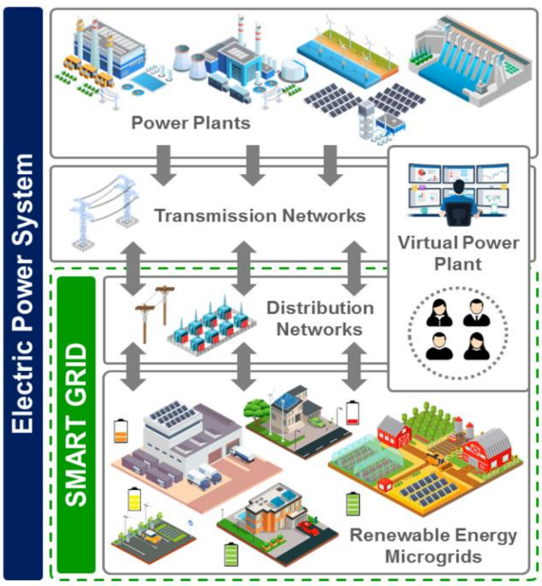

Figure 1. Smart Grid and interaction components

2.3. The Organizational Strategy (OS) of PM:

The OS management model of the PMBOK organizes the governance processes related to the projects and also it facilitates the exchange of resources, methodologies, tools and techniques. The OS generates a structure that seeks to assure the correct order of the working groups, the adequate monitoring of the objectives to guarantee their fulfillment, the availability of the resources, and the continuous improvement in the decision-making based on the needs of the Portfolios, Programs, and Projects specified by the Stakeholders [12], as shown in *Figure 2*.

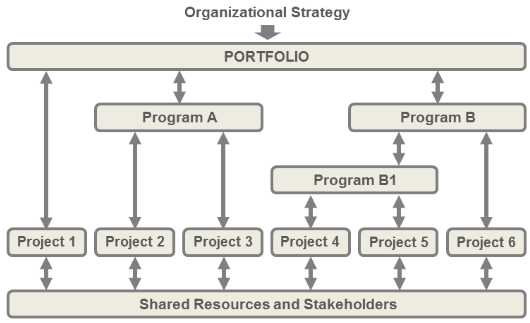

Figure 2. Portfolio, Programs and Projects (PMBOK adaptation)

3. Model description

Considering the fact that SG need to apply a model for VPP, which systematically establishes the development of guidelines in order to continuously improve governance policies and protocols, the authors of this paper propose an innovative usage of an existing model for solving the following key question: What direction model can be applied in VPP to manage and keep reliable governance standards in the SG?

The model has been adapted following the PM best practices by the authors of this paper, who argue whether a hierarchically structured organization model in levels is the best alternative for the VPP, since it helps to define and maintain reliable governance standards for SG. To justify and validate the structure of the model presented in this paper, the following items were considered: i). The PM guidelines introduced by the PMBOK Guide, which address the structure and management of an OS towards the relationship between Portfolios, Programs, and Projects, as well as the link between organizational governance and project governance [12], and ii). The average power consumption of a Single-Family House (SFH), the historical data of all power consumption, and the historical data of renewal energies production (Photovoltaic Power) from Red Eléctrica de España (REE), which were used to adapt and calculate the conditions of a small PDGN [13].

The authors of this paper present the follow definitions: i). A *Project* is a daily transaction or daily transaction group in the PMk made by a Consumer, Producer or Prosumer within PDGN through the VPP, ii). The VPP *Portfolio* must assure the continuous supply and adequate exploitation of power, which flows within PDGN to obtain the best performance, achieving the strategic objective of maximizing the benefits of power production and minimizing power consumption costs, iii). The SG *Programs* are set-up according to the distances and zones where the DER are located, iv). The REM *Subsidiary Programs* are set-up according to the power transfer capacity of each DER and its relationship with the power network, and v). Prosumers, Producers, and Consumers *Projects* are defined according to the capacity of each DER for producing, storing and consuming power, for periods of 24 hours (daily time framework). The daily time framework is established according to some features of PMk.

The linkage between the OS concept with the SG and VPP ones are done according to the established hierarchical design. The input of the calculation is the dataset taken from the historical records of the REE and the output is a report which represents the quantity of power purchased and sold for all the agents.

3.1. Portfolio, Programs, and Projects of PDGN

As in PM, the PDGN can be organized according to the type and quantity of subsystems that are part of them. VPP must manage the governance framework in SG, establish the operating parameters for each component according to its structure within the system and/or subsystem. A component is an identifiable element that provides a particular function or a group of related functions [12], that is why, VPP can influence behaviors of the components according to the Stakeholders needs, adjusting the governance policies and protocols when they are required, as long as they maintain the focus of providing support to the SG, ensuring consistency and optimal balance between the production and consumption of power. Once the needs of the Stakeholders have been defined, and the functions and capabilities of the components specified, VPP perform their role of leadership over SG systematically, applying the criteria of alignment, risk, performance, and communications. Once each criteria is applied, the VPP can monitor, control, integrate and give support to the components of the SG [12], maximizing the benefits in production and distribution of power, and minimizing the storage, transfer and consumption costs within the SG.

The authors of this paper propose the managerial hierarchy described in *Figure 3*, which strategically organize the SG and establish the VPP leadership over the SG Operators, REM Operators, Consumers, Producers, and Prosumers.

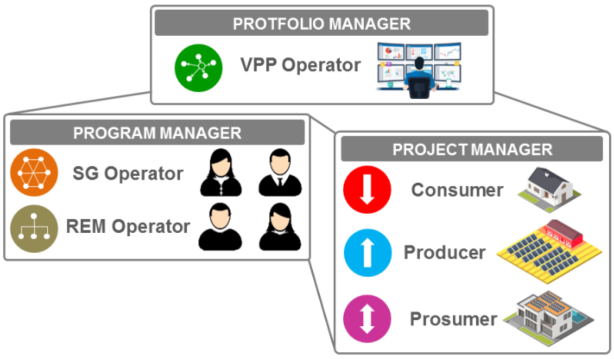

Figure 3. Managerial hierarchy according to OS

3.2. Support, Control and Management of VPP

TEPS are composed of elements such as Power Plants, Electrical Substations, Transmission Networks, and Distribution Networks, which work together within a network for producing, transporting and distributing power [6]. The main objective of the Power Plants is to produce enough power to supply the entire network. The power produced by the Power Plants cannot be stored in large quantities or for long periods of time, which means, the power produced is consumed or wasted. One of the main differences between TEPS and SG is the power storage capacity [1]. Taking advantage of the power storage capacity, the REM can supply the Prosumers and Consumers facilities with their own power, without requiring the power supplied by the TEPS [14]. However, the REM shall ideally be the main source of power for a Prosumer and Consumer, and the power from the TEPS shall ideally be the secondary source or contingency one, in order to maintain the continuous supply of power all the time in the SG [9].

Consequently, the support, control, and management of the VPP over the components of the SG should initially be directed towards the following objectives: i). Identify the amount of power produced, distributed, stored, consumed and traded by each of the components of SG, ii). Identify which DER of a REM is able to transfer power or requires power according to its storage status [5], iii). Control the power flow and balance their distribution within REM considering DER needs and its power storage status [15], and iv). Manage the best sale and purchase price of power in the PMk for Stakeholders according to the charging needs and power transfer capabilities [4]. In *Figure 4* the OS led by a VPP considering the above objectives, and the interaction between the components of the SG is described.

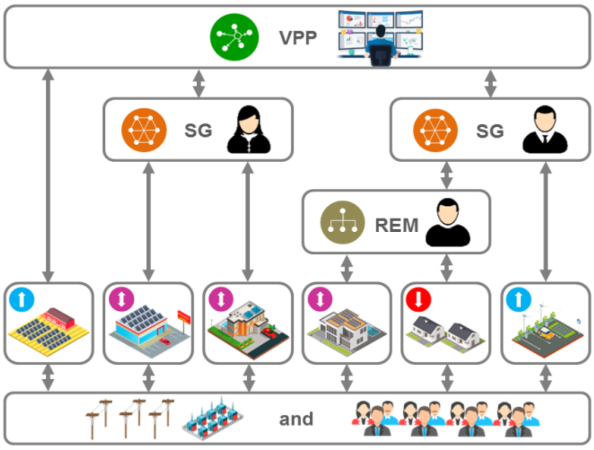

Figure 4. OS directed by a VPP

4. Case study

Considering the described in Section 3, the calculation has been generated according to structure of *Figure 5*:

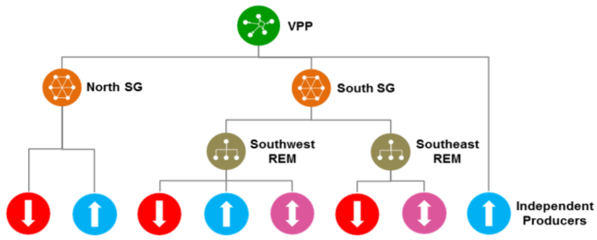

Figure 5. Structure OS to VPP

The *Table 1* contains the set up information of active agents.

ITEM	Consumers NSG	Producers NSG	Consumers SWREM	Producers SWREM	Prosumers SWREM		Consumers SEREM	Prosumers SEREM		Independent Producers
					Consumers PSWREM	Producers PSWREM		Consumers PSEREM	Producers PSEREM	
SFH	17	0	16	0	3	1	18	3	1	0
DER	0	2	0	2	1	1	0	0	1	2
PVP	0	70	0	90	0	60	0	0	60	90

SFH: Single-Family House; DER: Distributed Energy Resources; PVP: Photovoltaic Panel

Table 1. Setting up OS model

The *Table 2* contains the power information of a 24 hours dataset used as input.

HOUR	Consumers NSG	Producers NSG	Consumers SWREM	Producers SWREM	Prosumers SWREM		Consumers SEREM	Prosumers SEREM		Independent Producers
					Consumers PSWREM	Producers PSWREM		Consumers PSEREM	Producers PSEREM	
00:00	5,13	0,02	4,73	0,11	0,95	0,03	5,47	0,82	0,02	0,05
01:00	4,69	0,03	4,29	0,12	0,87	0,03	5,01	0,73	0,02	0,05
02:00	4,42	0,03	4,02	0,12	0,82	0,03	4,73	0,68	0,02	0,05
03:00	4,32	0,02	3,92	0,11	0,80	0,03	4,62	0,66	0,02	0,06
04:00	4,21	0,02	3,81	0,11	0,78	0,03	4,51	0,64	0,02	0,05
05:00	4,35	0,02	3,95	0,11	0,80	0,03	4,65	0,67	0,02	0,04
06:00	5,06	0,02	4,65	0,07	0,94	0,02	5,39	0,80	0,01	0,04
07:00	5,57	0,01	5,17	0,09	1,04	0,02	5,93	0,90	0,02	0,03
08:00	6,21	1,63	5,81	1,72	1,16	0,57	6,59	1,02	0,56	1,65
09:00	6,72	6,24	6,32	6,33	1,26	2,10	7,12	1,11	2,09	6,26
10:00	7,20	11,52	6,80	11,61	1,35	3,86	7,61	1,20	3,86	11,55
11:00	7,39	11,75	6,99	14,54	1,39	4,84	7,81	1,23	4,83	14,47
12:00	7,66	11,92	7,26	16,96	1,44	5,64	8,09	1,28	5,64	16,89
13:00	7,82	12,80	7,41	18,29	1,47	6,09	8,25	1,31	6,08	18,23
14:10	7,67	13,29	7,27	18,78	1,44	6,25	8,10	1,29	6,25	18,72
15:00	7,50	13,14	7,10	18,63	1,41	6,20	7,92	1,25	6,20	18,57
16:00	7,37	12,29	6,97	17,78	1,38	5,92	7,79	1,23	5,91	17,71
17:00	7,36	12,64	6,96	15,88	1,38	5,29	7,78	1,23	5,28	15,81
18:00	7,27	9,90	6,87	13,14	1,36	4,37	7,68	1,21	4,37	13,08
19:00	7,06	8,86	6,65	8,95	1,32	2,97	7,46	1,17	2,97	8,88
20:00	6,90	5,15	6,50	5,24	1,29	1,74	7,30	1,14	1,73	5,18
21:00	6,97	0,77	6,57	0,86	1,31	0,28	7,37	1,16	0,27	0,79
22:00	6,73	0,09	6,32	0,18	1,26	0,05	7,12	1,11	0,05	0,12
23:00	6,14	0,07	5,74	0,16	1,15	0,05	6,52	1,00	0,04	0,09
Total	151,72	132,25	142,06	169,91	28,37	56,46	160,83	24,86	56,28	168,36

Table 2. 24 Hours dataset [kWh]

4.1. Calculation Expression

The Transaction Balancing (TB) calculation was generated with a SFH Consumption Rate of 9 kWh/day, Market Power Rate of 0,15 €/kWh, where 1 PVP is equivalent to 100 W, and 10 hours per day of full solar radiation in the summer season, using the follow expression:

$$TB = \sum_{h=1}^{24} PC_C - PP_P + \left(PC_{Ps} - PP_{Ps}\right) \qquad (1)$$

Meanings of acronyms: PC: Power Consumption; PP: Power Production; C: Consumers; P: Producers; Ps: Prosumers.

Considerations: if "$TB > 0$" it is necessary to purchase external power, and if "$TB < 0$" It is required to sell external power.

4.2. Calculation Results

The calculation results are shown in *Figure 6* and *Table 3*.

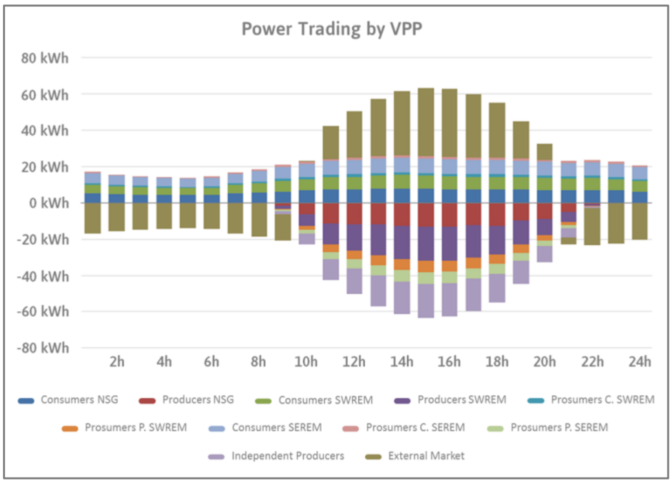

Figure 6. Calculation of Power-Trading

ZONES	Purchased		Sold		Totals	
	Energy [kWh]	Cost [€]	Energy [kWh]	Revenue [€]	Energy [kWh]	Cost [€]
North SG	**151,72**	**22,76**	**132,25**	**19,84**	**19,47**	**2,92**
Consumers NSG	*151,72*	*22,76*	*0,00*	*0,00*	*151,72*	*22,76*
Producers NSG	*0,00*	*0,00*	*132,25*	*19,84*	*-132,25*	*-19,84*
South SG	**356,13**	**53,42**	**282,65**	**42,40**	**73,48**	**11,02**
Southwest REM	*170,44*	*25,57*	*226,37*	*33,96*	*-55,93*	*-8,39*
Consumers SWREM	142,06	21,31	0,00	0,00	142,06	21,31
Producers SWREM	0,00	0,00	169,91	25,49	-169,91	-25,49
Prosumer SWREM	28,37	4,26	56,46	8,47	-28,09	-4,21
Consumption	*28,37*	*4,26*	*0,00*	*0,00*	*28,37*	*4,26*
Production	*0,00*	*0,00*	*56,46*	*8,47*	*-56,46*	*-8,47*
Southeast REM	*185,69*	*27,85*	*56,28*	*8,44*	*129,41*	*47,83*
Consumers SEREM	160,83	24,13	0,00	0,00	160,83	24,13
Prosumer SEREM	24,86	3,73	56,28	8,44	-31,42	-4,71
Consumption	*24,86*	*3,73*	*0,00*	*0,00*	*24,86*	*3,73*
Production	*0,00*	*0,00*	*56,28*	*8,44*	*-56,28*	*-8,44*
Independent Producer	**0,00**	**0,00**	**168,36**	**25,25**	**-168,36**	**-25,25**
External Market	**280,47**	**42,07**	**205,07**	**30,76**	**75,40**	**11,31**
Total Trades	***788,32***	***118,25***	***788,32***	***118,25***	***0,00***	***0,00***

Table 3. Transactions Summary

The output of the power-trading calculation (*Figure 6*) and the calculation transaction summary (*Table 3*) shows that the VPP manages the balance between the purchase and sale of power, according to the supply and demand requirements established by each SG Program, REM Subsidiary Program, and the Projects of Consumers, Producers, and Prosumers. The approach used by the VPP Portfolio is of bottom-up type for the interpretation of the information, and of top-down type for power tasks direction.

- In the early hours of the day, the North SG and the South SG required power supply by External Market.
- In full radiation hours, the over-power produced by Independent Producers was sold to External Market.
- The North SG and South SG were supplied with more of 50% using their own power.
- All power produced by Independent Producers was sold to the North SG, South SG and External Market.

5. Conclusions and future work

This paper indicates the benefits of applying the OS model (oriented by PMBOK) in a PDGN, showing the correct management for interaction between the VPP, the SG Operators, the REM Operators, the Consumers, the Producers, and the Prosumers. Apart from that, the OS model enables the balance of:

- The distribution of power at times of maximum load.
- The price according the market supply and demand.

Consumers, Producers, and Prosumers can manage their projects following the guidelines of VPP, SG Operators, or REM Operators, which assure the creation of reliable governance standards for power transactions.

The maximization of benefits for the power production and the minimization of costs, according to organized consumption are possible since the management of the VPP as Portfolio Manager coordinating the management of all programs, subsidiary programs, and projects that interact in the PDGN. All these would not be possible if they were managed individually.

In a *Future Work*, the research will be focused on the VPP management for information transmission security, and its smart interaction with the SG, PMk, and Stakeholders.

Acknowledgement

This work was supported in part by the Ministry of Science, Innovation and Universities of Spain, under Project RTI2018-096108-A-I00.

References

[1] G. Dileep, “A survey on smart grid technologies and applications,” *Renew. Energy*, vol. 146, pp. 2589–2625, 2020.

[2] M. A. Hossain, H. R. Pota, M. J. Hossain, and F. Blaabjerg, “Evolution of microgrids with converter-interfaced generations: Challenges and opportunities,” *Int. J. Electr. Power Energy Syst.*, vol. 109, no. February, pp. 160–186, 2019.

[3] M. H. Rehmani, A. Davy, B. Jennings, and C. Assi, “Software Defined Networks-Based Smart Grid Communication: A Comprehensive Survey,” *IEEE Commun. Surv. Tutorials*, vol. 21, no. 3, pp. 2637–2670, 2019.

[4] S. Yu, F. Fang, Y. Liu, and J. Liu, “Uncertainties of virtual power plant: Problems and countermeasures,” *Appl. Energy*, vol. 239, no. December 2018, pp. 454–470, 2019.

[5] G. Plancke, K. De Vos, R. Belmans, and A. Delnooz, “Virtual power plants: Definition, applications and barriers to the implementation in the distribution system,” *Int. Conf. Eur. Energy Mark. EEM*, vol. 2015-Augus, pp. 1–5, 2015.

[6] A. Karabiber, C. Keles, A. Kaygusuz, and B. B. Alagoz, “An approach for the integration of renewable distributed generation in hybrid DC/AC microgrids,” *Renew. Energy*, vol. 52, pp. 251–259, 2013.

[7] U. Akram and M. Khalid, “A Coordinated Frequency Regulation Framework Based on Hybrid Battery-Ultracapacitor Energy Storage Technologies,” *IEEE Access*, vol. 6, pp. 7310–7320, 2017.

[8] J. J. Justo, F. Mwasilu, J. Lee, and J. W. Jung, “AC-microgrids versus DC-microgrids with distributed energy resources: A review,” *Renew. Sustain. Energy Rev.*, vol. 24, pp. 387–405, 2013.

[9] E. Unamuno and J. A. Barrena, “Hybrid ac/dc microgrids - Part I: Review and classification of topologies,” *Renew. Sustain. Energy Rev.*, vol. 52, pp. 1251–1259, 2015.

[10] B. M. Buchholz, Z. Styczynski, B. M. Buchholz, and Z. Styczynski, *European Smart Grids Technology Platform - Vision and Strategy for the Electricity Networks of the Future*, First Edit. Luxembourg: Office for Official Publications of the European Communities: European Communities, 2014.

[11] A. Colmenar-Santos, C. Reino-Rio, D. Borge-Diez, and E. Collado-Fernández, “Distributed generation: A review of factors that can contribute most to achieve a scenario of DG units embedded in the new distribution networks,” *Renew. Sustain. Energy Rev.*, vol. 59, pp. 1130–1148, 2016.

[12] Project Management Institute, *A guide to the project management body of knowledge (PMBOK guide)*, Sixth Edit. Newtown Square, Pennsylvania 19073-3299 USA: Project Management Institute, Inc., 2017.

[13] R. E. de E. REE, “Red Eléctrica de España,” *Red Eléctrica de España*. [Online]. Available: https://www.ree.es/es. [Accessed: 24-Dec-2019].

[14] S. A. A. Kazmi, M. K. Shahzad, A. Z. Khan, and D. R. Shin, *Smart distribution networks: A review of modern distribution concepts from a planning perspective*, vol. 10, no. 4. 2017.

[15] A. Khodaei, “Resiliency-oriented microgrid optimal scheduling,” *IEEE Trans. Smart Grid*, vol. 5, no. 4, pp. 1584–1591, 2014.

Analysis of Project Manager Work Time: a study based on real data from projects.

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Abstract:

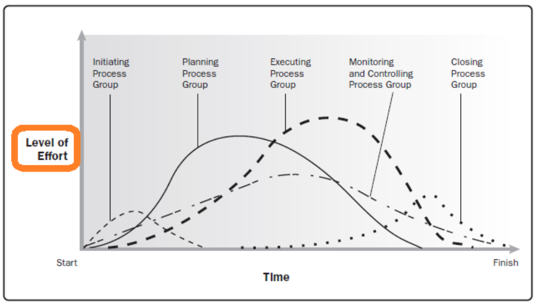
This paper shows an analysis of work time required of project managers across different phases of a project. The three phases analyzed were: Initiating & Planning, Executing & Monitoring, and Closing. The data are displayed in percentages. The data was collected from 27 different projects with approximately 6,000 hours reported. The projects had durations between 127 and 1,348 days. The role of Beesy´s team members were, mainly, of project manager or assistance to internal project managers of Beesy´s customers.

Keywords: project manager, work time, data analysis

1. Introduction

One question that concerns organizations is the amount of work project managers must perform across the complete life-cycle of a project. Demonstrating the workload of project managers is key to understanding which phases and which roles require the majority of a project manager's time. This paper shows data from many different projects from several companies in various environments.

We consider this issue is not widely analyzed in the project management literature. As an example we show here the only figure that PMBOK® Guide includes in its more than 900 pages in which refers to the effort dedicated to each project phase. It is important to say that this graphic refers to the whole work of all the people involved in a project and not only to the role of project manager.



Source: PMBOK® GUIDE (Sixth Edition) - The Standard for Project Management

So that, the purpose of this paper is to analyze the data instead of reaching definitive conclusions.

2. Environment

Project

We used the PMBOK®[1] definition of project: "*A temporary endeavor undertaken to create unique product, service, or result.*"

Number of Projects

The data analyzed was collected from 27 projects.

Project Managers Work Time

The work time of the project managers was between 39,25 and 652 hours by project.

The total work time reported was 6,001,06 hours.

Work time only refers to project activities. Travel to and from the customer's facility and similar activities were not collected.

Duration of the projects

The duration of the projects was between 92 and 965 workdays.

The total duration of all the projects was 8,756 workdays.
The function to calculate the workdays in Google Sheets was Networkdays which returns the number of networking days between two provided days. The *holidays* parameter was not used in the calculations.

Types of Projects

The types of projects analyzed include ERP Implementation and Evolution, Value Stream Mapping, Web Design and Deployment, Customer

Assistance, Medical Laboratory, Annual Plan, Medical Protocols, Document Management System, Physical Therapy Management System, Project Methodology Implementation, Sustainable Urban Mobility Plan, Laboratory Information Management System, and Customization and Deployment of Legal Software.

Tools

Times were reported project-by-project in Google Calendars for Beesy team members.

The tool used to collect the data was Time Tackle (https://www.timetackle.com/).

The data and graphics were generated with Google Sheets.

About Beesy

Beesy is a company founded in 2013 and located in the north of Spain. One of the professional services that Beesy offers to its clients is the project management in all its phases.

3. Role of project manager

Phases, activities accomplished, techniques and tools applied

The following activities were executed by the project manager in solitaire or with the project team:

Initiating & Planning:

- Define the scope of the product, result or service: mapping user stories[2], project charter

- Define the scope of the project: Work Breakdown Structure (WBS Schedule Pro), Network Diagram (WBS Schedule Pro), Gantt Chart (WBS Schedule Pro), estimates of activity durations (planning poker)

- Risk analysis[3]: matrix of risk, probability and impact

- Matrix of stakeholders

Executing & Monitoring:

- Acceptance of deliverables

- Meetings to monitor the advance of work

- Kanban boards[4] (Trello)

- Milestones table

- Work Breakdown Structure indicating the progress of each work package (WBS Schedule Pro)

Closing:

- Retrospectives[5]

- Closing chart

4. Analysis of information

Figure 1 shows the total work time, indicated in hours, of the project manager grouped by project. The code appearing on the x axis is the key name for the project.

This figure shows the diversity of projects analyzed.

Figure 2 shows the percentage of project manager work time on the Initiating - Planning phase over the total work time grouped by project.

Except in only three cases (MN, MUTUALAB - MN, SERVLAB and TRA, FINSA II) the rest of the projects show a pattern close to or less than 25% of dedication in this phase.

Figure 3 shows the percentage of project manager work time on the Execution - Monitoring phase over the total work time grouped by project. In contrast to the Figure 2, the dedication in this phase is close to or greater than 70%.

Figure 4 shows the percentage of project manager work time on the Closing phase over the total work time grouped by project. With a few exceptions, dedication on this phase is less than 10%.

Figure 5 shows the average of project manager work time grouped by project phase.

Figure 6 shows the median of project manager work time grouped by project phase.

Figure 5 and *6* show in which phases the project manager have to spend more time. The results show that we could have 15% - 85% - 5% dedication in Initiating & Planning - Executing & Monitoring - Closing respectively.

Figure 7 shows the daily dedication of the project manager grouped by project and day (7.5 hours from Monday to Friday). On the other hand there are no clear conclusions of how many hours in total a project manager should dedicate to each of them, which is totally logical.

5. Conclusions

- Although at Beesy we consider that the project manager typically offers the most value in the “Initiating - Planning phase” helping to create the project vision, the “Execution – Monitoring” phase is the phase which consumes more Project Manager work time. This is the phase where project resources, including team activity, have the most dedicated hours. (*Figures 5* and *6*)

- The projects MN, Mutualab and MN, Servlab, were executed consecutively and all show the major discrepancies of the data analyzed. The special characteristic of these projects was the validation of several hypothesis. On the other hand, other projects had a "mandatory" directive from the companies. (*Figures 2 to 4*)

- Although we can see a pattern more or less clear about what percentage of dedication each phase of the project requires, the question is “What is the daily dedication that a project requires?” It does not show a clear pattern because of it depends on each project. (*Figure 7*)

- Finally we hope that papers like this encourage the promotion of data collection around the project management work. This will serve to take decisions and estimates thanks to the analysis of information instead of intuitions.

6. Abbreviations and Acronyms

ERP: Enterprise Resource Planning
PMBOK®: Project Management Body of Knowledge
WBS: Work Breakdown Structure

Acknowledgment

We would like to thank Jim Spiller, CEO of Critical Tools (www.criticaltools.com), manufacturer of WBS Schedule Pro, for the project management software used create the referenced projects and a revision of this paper.

We also thank Dr. Idoia Aguirre Esparz for her comments and suggestions in the revision of this document.

References

[1] Project Management Institute, *A Guide to the Project Management Body of Knowledge (PMBOK® Guide) sixth edition*, 2017.

[2] J. Patton, *User Story Mapping*. O'Reilly Media, 2014

[3] ISO 31000:2018 *Risk management - Guidelines*

[4] M. Hammarberg, J. Sundén, *Kanban in Action*, Manning Publications, 2014

[5] L. Gonçalves, B. Linders, *Getting Value Out of Agile Retrospectives - A Toolbox of Retrospective Exercises*, Leanpub, 2014

Figure 1 - Total work time (hours) of the project manager in each project

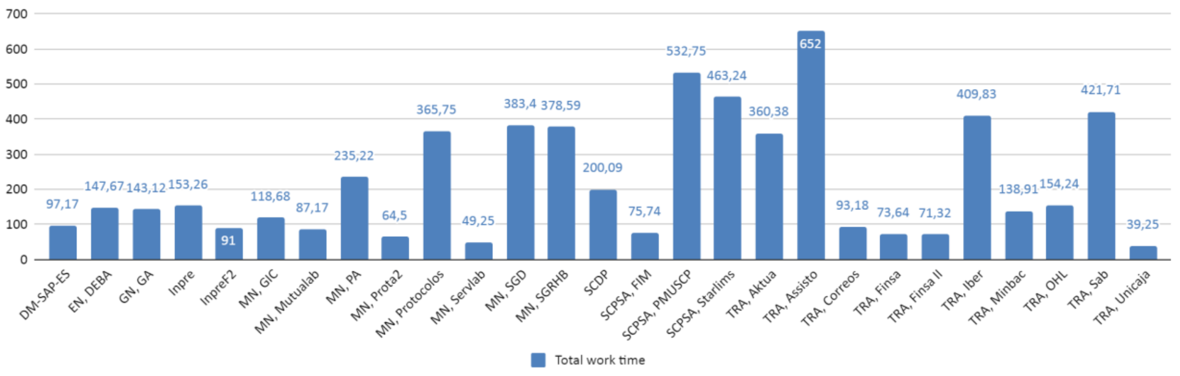
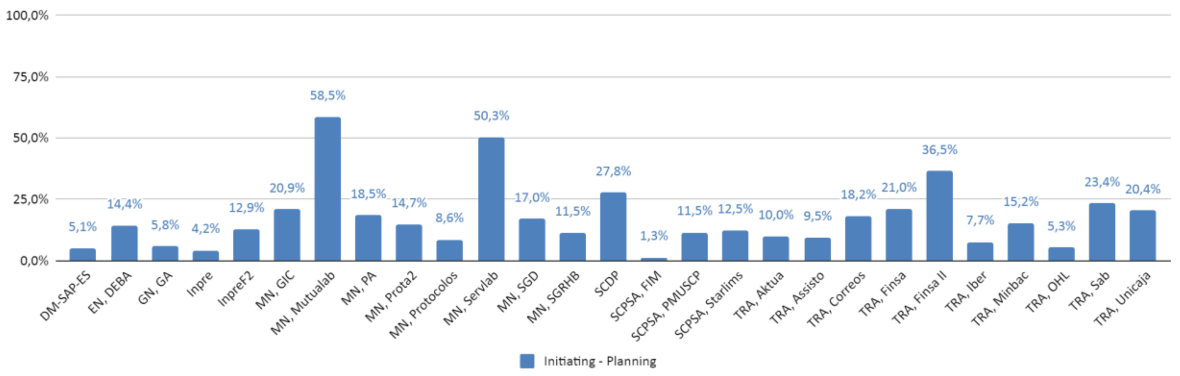


Figure 2 - % of project manager work time in the Initiating - Planning phase over the total work time grouped by project



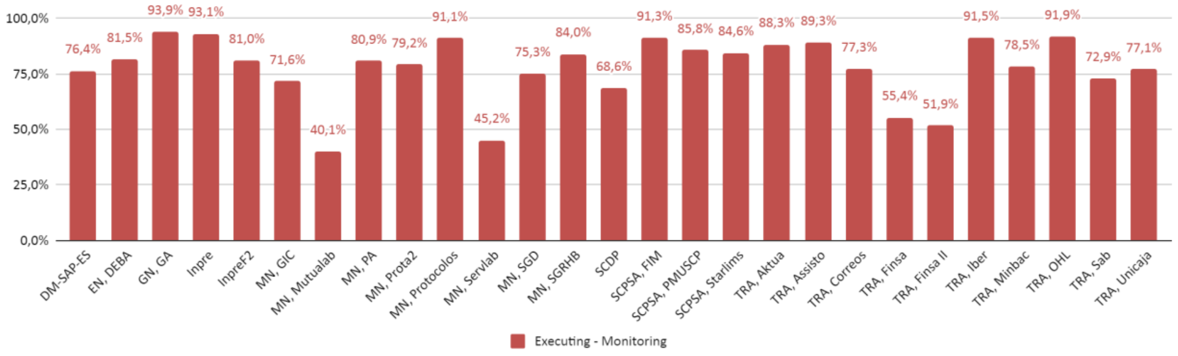


Figure 3 - % of project manager work time in the Executing - Monitoring phase over the total work time grouped by project

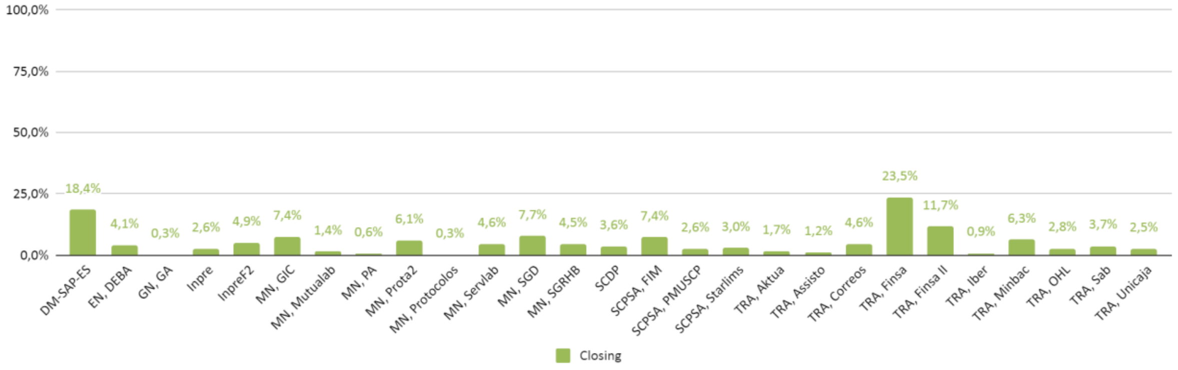


Figure 4 - % of project manager work time in the Closing phase over the total work time grouped by project

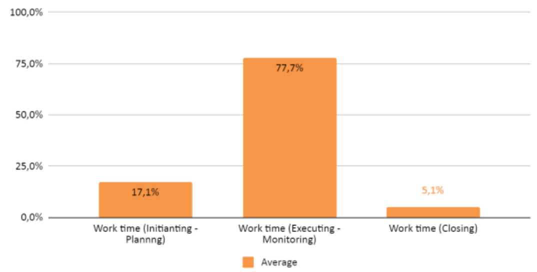


Figure 5 - Average of percentage of work time grouped by project phase

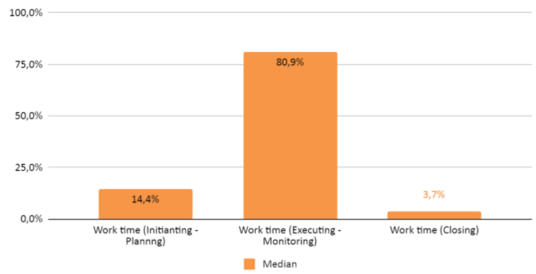


Figure 6 - Median of percentage of work time grouped by project phase

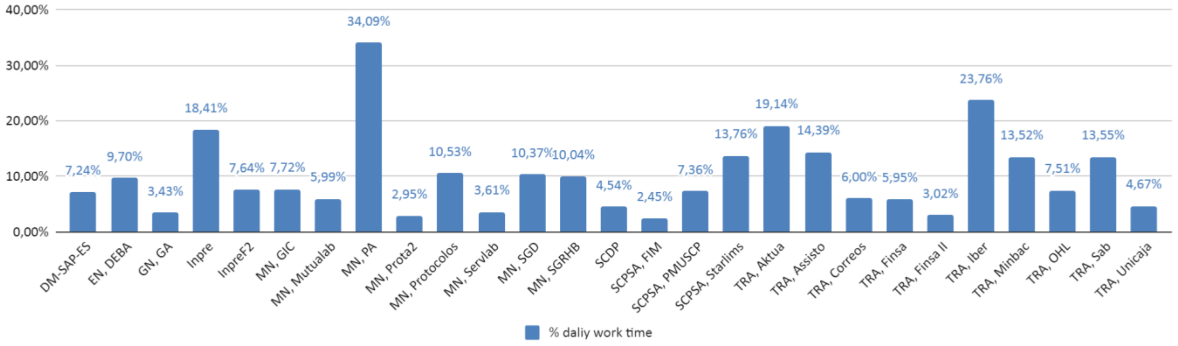


Figure 7 - Percentage of daily dedication of the project manager grouped by project and day (7.5 hours from Monday to Friday)

Digitalized and Projectized Education at Astana IT University

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Abstract:

The digital transformation is affecting the education in every region and country of the world. Research on best practices for future education systems and on the competences for the digital transformation has become a very important and very versatile field. The higher education system is confronted with the need to transform the competences and content delivered, the methods of delivery and themselves as organizations. This contribution analyses the case study of a newly founded higher education institution (HEI) – the Astana IT University (AITU) - in Nur-Sultan, Kazakhstan, which implements the national development strategy "Digital Kazakhstan" in order to support the transition of this large central Asian country into the digital era. The concept and strategy of AITU is driven by the needs of the labour market and innovation system of Kazakhstan. The ambition is to shape the digitalized and projectized economy of the 21st century in Central Asia.

Keywords: Digital University, Digital Education Ecosystem (DEE), Digital Kazakhstan.

1. Introduction

The development of higher education is confronted with the digital transformation. This leads to new requirements for the university as an organisation, for the way how education and research are delivered, and for the content and competences which are delivered. The path towards a "real" digital university is leading through three main areas for the digital transformation [12]:

- The university itself becomes a virtual collaboration of scientists, lecturers and students. The academic faculty forms an agile project team which works as a community of experts. It can be a cross-university and even cross-border team. Therefore, the *digital university as an organisation* is becoming projectized and digitalized at the same time.
- The *delivery of education and research* is transformed, too. Digital transformation of teaching goes well beyond online courses. It is a transformation towards individual competence development paths [4,13] which are facilitated with a variety of didactic formats. The didactics is using digital tools and projects to deliver a realistic and relevant learning experience. Research moves towards Open Innovation and publication of and access to primary data becomes a major source for science.
- The *content of the innovation and the competences* delivered by education deal with digital transformation, too. Many disciplines are becoming digitally transformed, offering new approaches and new knowledge due to the opportunities generated by the digital transformation. Scientist are researching on the competences required for the digital transformation and on innovations enabled by it.

Based on these assumptions the following chapters present the development of the Astana IT University (AITU), a university with the ambition to become a "real" digital university. AITU was founded in 2019 on the Expo 2017 innovation campus at Nur-Sultan, the capital of Kazakhstan in Central Asia. As a "pure" IT university it is expected to form the core of an innovation ecosystem for the country and the region. With this unique chance to develop a new university with a very recent thematic scope at a very prominent location using a greenfield approach with a high degree of freedom, AITU can serve as a case study and possibly (if successful) as a best practice for the digital university of the future. The following chapters describe first the environment and the requirements for AITU, then the general approach and organisational architecture of the university, based on this the concept of the educational programmes including the digitalized and projectized didactic concept, and finally the digital education ecosystem (DEE) which will be used to deliver and to manage the education.

2. Environment Analysis

Education towards the digital transformation is a key topic for most countries. The European Union has put a strong emphasis on it, e.g. with the EU Digital Education Action Plan [4]. This document outlines the relevant policy objectives, including:

- support for high-quality education;
- improving its relevance;
- developing Europeans' digital skills and making them more visible;
- boosting innovation and digital competences in all education institutions;
- opening up education systems.

The following core strategic initiatives are planned:

- Making better use of digital technology for teaching and learning
- Developing relevant digital competences and skills for the digital transformation

- Improving education through better data analysis and foresight

The EU addresses all three core areas of the digital university, the *delivery*, the *content* and the *education ecosystem* itself. The goal is to raise the quality and relevance of education, to improve digital competences and digital innovation, and to make the educational system more open for lifelong participation of a growing part of the population.

Kazakhstan is formulating the digital strategy in a government initiative called “Digital Kazakhstan” [5], which should support the transition of the country from a resource based economy (e.g. oil, gas) into a modern industrial and knowledge based economy. The strategy is a holistic approach driven by a ministry for digital transformation. Higher education is a very important part of it. The universities are required to address the following topics:

- Introduction of new specialties in higher educational institutions (data science, artificial intelligence, cloud computing, etc.).
- Increase in the number of state grants for ICT specialties.
- Integration of ICT in the disciplines of all specialties for 80% of universities.
- Development of distance education through the creation of a national platform for open education.
- Opening of ICT departments of universities on the basis of productions

Kazakhstan closely cooperates with the European Higher Education Area (EHEA), e.g. by introducing the European Standards and Guidelines (ESG) and the European Credit Transfer System (ECTS). According to the Astana Declaration [6], Kazakhstan took the lead for the cooperation of the Central Asian university system with the EU. Therefore, many education initiatives of the EU regarding digital transformation and university reform are implemented in Kazakhstan, too, e.g. through the Erasmus+ Capacity Building Programme.

Apart from being a digital university, the higher education of the future is also expected to be more international, more interdisciplinary and more oriented to job-field relevance with a focus on practical and professional skills [4,6]. Technical education is complemented by professional skills (e.g. project management, team work) and global skills (e.g. intercultural and international competence) [8]. A need analysis [14] conducted in Kazakh universities showed the demand of students especially for more practical elements and industry relevance on the one hand and for the documentation of these competences with professional certificates (in addition to the academic certificates) on the other hand.

3. Astana IT University

The Astana IT University (AITU) is striving to fulfil the expectations of the environment by establishing a university model which is digitalized and projectized in a comprehensive and holistic way. This involves the design of cause-and-effect- chains which deliver the results needed to be accumulated towards the desired impact. Setting up the university architecture is based on the logic of the results-oriented monitoring (RoM) and the input-output-outcome-impact (IOOI) approach [3]. This approach allows a projectized view on the university which implements the strategic programme as a portfolio of projects within the cause-and-effect logic.

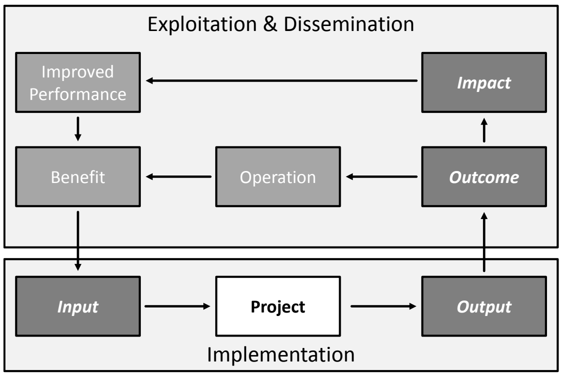

Figure 1. Project evaluation based on inputs, outputs, outcomes and impact (adapted from [11])

The basic idea (see Fig. 1) is that the organisation (university) turns resources (inputs, e.g. lecturers) into deliverables (outputs) by doing projects. The outputs (e.g. courses) contribute to the outcomes of the university, e.g. graduates or innovations. The outcomes as the main results of the operations of the university are generating benefits, e.g. tuition fees. With the outcomes, the university satisfies the desired impact of the stakeholders, e.g. Digital Kazakhstan. In this IOOI logic, the digital university looks as follows:

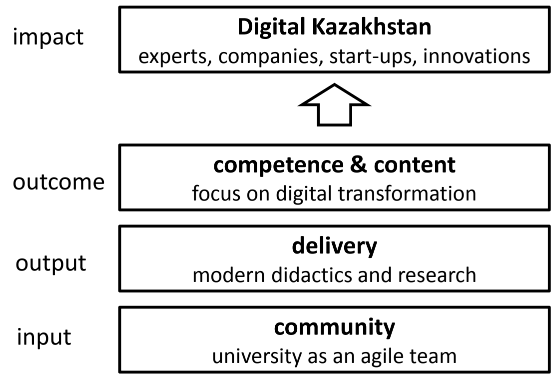

Figure 2. IOOI logic of a digital university

The patterns of *digital transformation*, *project orientation* and *adaptiveness* need to be applied on all layers of the IOOI logic of the digital university:

- The academic *community* of the lecturers, scientists, staff (and students) should be organized as agile teams working on the current topics from the backlog of the university, e.g. by using digital, service-oriented processes, working as agile project teams, and utilizing virtual collaboration, even cross-border.
- The *delivery* of the education and the research should use tailored, target group oriented

blended learning approaches (online, digital) to allow individual learning trajectories, guarantee a high practical relevance (e.g. by using project-, case- or problem-based learning), and deliver applied, transdisciplinary research.
- The *competences* and knowledge delivered as *content* and the innovations resulting from the research should be relevant for the digital, projectized and service oriented future.

The development of a digital university is implemented over time according to a strategic roadmap based on maturity levels, especially covering organisational maturity according to well defined maturity models and levels [1]. In addition, models for the digital maturity are on the way, e.g. for industry 4.0 [2,9]. These maturity models try to address the digital maturity in terms of the holistic view of the digital transformation, including organizational and cultural change, not only technological progress. For projectized organisations there are maturity models related to project management and organisational development, too [10]. Based on the maturity level approach, the development of the digital university model for AITU is put on a roadmap to allow planning and assessment of the progress.

4. Educational Programme Design

The educational programmes (EP) of AITU are designed both according to Kazakh national standards and according to European standards (ESG, ECTS). This is difficult, but the ambition is to be a digital *and* international university. The EPs of AITU cover all three Bologna cycles, Bachelor's, Master's and PhD programmes. The focus is IT with a *Faculty of Digital Technologies*. Later, Business IT will be added in a *Digital Business School*. The Master's and PhD programmes are organized in a cross-disciplinary *International Postgraduate Institute* which also covers professional education and certifications.

AITU launched 8 Bachelor's programmes in Sep 2019, in Computer Science, Software Engineering, Data Analytics, Industrial Automation, Media Technologies, Telecommunication, Cybersecurity and IT Management. All are 3 years, 240 ECTS programmes with 9 trimesters (3 trimesters per year). The programmes are fully modularized (with 5 ECTS modules in general) and follow a similar outline. For example, the Bachelor Software Engineering educates for the following job profiles:
- Software Developers
    - Web Applications
    - Mobile Applications
    - Database Applications
- Software Testers
- (Requirements Engineers)

This programme covers several competence areas:

Basic Competences are covered in the first year of every programme and form the foundation, e.g.:
- Mathematics (Analysis, Linear Algebra, Statistics), level 1+2
- Computer Science (Alg. + Data Structures, Computer Architecture + Operating Systems 1, Computer Science Theory 1)
- Programming (Java, C# or C++), level 1+2

Within the competence areas, certain competence levels are assigned to each competence (e.g. IT Management students do not need to reach level 2 in programming)

Core Competences (Specialisation, the Major of the programme) define the set of competences covered in the second year which shape and justify the name and the specific profile of the programme:
- Programming (Java, C# or C++), level 3
- Software Engineering (level 1 + 2):
    - patterns, component based design, SW architectures
    - SW testing (ISTQB)
    - SW development processes, tools & frameworks, SW QM
- Databases 1
- Project Management & Tools

The *Elective Competences* form the Minor of the programme and are covered in the third year, e.g.:
- Web Technologies & Frameworks
- Mobile Technologies & Frameworks
- Database Technologies & Frameworks

Transversal, Scientific & Soft Skills are taught in parallel to the technical subjects throughout the complete three years, e.g.:
- English, (Russian) => mainly in first year
- Liberal Arts (Psychology, History etc.)
- Business Administration, Entrepreneurship
- Creativity, Presentation, Innovation
- Research Methods & Tools A

Practical Skills are also part of every year. Especially, every year is concluded with a bigger capstone project, enabling students to start with a side-line job already after the first year:
- Coding Lab => first year
- Software Factory (Project) => second year
- Internship => third year
- Bachelor Project/Thesis

The learning path through the programmes is fully supported by Learning Management Systems (LMS, Moodle). Based on the LMS and on continuous evaluation, Learning Analytics [7] is applied to monitor the progress on an (almost) weekly basis.

5. Digital Education Ecosystem

The digital university approach is operated on a Digital Education Ecosystem (DEE) which contains some typical elements of digital infrastructure:
- *Campus Management System*, including the *Student Lifecycle Management* from enrolment to graduation. In Kazakhstan, all modules, students and grades are stored in a central government database with which the Student Lifecycle Management interfaces.
- *Learning Management Systems* (LMS) – at AITU Moodle is used – as the basis for the

management of the learning process in the degree programmes. The LMS is integrated with the Student Lifecycle Management.

- AITU hosts a broad variety of *online courses* which are franchised from relevant IT companies (e.g. Cisco, Microsoft, Kaspersky) and are connected to professional certifications. These online courses are marketed to companies and are (partly) integrated into the modules of the degree programmes. Lecturers of AITU are certified trainers for these courses.
- *Preparatory online courses and self-assessment tools* for applicants and for the career planning of enrolled students.
- The *lab infrastructure* of AITU is to a large extent *virtualised*, hosting labs in the cloud and making them accessible via Internet.
- AITU provides a *digital classroom infrastructure* which allows facilitation of classrooms with students and lecturers in different locations.
- The operational IT (e.g. workflow management, team spaces, office tools, email, blog, chat) is *virtualised via cloud services* (e.g. Microsoft 365) and accessible from anywhere.

Apart from the more or less traditional elements of a digital university, AITU is working on more sophisticated tools and infrastructures:

- An *Educational Social Network* will connect students (with each other) and lecturers to allow the fast forming and performing of teams.
- A *Cloud-based development and operations environment* allows the tailoring and configuration of virtual software development (tool chains, repositories) and IT operations environments which follow industry standards and provide professional working environments. This goes beyond virtual labs and is closer to the cloud-based IT landscapes of companies.
- An *expert knowledge exchange platform* as a forum (integrated with rating and recommender systems) where people can find expert answers and discussion rooms for their questions.
- A *matching platform for students and companies* with dynamics over the student lifecycle and intelligent matching algorithms.
- A *predictive analytics platform* with tools and methods available to everybody and usable (data privacy provided) based on the data of the digital university.
- A *Student Journey Configurator* which allows students to plan and manage their individual learning trajectory.
- A *Mobility Planner* with individualized workflows for the specific student and staff mobility offers available at AITU.
- A *(student) data exchange platform* and open *identity management system* for cross-university cooperation.

6. Conclusion and Outlook

Astana IT University (AITU) is an example for the development of a projectized and digitalized university following a greenfield approach – meaning without the legacy of a traditional university. This offers a quite unique opportunity to plan and implemented the current state-of-the-art of a digital university and maybe going beyond this. Furthermore, the digital transformation of a “pure” IT university benefits from many cross-correlations. The data produced during the implementation and university operation will serve as the basis for further research on the efficiency and effectivity of the approach and the validation of the basic assumptions.

References

[1] M.F. Agorio Comas, N. Toledo Gandarias, J.R. Arraibi, A. Gutiérrez Terrón, Maturity models' selection criteria for assessment in a specific organisation: a case study. Proceedings of the 1st International Conference on Research and Education in Project Management – REPM 2018, Asociación Española de Dirección e Ingeniería de Proyectos (AEIPRO), ISBN-13: 978-84-697-9972-7, Bilbao, Spain, 2018

[2] J. Basl, “Analysis of Industry 4.0 Readiness Indexes and Maturity Models and Proposal of the Dimension for Enterprise Information Systems,” in Tjoa A., Raffai M., Doucek P., Novak N. (eds) Research and Practical Issues of Enterprise Information Systems. CONFENIS 2018. Lecture Notes in Business Information Processing, vol.327, Cham, Springer, 2018.

[3] Bertelsmann Stiftung, Corporate Citizenship planen und messen mit der iooi-Methode, Bertelsmann Stiftung, 2010

[4] Digital Education Action Plan, European Union (EU), 2018

[5] Digital Kazakhstan, https://digitalkz.kz/en/, last accessed Jan 18,2020

[6] European Commission, Astana Declaration of the Second Meeting of Ministers for Education of the Member States of the European Union and of the Central Asian Countries, European Commission, Brussels, 2017

[7] R. Ferguson, The State Of Learning Analytics in 2012: A Review and Future Challenges. *Technical Report KMI-12-01, Knowledge Media Institute*, The Open University, UK. http://kmi.open.ac.uk/publications/techreport/kmi-12-01, 2012

[8] S.A. Rajala, Beyond 2020: Preparing Engineers for the Future. Proceedings of the IEEE, Vol. 100, pp. 1376-1383, DOI 10.1109/JPROC.2012.2190169, 2012

[9] G. Schuh, R. Anderl, J. Gausemeier, M. ten Hompel, W. Wahlster, Industrie 4.0 Maturity Index. *Managing the Digital Transformation of Companies (acatech STUDY)*, Munich: Herbert Utz Verlag, 2017

[10] T.F. Souza, C.F.S. Gomes, Assessment of Maturity in Project Management: A Bibliometric Study of Main Models. *Procedia Computer Science, vol. 55*, (Suppl. C), pp. 92-101 . DOI: https://doi.org/10.1016/j.procs.2015.07.012, 2015

[11] R. Turner, R. Zolin, Forecasting success on large projects: Developing reliable scales to predict multiple perspectives by multiple stakeholders over multiple time frames. *Project Management Journal, 43(5)*. https://doi.org/10.1002/pmj.21289, 2012

[12] C. Wolff, Managing the Digital Transformation – Digital & Projectized Master Education, *Proceedings of the Dortmund International Research Conference 2017*, Eds. Carsten Wolff, Christian Reimann, ISBN 978-3-00-058090-1, Dortmund, 2017

[13] C. Wolff, O. Mikhieieva, A. Nuseibah, Competences and the Digital Transformation, *Project Management and Engineering Research: AEIPRO 2018, Ayuso Muñoz at al., Lecture Notes in Management and Industrial Engineering*, Springer, 2018.

[14] C. Wolff, A. Omar, Y. Shildibekov, How will we build competences for managing the digital transformation?, *10th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications*, Metz, France, 2019.

Stakeholder collaboration methodology development through IPD, BIM and Lean interactions

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Abstract:

Architecture, Engineering and Construction industry suffers from inefficiencies regarding planning and cost objectives, being the lack of appropriate collaborative procedures one of the causes. In this context, new methodologies provide upgraded systems of cooperation, of which BIM methodology, Integrated Project Delivery and Lean construction are gaining high acceptance. The research aims to investigate the synergies among these methodologies and propose a framework for its implementation as a key element within stakeholder interactions. With this purpose, academic articles have been researched and experienced practitioners interviewed. According to the gathered information, it is concluded that it is desirable moving towards more collaborative methodologies to achieve higher levels of cooperation. Moreover, the integration of IPD, BIM and Lean not only would bring improvements within collaboration and objectives, but it would also facilitate helping each other in their implementation. Lastly, a theorical framework is developed proposing an integration scheme through the project life cycle.

Keywords: Integrated Project Delivery; BIM; Lean Construction; Stakeholder Collaboration

1. Introduction

Compared to other industries, the Architecture, Engineering and Construction (AEC) industry is not as efficient in terms of meeting planning and cost project objectives. One of the main reasons for this problem lies in the initial planning that does not involve all the stakeholder from the earliest stages of the project. In this sense, it is common to find a collaboration gap between the design and initial planning phases, in which only the developer and the engineering company are normally involved, and the development and execution stages [1], [2]. Due to this gap, different problems related to communication, collaboration and project understanding can arise which are often a source of potential risks with great effects in project goals. As a result, the capacity for flexibility, adaptation and manoeuvrability during the development of the project decreases.

In addition, in the traditional contractual and planning framework, by not involving all stakeholders, it is more difficult to build united teams sharing the same project global objectives, giving rise to a tendency towards an individualistic approach and non-distribution of risks and successes.

In the meantime, new methodologies emerge and get stablished within the AEC industry in order to provide an answer to the problems mentioned in the previous points [3]. Among those new approaches, BIM methodology, Integrated Project Delivery (IPD) and Lean Construction are gaining high acceptance among the practitioners. The three of them have as a common characteristic that they base their potential on proposing collaborative systems.

Although these new approaches are designed to work separately, several academic articles analyse the interactions and possible integrations of those systems either bilaterally (BIM-IPD, BIM-LEAN and IPD-LEAN) or, although less common, trilaterally (BIM-IPD-LEAN) [3].

Analysing and proposing a system capable of integrating the three approaches globally and transversally within project management, is still an open path to investigate that can bring new procedures to improve the collaboration in different project knowledge areas such as Project Integration, Schedule, Cost, Procurement or Risk. Following this aim, the article focuses on analysing the cohesion of the three approaches in terms of Stakeholder Collaboration through academic article research and practitioner interviews. Besides this, a preliminary theorical framework proposal and conclusions are described based on the developed research.

To conclude, the research question that guides this investigation would be: How could stakeholder collaboration methodologies develop through the interaction of IPD, BIM and Lean Construction?

2. Literature review

In order to explore the suitability of the research topic, academic articles have been researched and selected. In the following subchapters, having as a reinforcing base the arguments developed in the selected articles, the correlations between BIM, IPD and Lean Construction are described.

2.1. Synergies between BIM and IPD

Even if achieving IPD without BIM is possible, BIM is necessary to achieve efficiently the collaboration required in IPD as it enables all stakeholders to share data in a common and accessible place using a collaborative IT [4], [5]. In a BIM based work environment, a shared 3d model is used in which construction elements from different stakeholder are added and updated, facilitating the integration and distribution of the information of each involved actor [5], [6]. Besides this, this collaborative process boosts the confidence and risk avoidance and improves the collaboration between the stakeholders from different organizations as it allows working from different locations within a common server [5], [7]. In conclusion, BIM methodology is seen as a valuable and powerful tool for a more efficient IPD implementation as it provides the needed IT collaborative environment that ensures the efficient flow of updated documentation, communications and workflows.

However, BIM is not ensuring project collaboration by itself, a proper project management is also needed both for achieving a proper overall project collaboration and a fully efficient BIM use. Therefore, BIM provides a powerful collaborative IT tool but it has to be empowered through an efficient project management [5]. Besides this, BIM implementation issues have been found as proper modelling, collaboration, communication procedures and protocol accomplishment are not always followed [7], [8].

In this sense, using IPD collaborative contracts, BIM objectives can be defined and reinforced, collaborating in the proper implementation of BIM. Apart from this, within the contractual obligations, IPD also includes the project required technologies, being able to mandate the use of collaborative systems such as BIM methodologies. Furthermore, IPD can unify the contractual terms and responsibilities, an improvement needed for a proper BIM implementation and use, which helps out defining goals and distributing responsibilities [9]. All in all, it can be concluded that BIM and IPD mutually empower each other and help reducing errors [2].

2.2. Synergies between Lean and BIM

Although BIM is considered one of the most important changes in AEC industry at this moment, the project management practice has not been able to achieve the full potential use of it. Even in BIM based work environments, communication and collaboration problems are usually found. One of the reasons is that design processes are seen as a series of different tasks without internal relationships. Lean design management however, understands the design process as a flow that generates values and includes a list of tools to empower the design management process. It is proved that the use of Lean practices such as the Last Planner System could increase project collaboration efficiency, transparency and team work collaboration and commitment. In this sense, Lean tools have been found to have the potential to break the barriers to reach the full potential of BIM methodologies. However, in order to use those Lean tools efficiently, a strong lean culture implementation would be required within the strategy of the companies [8]. Therefore, although BIM does not need Lean Construction in order to be adopted, it is considered that its full potential can only be reached when there is an integration of them [4].

The use of BIM methodologies can help improving the Lean Construction implementation experience as well. Using BIM, design work progress can be visualized through a 3D model that shows all elements from different stakeholders and, therefore, the non-valuable design tasks can be identified and removed [8]. Besides this, traditional IT solutions do not provide the necessary collaborative environment needed when implementing Lean [5].

2.3. Synergies between IPD and Lean

IPD contract is based on collaboration and trust which is focused on project commons goal more than on individual goals. For doing so, participants need to be aware of their mission inside the global project objectives and perform in a collaborative way. This vision is aligned with the Lean construction philosophy. In this sense, the contractual approach of IPD could help out ensuring Lean based tools and methodologies during the process [5].

According to Project Delivery Guide by the AIA, IPD is defined as “a project delivery approach that integrates people, systems, business structures and practices into a process that collaboratively harnesses the talents and insights of all participants to reduce waste and optimize efficiency through all phases of design, fabrication and construction” [5],

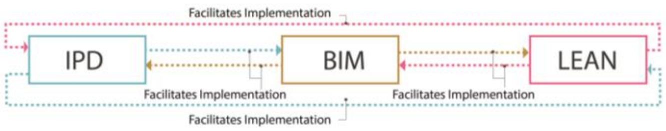

Figure 1. Mutual implementation facilitation

[10]. According to this definition, a strong alignment between Lean Construction and IPD contracts is found. Therefore, Lean systems, associated with the use of BIM methodologies, could be valuable tools to reinforce IPD implementation (*Figure 1*).

3. Methodology

Apart from the use of the literature review so as to analyse the feasibility of the preliminary thoughts related to the research topic, interviews have been developed as well. Those interviews have as an objective to collect qualitative data that could reinforce the developed ideas and bring new approaches that could help building up theorical framework proposals.

3.1. Interview procedure

In order to develop the interview-based investigation, different practitioners were selected.

In this sense, a project manager with 25 years of experience in complex construction projects in BIM environments (Respondent 01) and a BIM Manager with 8 years of experience in large scale projects (Respondent 02) were selected to carry out the interview. Both of them work at LKS.

According to their experience, the asked questions are:

- Are collaborative methods implemented at a contractual, process and IT integration level?
- Would it be suitable an integration that brings together collaborative systems at contract, process and IT solution level?
- BIM, IPD and Lean could help each other in their implementation?

4. Interview Results

Following the order of the questions presented in the previous chapter, the results based on contestants' answers are described.

4.1. Collaborative method state at contractual, process and BIM integration level

According to the Respondent 01, there is a collaborative workflow in the design and definition phases, even without using BIM methodologies. At this first phase, usually both developers and the engineering companies are involved. However, this collaborative atmosphere decreases when entering in next phases that involve municipalities and contractors and suppliers. From the experience of the Respondent 01, those have their own procedures, which makes difficult to implement more collaborative systems. In this sense, the collaboration gap between de design phase and execution phase is proved. Besides this, each stakeholder looks after its own interest, normally based on monetary goals, and even developers usually see the engineering company as a service supplier more than a team member. Due to this fact, communication problems can arise and, in some cases, the engineering companies find difficulties to solve client's problems due to this lack of information.

According to the Respondent 02, the level of collaboration depends on the scope and complexity of the projects. In larger projects in which a big quantity of resources is needed, project planning controls are usually further developed considering every stakeholder, whereas in smaller scope project is not taken into account at the same level. However, in Respondent 02's opinion, this is one of the main reasons why in many occasions smaller project become more problematic in terms of time and cost. Regarding the use of BIM as a collaborative tool, nowadays still is not widely used in an efficient way.

4.2. Suitability of integrating together collaborative systems at contract, process and IT solution level

In Respondent 01 opinion, although finding this integration suitable, there are some disadvantages as well. The main difficulty is found when trying to integrate every stakeholder in one single contract. As an example, trying to integrate subcontractor's needs in the main contract could be too complex as nowadays subcontractor negotiate directly with the main contractors. In order to change this, a deep collaboration mentality change would be needed. However, there are advantages too when it comes to the flexibility that could be achieved through a more collaborative contract. Construction projects suffer issues regarding time and cost due to changes asked by the developers and complications in the construction processes faced by the contractors. Having a contract system that allows updating the economic control of the construction phase due the needed changes would be suitable. At this point collaborative systems could be useful in order to proceed on those changes. According to Respondent 01, when a change is needed, this change becomes project by itself. Using IPD contracts, a collaborative protocol could be settled that could be executed with the help of collaborative IT systems and collaborative processes. Those collaborative systems could be, on the one hand BIM methodologies in which every stakeholder affected by this change could access and update, and on the other hand Lean Construction methods in order to use agile and collaborative processes such as Last Planner.

According to Respondent 02, there are only advantages in the integrated use of different collaborative systems. A clear example is seen in the use of BIM methodologies without clear processes, objectives and commands. Teams can work on BIM methodologies but if there is a lack of communication and the team members do not know the global objectives and processes, then BIM methodologies can become inefficient and even useless. Therefore, integrating collaborative processes would help out when using BIM methodologies.

4.3. Help each other in their implementation

According to Respondent 01, they would absolutely help each other as, in order to use the three methodologies, an open mind towards collaboration is needed, a mentality that is required in every field. Besides this, the contract includes a budget and planning that can be defined from a BIM model, and a Lean process can ensure a proper BIM use across the teams. Apart from this, so as to proceed with the needed project changes, the IPD contract can state that the BIM methodologies and Lean Processes have to be used, anchoring the implementation of those.

According to Contestant 02, IPD contracts could help building up a framework to use BIM correctly. Through this framework BIM objectives can be defined making team members more aware of the use and purpose of the BIM models. Therefore, reinforcing those objectives in a contract level would be suitable. Finally, acquiring better practices through more efficient Lean processes would help in the BIM implementation as well.

5. Theoretical work framework

Once the suitability of an integrated application of BIM, IPD and Lean is validated, designing a theorical framework to integrate them through the project life cycle is proposed as a next step for its implementation. Following this idea, in each process group, the roles of IPD, BIM and Lean are defined. Although each system should be used in every process group, the framework highlights the ones used more intensively in each of those groups (*Figure 2*).

According to this framework, in initial phase processes, IPD has a biggest potential as a key actor due its contractual capability. This means, it has the capacity to define the project objectives and how to achieve those objectives through collaborative methodologies. In the next phase involving project planning, Lean based processes gain importance as they facilitate planning development involving stakeholders through collaborative and transparent processes. During the project execution, both BIM methodologies and Lean Construction gain more visibility. Guided by the IPD procedure instructions, they will lead, on the one hand the collaborative processes by the use of Lean systems and, on the other hand, the collaborative IT, 3D visualization and documentation collaborative workflow through BIM methodologies. At this point, Lean and BIM will work closely and collaborating with each other.

In the monitoring phase, the three of them gain importance. Guided again by the procedures mandated on IPD, the required project changes will be executed through collaborative Lean processes and BIM methodologies. In this context, project teams respond on those changes using coordinated and agile planning processes given by Lean and by sharing and visualising their data and work progression through BIM methodology-based applications. At this point, Lean helps BIM in the efficient application of the process and BIM helps Lean in the correct visualization of progresses. Finally, within the closing phase, BIM methodologies have an important role when gathering the documentation related to the processes during the project development.

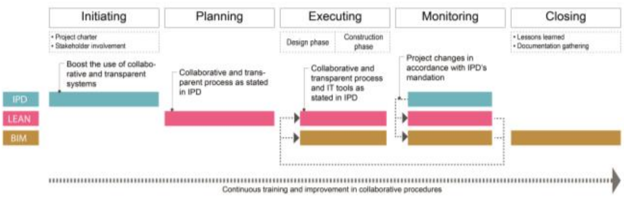

Figure 2. Intensively used systems

6. Conclusions

Following the gathered information, it is concluded that a higher commitment towards stakeholder collaboration would be desirable [1]. In this sense, implementing BIM, IPD and Lean in construction project shows beneficial effects within stakeholder collaboration. Inside this scheme, each system acquires different implementation roles (*Figure 3*).

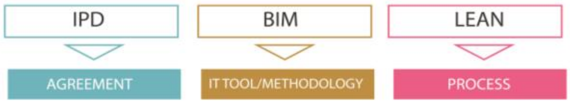

Figure 3. Roles of IPD, BIM and Lean

However, it has to be remarked that an efficient implementation of this scheme still finds barriers due a lack of a clear collaborative mindset within the way organizations cooperate with different parties. Although this fact, due its proved potential and because it is still a novel framework, the IPD, BIM and Lean interaction shows the required potential for carrying out further research towards new implementation approaches. Linked with this, besides their collaborative characteristics, the

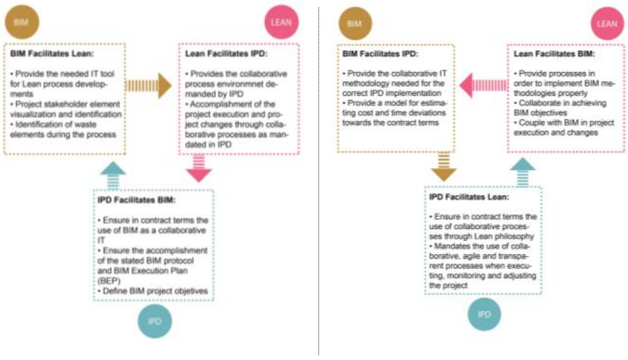

Figure 4. Implementation mutual help diagram

capability of helping each other in their implementation is found as a remarkable contribution of their interaction. This would mean that the performance capabilities of each system could become stronger if they are accompanied by at least one of the other two systems. Therefore, within this interaction, each system would bring and receive complementary characteristics to and from the others (*Figure 4*).

References

[1] C. Boton, D. Forgues "The need for a new systemic approach to study collaboration in the construction industry", Procedia Engineering, vol 196, pp. 1043-1050, 2017

[2] F. Elghaish, S. Abrishami, M. R. Hosseini, S. Abu-Samra, M. Gaterell "Integrated project delivery with BIM: An automated EVM-based approach", Automation in Construction, vol. 106, 102907, 2019

[3] A.H. Fakhimi, J. Majrouhi Sardroud and S. Azhar "How can Lean, IPD and BIM Work Together?", in 33rd International Symposium on Automation and Robotics in Construction ISARC, Auburn, USA, 2016

[4] R. Sacks, L. Koskela, B. Dave, R. Owen "Interaction of Lean and Building Information Modeling in Construction", Journal of Construction Engineering and Management © ASCE, pp. 968-980, 2010

[5] A. de Marco, A. Karzouna "Assessing the Benefits of the Integrated Project Delivery Method: A Survey of Expert Opinions", Procedia Computer Science, vol 138, pp. 823-828, 2018

[6] H. A. Mesa, K.R. Molenaar, L.F. Alarcón "Comparative analysis between integrated project delivery and lean project delivery", International Journal of Project Management, vol 37, pp. 395-409, 2019

[7] M. Oraee, M. R. Hosseini, D. J. Edwards, H. Li, E. Papadonikolaki, D. Cao "Collaboration barriers in BIM-based construction networks: A conceptual model", International Journal of Project Management, vol. 37, pp. 839–854, 2019

[8] M.Tauriainen, P. Marttinen, B.Dave, L.Koskela "The effects of BIM and lean construction on design management practices", Procedia Engineering, vol 164, pp. 567-574, 2016

[9] P. Piroozfar, E. R. P. Farr, A. H.M. Zadeh, S. Timoteo Inacio, S. Kilgallon, R. Jin "Facilitating Building Information Modelling (BIM) using Integrated Project Delivery (IPD): A UK perspective ", Journal of Building Engineering, vol 26, 100907, 2019

[10] American Institute of Architecture "Integrated Project Delivery: A Guide", version 1 https://www.aiacontracts.org/resources/64146-integrated- project-delivery-a-guide, 2007

Blockchain as a Trust Building Tool for the Promotion of Knowledge Sharing in Project Management

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Abstract:

The management of the knowledge generated throughout the projects and its sharing, with the aim of being used and thus providing maximum value, is a challenge today. The lack of trust between the different stakeholders in many cases acts as a barrier to such operations and hinders collaborative relationships. Blockchain is a tool designed to provide mutual trust between different parties, establishing rules for sharing and transferring value and knowledge between participants integrated in the network. Its deployment allows the generation of new collaborative environments within the development of projects, regulating the flow of knowledge and encouraging its sharing. The blockchain network enables new project development scenarios implemented using smart contracts, giving rise to what can be called Decentralized Autonomous Projects.

Keywords: Project Management; Knowledge Management; Blockchain; Distributed Autonomous Projects; DAP.

1. Introduction

Within Project Management (PM) there is a flow of information generation. All the phases of the project: initiation, planning, execution, monitoring and control, and closing, contemplate as input a set of necessary data that are modified during its development [1].

Documentation, information and knowledge is a living element that evolves throughout the project and does not end at its conclusion, but is inherited within the organization and transmitted as tacit or explicit knowledge in the form of experience and lessons learned to new projects.

The knowledge generated in order to provide value must be shared and used [2], becoming a fundamental element of innovation, allowing to face increasingly complex projects [3], or improving new developments.

One of the main problems in sharing information and, to a greater extent, knowledge, is the relationship of trust among the different parties. The lack of trust usually leads to problems of knowledge protection across stakeholders (i.e. intellectual property, know-how...) or even within the same organization.

Blockchain (BC) is a technology that brings trust among its members by the fact of using it [4]. Besides, it was designed to transfer value in a distributed way so that its deployment within information management processes inside PM can bring numerous advantages.

2. Knowledge Management in Projects

The use of information management tools, such as Project Management Information Systems (PMIS), improves the efficiency of PM in all its phases, increasing productivity and playing an important role in the decision-making process [5].

These systems often implement collaborative tools that allow the integration of multidisciplinary teams distributed in different locations. In this case, the PMIS could act as the project backbone by serving as a communication link among different stakeholders.

When projects involve different organizations, the establishment of a common collaboration platform can bring great advantages if problems such as protection of shared information, trust between different entities, ownership, and value transfer, can be overcome.

There are two common methods to implement data sharing between users in a group: one-to-many and many-to-many [6]. In the case of the PM, there are multiple sources of data generation, which can be centralized in the Project Manager role or used establishing decentralized sharing mechanisms. This last option, if it is implementable, seems the most adapted to reality if the sources of information generation and its use within the evolution of the project are taken into account.

3. Blockchain

Blokchain was firstly designed for bringing to life the first reliable decentralized cryptocurrency: Bitcoin [7]. Basically, it could be defined as a secure distributed ledger of transaction history, stored across participating computers, that allows trusted transactions without the need of a central authority [4].

Despite being born with the purpose of enabling decentralized economic transactions, it is considered an emerging disruptive technology in many other areas besides financial ones [8]. Its possibilities increase considerably when BC has the ability to support Smart Contracts (SC). This capability make it possible to establish automatic complex contractual relationships among the network participants, enabling new possibilities for collaboration that have never been seen before.

BC solutions as well as being deployed in public networks (as it is the case of Bitcoin or Ethereum) can also be implemented in private or consortium environments. In addition, depending on the requirements, the access to the BC network can be premissionless or permissioned. These facts improve its usage capabilities and make them more tailored to the needs of each application.

4. Blockchain and Knowledge Sharing

One of the fastest growing areas of BC application outside the financial world is within information sharing. This is causing a revolution in sectors that handle critical data such as those related to health, industry or energy among others.

BC allows access to critical and confidential information between medical entities, universities and research centers to improve their diagnoses and progress in the fight against diseases. In the same line, new possibilities for decision making based on the information shared by the devices installed in the Smart Grid are raised, optimizing and making possible its flexible planning and use [9]. The trust and immutability characteristics of the BC network make this type of application possible by enabling the collection of reliable data captured by the IoT devices to be later exploited by different companies [10].

BC applications within the supply chain can also guarantee the origin of each component and sometimes, combined with IoT sensors, maintain their traceability [11]. This is of great importance in sectors such as food and pharmaceutical industry [12].

This type of applications where the quality of the data, its immutability, trust and privacy protection are necessary, unveil how the application of BC can be used in the information and knowledge management areas. Recent studies make proposals for the use of secure and private data sharing systems based on BC in fully distributed environments [13], related even to research, by giving incentives to those who bring in the most [14].

5. Knowledge Sharing in Project Management with Blockchain

All the capabilities BC has for data sharing among individuals, systems or organizations can be applied to different project management areas. The establishment of a BC network in a project development environment allows:

Within a single project:

- To record the evolution of the project to be used as a source of secure and reliable information in real time of the monitored KPIs. In this case, it would be the source for algorithms that provide data to the project manager's dashboards.
- To have an immutable real-time record of the data included in the BC registry to make it available to the auditors when needed. This is even more important when dealing with highly critical sectors (medical, military, aeronautical, etc.)
- The information recorded after the project is completed will be very useful as a source of lessons learned. The fact of being registered means that it is kept explicitly in the organization, serving not only the project manager, but also the rest of its members, remaining in the organization, and it can be used as input for other information technology systems.
- If the BC network is extended and shared throughout the supply chain, it can serve as a means of ensuring the traceability of the components used [11] [12], as well as a system for real-time communication and consensus. The BC network using the SC capabilities establishes contractual links among participants when changing requirements happen or dealing with risks that arise during the course of the project

In a project-oriented organization:

- As a source of inter-project data to enable better decision making. The availability of data from past projects, as well as those that are being carried out in parallel within the shared BC network, is a mechanism for knowledge sharing and collaboration articulated by the network itself.
- The integration of the supply chain of each project in the BC network, including the assessment of suppliers or collaborators by the project managers, makes the system able to propose the best option in each case. Having a BC system that integrates suppliers' offers and information on their performance throughout different projects, would present the BC network as a virtual marketplace capable of suggesting possible risks to the Project Manager.
- As BC serves as a joint information platform for each and every project, both past and future, it could become one main source of KPIs to be presented in the management dashboard and taken into account in the decision-making process of the project portfolio.

In a consortium of organizations:

- The BC network can be extended beyond the supply chain integrating different partner companies within it. The fact of being completely distributed breaks the barrier of one of the companies being the data centralizer. This would make it possible for smaller companies to offer broader services, enabling them to compete in markets where the offer of large corporations is currently superior to their own [15].

- BC together with the agreed rules in the SCs can act as a linking tool between similar companies to join themselves for developing projects where the critical mass required is higher than the individual one. In this case, unlike the previous point, the advantage would not be to expand the services offered but to increase the economic and labor force in order to address larger projects.

- The deployment of a collaborative BC network with integrated value transfer capabilities allows the creation of a Business-to-Business (B2B) environment where different professionals and companies can share their work

- As a mechanism for registration, sharing and exchange of intellectual property. Using proposals similar to those proposed to be applied using BC in copyright licensing [16].

One of the main advantages of using BC to generate this type of collaborative network is that its properties can make it possible to share not only economic but also conceptual value. In order to carry out many projects it is necessary to transfer or share part of the knowledge that an organization has. This is more extreme in projects where research results, know-how or intellectual property are fundamental elements in the business. With BC as a tool, and using its SCs, these objectives can be achieved.

6. Decentralized Autonomous Projects: DAP

BC has the potential to change those business models that currently need the figure of an intermediary to provide the necessary level of trust. This scenario is typical in collaborative frameworks where the rules to be followed or the trust among members need a third party to guarantee it.

A business organization can be a clear example of this. It can be represented by its ownership and a set of rules governing the individuals who compose it [17]. Therefore, since the appearance of BC, people started to talk about collaborative frameworks where the rules and their property could be included in the BC network, implementing a complete organization [18]. These types of organizations are called DAO: decentralized autonomous organizations, keeping the rules and procedures in the network SC, and its property in its crypto-shares.

In line with DAO, decentralized autonomous project development entities (DAP) could be proposed, whose rules and operating culture were present in the SCs of the BC network. These DAP could join together complete structures of practitioners of classic or agile methodologies depending on the projects to be developed. As an example, it could be a DAP of Scrum teams, in where rules, roles and events are inside SC as well as payments and penalties.

In this scenario we could talk about the profile of a project manager inside a DAP (DAPM), in charge of coordinating the project between the BC based organization and the rest of the stakeholders (customers, institutions...). New challenges and opportunities could appear for this specific project manager.

7. Conclusions

Knowledge and its management are one of the key elements in PM. Having a tool like BC not only complements the current PMIS but opens new possibilities for collaboration within all members of a project, throughout the organization and between different companies.

BC is established as the base of trust among all participants that, integrated in its network, promotes the contribution of knowledge and its later management based on pre-agreed rules settled in the SCs that govern it.

This BC collaborative environment contemplates the sharing of knowledge that can be considered critical to the business: controlling and ensuring that all project requirements are met, guaranteeing the traceability of each and every one of the components used, and getting to have mechanisms for sharing and transferring know-how and intellectual property.

The capabilities of BC opens the way to new concepts such as 'Decentralized Autonomous Projects' and the figure of the Project Manager in this new scenario. Just as BC has become a disruptive technology in other sectors, these new terms may revolutionize the way collaborative projects are carried out in the future.

References

[1] Project Management Institute, Ed., *A guide to the project management body of knowledge: (PMBOK® guide) ; an American National Standard ANSI-PMI 99-001-2013*, 5. ed. Newtown Square, Pa: PMI, 2013.

[2] J. Olaisen and O. Revang, “The dynamics

of intellectual property rights for trust, knowledge sharing and innovation in project teams," *International Journal of Information Management*, vol. 37, no. 6, pp. 583–589, Dec. 2017, doi: 10.1016/j.ijinfomgt.2017.05.012.

[3] T. Ahern, B. Leavy, and P. J. Byrne, "Complex project management as complex problem solving: A distributed knowledge management perspective," *International Journal of Project Management*, vol. 32, no. 8, pp. 1371–1381, Nov. 2014, doi: 10.1016/j.ijproman.2013.06.007.

[4] I. García-Pastor, J. R. Otegi-Olaso, and F. Sánchez-Fuente, "Unveiling the Opportunities of Using Blockchain in Project Management," *Proceedings of the 1st International Conference on Research and Education in Project Management. Bilbao. 2018*, Feb. 2018.

[5] L. Raymond and F. Bergeron, "Project management information systems: An empirical study of their impact on project managers and project success," *International Journal of Project Management*, vol. 26, no. 2, pp. 213–220, Feb. 2008, doi: 10.1016/j.ijproman.2007.06.002.

[6] H. Huang, X. Chen, and J. Wang, "Blockchain-based multiple groups data sharing with anonymity and traceability," *Science China Information Sciences*, vol. 63, no. 3, Mar. 2020, doi: 10.1007/s11432-018-9781-0.

[7] S. Nakamoto, "Bitcoin: A Peer-to-Peer Electronic Cash System," p. 9.

[8] P. Boucher, S. Nascimento, and M. Kritikos, "How blockchain technology could change our lives," EPRS European Parlamientary Research Service, PE 581.948, Feb. 2017.

[9] M. Andoni *et al.*, "Blockchain technology in the energy sector: A systematic review of challenges and opportunities," *Renewable and Sustainable Energy Reviews*, vol. 100, pp. 143–174, Feb. 2019, doi: 10.1016/j.rser.2018.10.014.

[10] S. Badr, I. Gomaa, and E. Abd-Elrahman, "Multi-tier Blockchain Framework for IoT-EHRs Systems," *Procedia Computer Science*, vol. 141, pp. 159–166, 2018, doi: 10.1016/j.procs.2018.10.162.

[11] P. Helo and A. H. M. Shamsuzzoha, "Real-time supply chain—A blockchain architecture for project deliveries," *Robotics and Computer-Integrated Manufacturing*, vol. 63, p. 101909, Jun. 2020, doi: 10.1016/j.rcim.2019.101909.

[12] T. Bocek, B. B. Rodrigues, T. Strasser, and B. Stiller, "Blockchains everywhere - a use-case of blockchains in the pharma supply-chain," in *2017 IFIP/IEEE Symposium on Integrated Network and Service Management (IM)*, Lisbon, Portugal, 2017, pp. 772–777, doi: 10.23919/INM.2017.7987376.

[13] P. Wang, W. Cui, and J. Li, "A Framework of Data Sharing System with Decentralized Network," in *Big Scientific Data Management*, vol. 11473, J. Li, X. Meng, Y. Zhang, W. Cui, and Z. Du, Eds. Cham: Springer International Publishing, 2019, pp. 255–262.

[14] A. K. Shrestha and J. Vassileva, "Blockchain-Based Research Data Sharing Framework for Incentivizing the Data Owners," in *Blockchain – ICBC 2018*, vol. 10974, S. Chen, H. Wang, and L.-J. Zhang, Eds. Cham: Springer International Publishing, 2018, pp. 259–266.

[15] I. García Pastor, F. Sanchez Fuente, and J. R. Otegi Olaso, "BLOCKCHAIN COMO COMPONENTE CLAVE EN EL SECTOR MÁQUINA HERRAMIENTA EN LA INDUSTRIA 4.0," *DYNA INGENIERIA E INDUSTRIA*, vol. 94, no. 1, pp. 253–257, 2019, doi: 10.6036/8834.

[16] B. Bodó, D. Gervais, and J. P. Quintais, "Blockchain and smart contracts: the missing link in copyright licensing?," *International Journal of Law and Information Technology*, vol. 26, no. 4, pp. 311–336, Dec. 2018, doi: 10.1093/ijlit/eay014.

[17] V. Buterin, "DAOs, DACs, DAs and More: An Incomplete Terminology Guide." [Online]. Available: https://blog.ethereum.org/2014/05/06/daos-dacs-das-and-more-an-incomplete-terminology-guide/. [Accessed: 21-Oct-2018].

[18] C. Jentzsch, S. It, C. Jentzsch, and S. It, "DECENTRALIZED AUTONOMOUS ORGANIZATION TO AUTOMATE GOVERNANCE," p. 31.

Agile Mindset Competencies for Project Teams

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Abstract:

An agile approach's is strongly based on a team factor and human interactions are crucial for it. However, the literature analysis shows that the competencies that distinguish agile project teams from others are underexplored. This paper represents the results of the literature review on competencies that are important for a project team and make it agile.

Keywords: agile; competencies; mindset.

1. Introduction

An agile approach is one of project management approaches. As any other approaches, it requires people who possess certain competencies in order to implement it successfully. Competencies represents abstractions of work-relevant human behavior and introduce a useful concept for making human skills, knowledge and abilities manageable and addressable in a wide range of application areas.

Although the agile approach originated from software development projects, its success heavily depends on human factor, for example, a mindset [1, 2] and a team's set up. Thus, the question arises which competencies are important for a team to act as an agile team?

In this paper, the author uses a competency-based approach in order to answer this question. The existing literature sources have been studied in order to identify those competencies which are the most important for agile team members. The author has studied agile competencies based on two main limitation factors: 1) competencies specific for a project team, due to the fact, that teamwork is, basically, the main highlight of an agile approach as such; 2) competencies related to a mindset, as an agile mindset is reported to be decisive for a successful agile project management [1, 2].

2. Research description

The following definition of "agile" was used as a basis for this research: "Agility is an ability of an organisation to detect changes in an environment, fast and flexible adjust to these changes, recognize chance, opportunities and risks and align its approaches on those factors; at the same time, it also implies such an essential aspect as learning from own experience and make future-oriented actions" [3]. This definition was chosen for this research as it reflects the importance of mindset for agility.

The author have studied available scientific articles and books as well as widely known competence-based project management standards, searching for agile competencies. Around thirty sources have been chosen and studied in the first iteration.

However, agile competencies do not appear that often in scientific sources. Basically, only half of the sources contained some or little information regarding competencies that differentiate an agile project team from other types of project teams. Interestingly enough, most sources discuss which agile leadership competencies are important for a project manager. In other words, the attention is on agile leadership and what differentiates an "agile" project manager from, a "traditional" project manager. Another finding was that many competencies found by author could be considered as such that belong not only to successful agile teams but to any project team in general. Each competency that is included in the resulting list, however, thoroughly chosen as a competency which does make a difference in the agile team work.

2. Agile mindset competencies

The conducted research resulted in eighteen agile mindset competencies presented in *Table 1*. In the table, each competency is described with its "name" and its definition. These definitions do not aim to serve as definitions as such but as a ground for an elaborated competency definition for each given competency. When competencies are used to profile some rather new fields, it is not sufficient just to use them in their short form, so called "input approach" [4] (i.e. "communication", "flexibility"). The author deliberately studied and searched for agile mindset competencies in their elaborated form, so called "output approach". Competencies described in an output approach refer to the outputs, or results of the training or the study process [4].

3. Conclusions

This paper represents an attempt to summarize existing in current research literature information on the agile mindset competencies that differentiate an agile project team and reflect what agility is.

The subject of agile mindset competencies is not widely discuss yet. Most studied sources discuss competencies which are important for agile leadership, for the agile project manager, etc. but very little on individual competencies and even less on competencies for project teams.

The main finding of this paper is the list of 18 agile mindset competencies. This list was represented during 2019 at three industry workshops in two large project oriented company and one international professional project management association. The received feedback and occurred discussions proved the importance of agile mindset and a need to manage its development on it through some tangible methods as, for example, agile mindset competencies.

	Competency name	Competency's definitions	Sources
1	Cooperation	Capable to engage current and future interested parties by building a trusting environment that aligns their needs and expectations and balances their requests with an understanding of the cost/effort involved. Promote participation and collaboration throughout the project life cycle and provide the tools for effective and informed decision making. Working together to accomplish a task, the other is discussing with each other to solve some difficult problems [5]	PMI, 2014 PMI Agile Certified Practitioner (PMI-ACP)® Examination Content Outline; PMI, Agile Practice Guide, 2017; Hui, 2013; Agile manifesto; Mishra et al., 2012; Rico et al., 2009; Hofert, 2018; Dickert et al., 2016; Pröper, 2018
2	Communication	Capable to communicate the change intensively Make the change transparent Create and communicate positive experiences in the beginning Willingness to communicate in various ways so that entire team can work together well	Dickert et al., 2016; PMI, Agile Practice Guide, 2017; Hofert, 2018; Putta et al., 2018; Hui, 2013; Agile Manifesto; Mishra et al., 2012; Alsaqaf, 2019
3	Innovation fostering	Capable to contribute to a safe and trustful team environment by allowing everyone to experiment and make mistakes so that each can learn and continuously improve the way he or she works.	PMI, 2014 PMI Agile Certified Practitioner (PMI-ACP)® Examination Content Outline; Hofert, 2018; Alsaqaf, 2019; Welpe et al., 2018
4	Emotional intelligence	Capable to fathom perspectives of others, develop an understanding of different personalities, points of view and mindsets, and recognise and acknowledge ideas of others	PMI, 2014 PMI Agile Certified Practitioner (PMI-ACP)® Examination Content Outline; Hofert, 2018; PMI, Agile Practice Guide, 2017; Pröper, 2018
5	Self-organisation	Capable to take ownership of the development process and voluntarily improve it even further	PMI, 2014 PMI Agile Certified Practitioner (PMI-ACP)® Examination Content Outline; Hofert, 2018; Dickert et al., 2016; Freire et al., 2018; Putta et al., 2018
6	Flexibility	Capable to change one's own opinion, when it is requested by new information; readiness to adapt to changing conditions	Hofert, 2018
7	Honesty	Demonstrates a courage to speak openly about issues as well as regularly check own job and oneself according to specific measurable criteria in order to learn more about own performance	PMI, Agile Practice Guide, 2017; Mishra et al., 2012; Alsaqaf, 2019; Kaltenecker, 2018
8	Readiness to learn	Capable to support change at the system or organization level by educating the organization and influencing processes, behaviors, and people in order to make the organization more effective and efficient.	PMI, 2014 PMI Agile Certified Practitioner (PMI-ACP)® Examination Content Outline; Hofert, 2018; Hui, 2013; Rico et al., 2009; Mollbach et al., 2017; Richenhagen, 2018; Welpe, 2018
9	Coordination	Capable oneself as a team member to coordinate with other team members so that contribution of everyone is aligned in an optimal way.	Mishra et al., 2012; Alsaqaf, 2019; Kaltenecker, 2018
10	Feedback culture	Provide feedback from inside the team and from others	Kaltenecker, 2018; Mishra et al., 2012; Alsaqaf, 2019; PMI, Agile Practice Guide, 2017; Nowotny, 2017
11	Leadership	Die Fähigkeit, andere im positiven Sinn zu beeinflussen, wobei man auch als Teammitglied andere Teammitglieder motivieren und inspirieren kann.	PMI, 2014 PMI Agile Certified Practitioner (PMI-ACP)® Examination Content Outline; Hofert, 2018; PMI, Agile Practice Guide, 2017
12	Self-leadership	Capable to confidently act within a changing organisation, demonstrating a constructive interaction with uncertainty, opposition, pressure, self-doubt and resistance	Hofert, 2018; Nowotny, 2017
13	Tolerance to ambiguity	Capable to handle ambiguous situations and chaos	Hofert, 2018; Nowotny, 2017
14	Self-reflection	Capable to possess a greater level of self-awareness about the nature and impact of their performance, an awareness that creates opportunities for professional growth and development	Hofert, 2018; Mishra et al., 2012; Osterman et al., 1993; Nowotny, 2017; Flück, 2017
15	Conflict resolution	Capable to resolve conflicts in a project at an early stage and openly, solving them essentially and demonstrating the readiness to compromise	PMI, 2014 PMI Agile Certified Practitioner (PMI-ACP)® Examination Content Outline; Hofert, 2018; Kaltenecker, 2018; Müller & Simon, 2012; Pröper, 2018
16	Analytical skills	Capable to capture and comprehend complex occurrences as well as break them into subsections down	Pröper, 2018
17	Reliability	Capable to inspire trust by one's own behavior and win trust of others	Pröper, 2018
18	Assertiveness	Capable not only to present possible improvements but also convince others on its' necessity for goals' achievement, interacting as equals	Pröper, 2018

Table 1. The most important agile mindset competencies. [own source]

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References

[1] T.S. Schmidt, S. Weiss, K. Paetzold. Expected vs. real effects of agile development of physical products: Apportioning the hype." In DS 92: Proceedings of the DESIGN 2018 15th International Design Conference, pp. 2121-2132. 2018.

[2] O. Mikhieieva, A. Chirkova. How agile are companies in Germany? PMI White paper: http://www.pmicc.de/download/praesentationen/WEB_PMI_Whitepaper_HowAgile_2020.pdf, 2019.

[3] S. Hofert. Das agile Mindset. Mitarbeiter entwickeln, Zukunft der Arbeit gestalten, Wiesbaden, 2018.

[4] M. M. Heffernan and P. C. Flood, "An exploration of the relationships between the adoption of managerial competencies, organisational characteristics, human resource sophistication and performance in Irish organisations," Jnl Euro Industrial Training, vol. 24, no. 2/3/4, pp. 128–136, 2000.

[5] PMI, 2014 PMI Agile Certified Practitioner (PMI-ACP)® Examination Content Outline

[6] PMI, Agile Practice Guide, 2017

[7] Agile manifesto, 2001.

[8] Putta, A., Paasivaara, M., & Lassenius, C. (2018, November). Benefits and Challenges of Adopting the Scaled Agile Framework (SAFe): Preliminary Results from a Multivocal Literature Review. In International Conference on Product-Focused Software Process Improvement (pp. 334-351). Springer, Cham.

[9] Hui, A. (2013, August). Lean change: Enabling agile transformation through lean startup, kotter and kanban: An experience report. In 2013 Agile Conference (pp. 169-174). IEEE.

[10] Mishra, D., Mishra, A., & Ostrovska, S. (2012). Impact of physical ambiance on communication, collaboration and coordination in agile software development: An empirical evaluation. Information and software Technology, 54(10), 1067-1078.

[11] Alsaqaf, W., Daneva, M., & Wieringa, R. (2019). Quality requirements challenges in the context of large-scale distributed agile: An empirical study. Information and software technology.

[12] Kaltenecker, S. (2018). Selbstorganisierte Teams führen: Arbeitsbuch für Lean & Agile Professionals. dpunkt. verlag.

[13] Osterman, K. F., & Kottkamp, R. B. (1993). ReflectivePractice for Educators: Improving Schooling through Professional Development. CorwinPress. Newbury Park, CA.

[14] MÜLLER, W., & SIMON, C. Mit zwei Regelprozessen einfach zur agilen Projektorganisation. Basiswissen Projektmanagement–Prozesse und Vorgehensmodelle, 169.

[15] Pröpper, N. (2018). Agile Techniken für klassisches Projektmanagement: Qualifizierung zum PMI-ACP. MITP-Verlags GmbH & Co. KG.

[16] Flück, C.K. (2017) Agile Transformation – Welche Kompetenzen begünstigen den erfolgreichen Wandel? Zhaw –School of Management and LawCAS PersonalentwicklungLeistungsnachweis-30.Juni 2017

[17] Richenhagen, G. (2018). Teamfähigkeit und andere Kompetenzen in agilen Organisationen–warum nicht immer viele Köche den Brei verderben. In Wissen schmeckt (pp. 319-334). Springer, Wiesbaden.

Private firm participation effectiveness on collaborative projects: analysis of a Small and Medium Enterprise's contribution on project outcomes and Research & Development investment

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Abstract:

Research & Development (R&D) projects and in concrete R&D collaborative partnership projects are gaining presence in the last decade. This is due to the strategy of the European Commission to invest into R&D projects though its Framework Programs. The aim is to facilitate collaboration and scientific performance to gain global competitiveness. Thus, the challenge remains on the private firm participation and founding for R&D projects. In Project Management few studies have been done regarding R&D joint projects and private firm participation. The question remains on how affects private firm participation on collaborative R&D projects. This paper presents a preliminary analysis on the effect of private founding on R&D project outcomes and its effectiveness. The empirical study is a quantitative research based on data analysis of project results of Horizon 2020 Programme. The results and a correlation analysis indicate that private firm participation is slightly associated to an improvement of Project outcomes and their participation stimulates R&D investment.

Keywords: R&D; quality; private founding.

1. Introduction

A project is an unique set of co-ordinated activities, with definite starting and finishing points, undertaken by an individual or organization to meet specific objectives within defined schedule, cost and performance parameters [1]. The most used criteria for project success evaluation are organisational value (how perfectly will results help company in the future), Social value (R&D output becoming as a public good such as social value for the city, region or country), professional value (renewing and regaining professional competences) and economic value (money return, creation of new jobs, economic growth or increasing innovation capacity). On the other hand, main criteria applied for R&D project success is added value to knowledge creation and systematisation [2]. By instance, one of the principal characteristics of R&D project is their high level of uncertainty, where the major features of variation are variation of their scope, uncertainty and risk [3]. Due to the high uncertainty level, private companies have been historically reluctant to invest on R&D. However, there has been an increase from Industrial revolution on R&D investment from private companies and industry [4]. Public financial support for R&D activities has been adopted during the last years as a tool to enhance competitiveness. However its effectiveness is a fact of discussion for policymakers [5].

This paper aims to study the effectiveness of private money founding in joint R&D projects and its implication on the quality of the output. Horizon 2020 Programme (H2020) R&D joint projects were used as the starting point of this analysis. The paper is structured as follows. First, we discuss previous studies on R&D spending in private companies. Then we introduce the methodology applied in this paper, where data was collected from European Commission (EC) Database Cordis and a statistical analysis was done using SPSS Statistics software. Section 4 resumes the results obtained after the analysis. Section 5 discusses relationship of the results with the previous studies done and its implications. Finally, a conclusion suggests limitations of the research and avenues for future research.

2. Literature Review

During the last year, public financial support to business R&D has increased in most OECD countries (AMBER). However, the effectiveness of the public support to business R&D depends on the kind of support scheme they benefit from. Research and development is an ability to conduct different type of research and use created knowledge for product and technology development [6]. According to OECD R&D project can be classified as i) pure research (experimental and theoretical work undertaken to acquire new knowledge without application); ii) applied research (uses pure research results and applies it) and iii) experimental development (product oriented). R&D subsidies are one of the largest and fastest-growing forms of industrial aid in development countries. R&D subsidies could be divided in Research (R) and Development (D), and both of them show different characteristics. D projects are the ones with a lower uncertainty degree and lower market failure expectations. On the other hand, R involves: i) more tacit knowledge, ii) higher intangibility, iii) greater outcome uncertainty and iv) larger distance to the market [7]. That could be the reason why D projects tend to be financed by private companies comparing to R projects.

Government founding on R&D towards private research can be divided into two categories: direct founding (such as subventions) or indirect financial support (tax incentives) [8]. On this paper we have focused our attention on direct founding schemes. Previous studies have concluded that R&D subsidies stimulate R&D activities within firms. By instance, according to Clausen T. H. R activities stimulate R&D spending within firms and Development subsidies substitute R&D spending within firms.

European Union (EU) Challenge for 2020 was that total expenditure of R&D should consist of 3% GDP (Europe 2020) by reinforcing R&D activities in Europe [9]. Horizon 2020 is the biggest EU Research and Innovation programme ever with nearly €80 billion of funding available over 7 years (2014 to 2020). By coupling research and innovation, H2020 is helping to achieve this with its emphasis on Excellent Science, Industrial Leadership and tackling Societal Challenges [10]. H2020 is, thus, a direct financing scheme for public and private companies for R&D. Some of the projects under H2020 Programme are Joint R&D projects, which have emerged as a useful tool to enhance regional country technological development. R&D collaboration has been promoted with the aim to improve industrial competitiveness and reduce technological gaps among regions and countries [11]. Cofounding projects for private companies (where 30% budget is invest by private money) may give an overall overview of the effectiveness of private R&D money in R&D project outcomes.

3. Methodology

3.1 Data Collection

In this paper, we exploit detailed information provided by EC within 8th Framework Programme called H2020. Data was collected from Cordis Project Results Dashboard from EC. A representative sample from Horizon 2020 results between 2014-2019 has been used clustered in Countries. The sample of 14 Countries is composed by all those Countries on which we had a complete information set on the variables of interest for this work: i) Total projects founded and EC Contribution, ii) Number of Intellectual Property Rights (IPR) and Publications and EC Contribution iii) Small and Medium Enterprises (SMEs) participation and EC contribution. The most representative Countries regarding their participation on EU projects were taking into account: Austria, China, France, Germany, Italy, Japan, Netherlands, Poland, Portugal, Romania, Spain, Switzerland, United Kingdom and United States. On the other hand, OECD ANBERD is the source for R&D expenditure.

3.2. Data Analysis

We analysed quality and private founding variables and measure their relationship with a regression analysis. Quality was measured with Number of IPR and Publications and EC Contribution to that, and Private Contribution was measured by Small and Medium Enterprises (SMEs) participation in Industrial Leadership Program. Industrial Leadership Budget estimation is 35% of the total budget for financed H2020 projects up to now. On the same way, an estimation of private founding was done, which is around 30% according to the money invested in H2020 RIA (Research and Innovation projects) and IA (Innovative Actions) projects. Those two variables were included in terms of perception similarity through a regression cluster analysis of variables per Country using the SPSS 25.0 software.

4. Results

Main IPR and Publication contribution per Country are listed in *Table 1*. United Kingdom and United States have been the Countries obtaining the highest amount of EC contribution during the period 2014-2019. This could be understood as the result of monetizing the outcomes of the project and thus taking advantage of the results for future business or research activities. Number of Publications and IPRs (or EC contribution of IPR and Publications) have been taken as indicators of a quality of the projects. This means that those countries having received a higher amount of money for IPR and Publication from EC are thought to be part of a higher quality of R&D projects.

Countries	Total IPR + Publications	Total EC contribution
Austria	229	1093730000
China	102	358550000
France	971	215000000
Germany	3573	320000000
Italy	299	620490000
Japan	380	634740000
Netherlands	7543	68010000
Poland	131	899770000
Portugal	59	69470000
Romania	87	115810000
Spain	181	288550000
Switzerland	3207	23300000
United Kingdom	18423	13914800000
United States	20662	14290800000

Table 1. Total number of IPR and Publications and EC Contribution in Euros under H2020 program (2014-2019)

Table 2 shows SMEs participation per country. SMEs participation differs among countries, as it is more focused for EU SMEs. So, SMEs contribution to EU projects differs among countries; only EU countries have been taken in count to study the dependence or association for a more precise regression analysis.

Countries	Private Founding	
	EU Contribution to SMEs	SMEs Contribution
Austria	177770000	26665500
China	255630000	38344500
France	448470000	67270500
Germany	639930000	95989500
Italy	439860000	65979000
Japan	20000	3000
Netherlands	492540000	73881000
Poland	72320000	10848000
Portugal	103430000	15514500
Romania	18790000	2818500
Spain	450590000	67588500
Switzerland	28150000	4222500
United Kingdom	591710000	88756500
United States	8591250	1288687,5

Table 2. Total EU Contribution to SMEs and SMEs Contribution in Euros under H2020 program (2014-2019)

Results obtained from regression analysis confirm that there is a medium association between IPR + Publication and SMEs contribution. This means that the quality of the projects is slightly influenced by private firm participation in collaborative projects (*Table 3*).

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,381[a]	,145	,050	3,9946E+9

Table 3. IPR + Publications Vs SMEs contribution Regression analysis results obtained in SPSS Statistics

Finally, private firm participation and investment effectiveness on R&D collaborative joint projects has been analysed. When comparing SMEs participation in H2020 joint projects with total business investment in R&D per countries, we can observe that there is a medium association of variables. *Table 4* confirms a correlation between SMEs participation and founding on R&D by Industry. By instance, those countries with a higher investment on R&D by Industry have a higher participation rates, and thus, return of EU money to firms.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,649[a]	,421	,357	1,437E+10

Table 4. Regression analysis results obtained in SPSS Statistics

5. Conclusions

This section discusses the main outcomes, limitations and future research avenues. Few empirical studies have been found which study Joint R&D projects. N. Arranz & J.C Fernández de Arroyabe studied the association of distinct kinds of projects with R&D activities and results. Hence, our study represents a new insight of the implication of private founding on R&D projects.

A preliminary hypothesis of the author was based on the general idea that private firms implication may result on a better outcomes. However, even our results indicate a correlation between the quality of the projects and private contribution, they are no conclusive. Main limitation of this study has been data collection from Cordis, as there was no possibility to distinguish those projects financed only by public money by those being financed by both private and public money within H2020 program. More, on the future research studies subsidy effectiveness could be analyzed by comparing those two types of collaborative projects. Another factor that may as well affect private founding is the likelihood of establishing a R&D alliance with academia and business [13] and the elasticity of firms from technological frontier [14].

Previous studies based as well on a meta-regression analysis indicate that subsidies may stimulate R&D efforts of private firms [15]. By instance, our study has confirmed that SMEs participation on joint EU projects stimulate industry investment on R&D. In all, this has been the first time where a quality and firm implication relationship has been studied within collaborative R&D projects. Results indicate that future research activities may gave us a wider overview of private founding implications on collaborative or joint projects.

References

[1] Project Management institute (PMI). "A Guide to the Project Management Body of Knowledge", 5th ed., p. 589, 2013.

[2] B. Mikulskienė "Research and development Project Management" Mykolo Romerio Universitetas, 2014.

[3] D. Kuchta, B. Gladysz, D. Skowron and J. Betta. "R&D projects in the science sector", R&D Management vol 47, no 1, 2017.

[4] G. Bakker, " Money for nothing: how firms have financed R&D projects since Industrial Revolution", Research Policy vol 43, pp. 1793-1814, 2013.

[5] T. H. Clausen, "Do subsidies have positive impacts on R&D and innovation activities at the firm level?", Structural Change and Economic Dynamis vol 20, pp 239-253, 2009.

[6] OECD. "Frascati Manual 2002. Proposed Standard Practice for Surveys on Research and Experimental Development". France: OECD Publications Service, 2002

[7] H. Hottenrott, C. Lopes-Bento, R. Veugelers "Direct and cross scheme effets in research and development subsidy program" Research Policy vol 46, pp-1118-1132, 2017.

[8] Dumont M. "Assesing the policy mix of public support to business R&D", Research Policy vol. 46 pp.1651-1862, 2017.

[9] Europe 2020. A strategy for smart, sustainable and inclusive growth, COM(2010) 2020 final.

[10] https://ec.europa.eu/programmes/horizon2020

[11] R. Zobel, "The European Union Fifth Framework Programme, in: D.F" Technology and Innovation Management pp. 571–576, Portland International Conference on the Management of Engineering and Technology, 1999.

[12] N. Arranz & J.C. Fernández de Arroyabe. "Joint R&D projects: Experiences in the context of European technology policy". Technological Forecasting & Social Challenge vol. 73, pp. 860-885, 2018.

[13] L. Grilli, S. Murtinu " Selective subsidies, entrepreneurial founders' human capital, and accress to R&D alliances" Research Policy vol 47, pp. 1945-1963, 2017.

[14] F. Bogliacino & S. Gómez "Capabilities and investment in R&D: an analysis on European data" Structutal Change and Economic Dynamics vol 31, pp. 101-111, 2014.

[15] C. Dimos , G. Pugh, "The effectiveness of R & D subsidies: a meta-regression analysis of the evaluation literature". Research Policy vol. 45, no.4, 797–815, 2016

The relationship between Project Management and Industry 4.0: Bibliometric analysis of main research areas through Scopus

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Abstract:

Industry 4.0 has been adopted by the entire world as the fourth industrial revolution. It is also known as Advanced Manufacturing or Smart Manufacturing, and it is often used interchangeably with the notion of the digital transformation. The Industry 4.0 term is also multidimensional, and it refers to the current trends of automation, digitalization and data exchange in advanced technologies and manufacturing processes. In this respect, the project managers are seeking to understand technological changes and their impact on project management processes. With this in mind, the main objective of this contribution is to develop a bibliometric analysis to evaluate the performance and conceptual evolution of the authors and publications that are directly related to Industry 4.0 and Project Management.

Keywords: Industry 4.0; Strategic Intelligence; Project Management; Bibliometric network analysis; Competitive Intelligence; Business Intelligence; SciMAT.

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1. Introduction

The Industry 4.0, or the fourth industrial revolution, is already evolving not only industrial production, but also the methods, techniques and tools that are related to any activity. This revolution is structured for multiple technologies and knowledge areas, among which are Automation and Control Systems, Computer Science, Engineering, Material Science, Mechanics, Robotics, Operations Research and Management Science, Telecommunications, Transportation, among others [1].

The term Industry 4.0 was presented in 2011 at the Hanover Fair as a strategy to improve and reach the technological level of European countries. Industry 4.0 has no generally agreed upon definition, but concepts frequently associated with it include the Digitalization, Automation, Machine Learning and Predictive Analytics, Additive Manufacturing, Integration of Data and Information, Remote Sensing, Disruptive Technologies, mainly [2-4].

With this in mind, it is interesting to analyze the relationship between Project Management (PM) and Industry 4.0 using advanced bibliometric methods. This analysis will help to understand the full impact of this revolution in the PM field [5, 6].

To do that, we target to quantify the main indicators related to bibliometric performance: published publications, received citations, most cited articles, most cited authors, data on geographic distribution of publications, among others. Lastly, using a bibliometric analysis software based on a bibliometric network, we will review the connections. In this way, bibliometric can be defined as a set of methods and tools for evaluating and analyzing academic publication and citation in order to explore its impact on a specific field and how it contributes to the progress of science in the main areas of research [7].

Furthermore, the role of Project Management on the development of Industry 4.0 is essential to its success, and vice versa. Taking into account that the Project Management evolves and is embedded in all work activities, it is necessary to engage in a serous analysis on main research themes within these fields and its evolution. Finally, PM is a suitable tool for achieving the objectives and challenges posed by the development of advanced and intelligent technologies [8].

2. Methodology and Dataset

Based on a prior review of the state of the art, we focused the analysis according to the terms related to Industry 4.0 (including Smart Manufacturing and Advanced Manufacturing concepts) and the Project Management as knowledge field. In addition to carry out the bibliometric performance and network visualization map analysis, the publications related to the Industry 4.0 and Project Management have been collected.

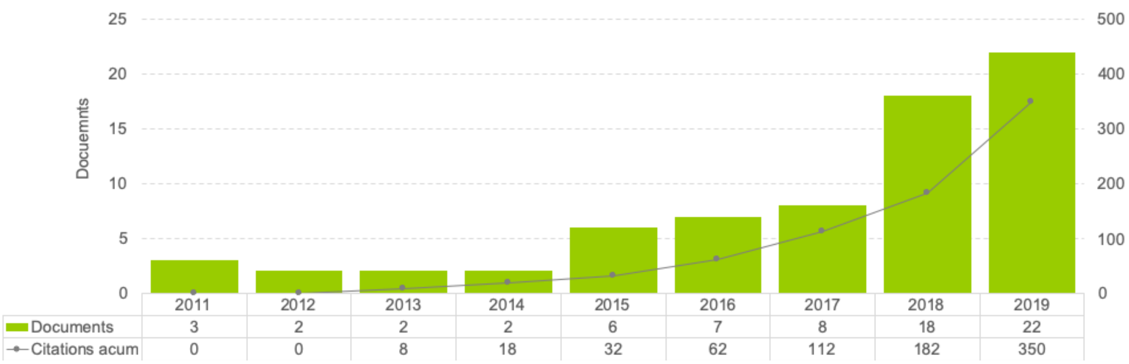

Figure 1. Distribution of Publications by year (2011-2019)

The raw data pertaining to Industry 4.0 and Project Management were retrieved from *Scopus* using the following advance query: *TITLE-ABS-KEY("Project Management") AND TITLE-ABS-KEY("Industry 4.0" OR "Smart Manufacturing" OR "Advanced Manufacturing") AND (LIMIT-TO(PUBYEAR, 2019) OR LIMIT-TO(PUBYEAR, 2018) OR LIMIT-TO(PUBYEAR, 2017) OR LIMIT-TO(PUBYEAR, 2016) OR LIMIT-TO(PUBYEAR, 2015) OR LIMIT-TO(PUBYEAR, 2014) OR LIMIT-TO(PUBYEAR, 2013) OR LIMIT-TO(PUBYEAR, 2012) OR LIMIT-TO(PUBYEAR, 2011)).*

In addition, the knowledge base was further refined and limited to Articles, Proceedings and Reviews published in English from 2011 to 2019 because the first publication related to Industry 4.0 concept was dated on 2011. This advance query retrieved a total of 70 publications. To accomplish this, we downloaded and reviewed all documents.

The bibliometric methodology used here classified the main Industry 4.0 research themes related to PM in four categories: (i) Motor themes, (ii) Highly developed and isolated themes, (iii) Emerging or declining themes and (iv) Basic and transversal themes. Moreover, the research themes within are represented as spheres, and its size is proportional to the number of publications associated with each research theme (see *Figure 5*) [9].

3. Performance Bibliometric Analysis of the Industry 4.0 in the Project Management field

To understand how the Industry 4.0 is moving in the Project Management field in terms of publication, citations and impact, we evaluated their performance through analysis of the following bibliometric indicators: most productive and cited authors, data on geographic distribution of publications, main sources and the most cited publications according to the h-index.

To do that, the bibliography performance analysis is structured in three sections. Firstly, evaluation of the publications and their citations with the aim of testing and evaluating scientific growth. Secondly, analysis of the authors performance, geographic distribution and most productive sources. Finally, thirdly, the most relevant publications according to the h-index.

3.1. Publication and Citations

The distribution of publications and citations related to Industry 4.0 and Project Management from 2011 to 2019 are shown in *Figure 1*.

Since the first publication related to Industry 4.0, the production was increasing every year. This evolution reveals the growing interest in the both areas and application and research of the Industry 4.0 technologies and the Project Management techniques, tools and methodologies.

As with the case of the publications, the citation distribution showed a positive developmental trend in the period 2011-2019. Based on the results of the advance query applied in the *Scopus*, the citation performance is summarized in the following indicators: Average citations per publication: 2,65, Sum of Times Cited (without self-citations): 186 (124) and 1.630 documents referenced.

3.2. Most Productive and Cited Authors, Geographic Distribution of Publications, Research Areas

It is also important to know which are the most productive and cited authors, along with the geographic distribution of publications and main sources. It complements the bibliometric performance analysis of the between Industry 4.0 and the Project Management field and allows for an evaluation of where developments have occurred within these fields. Consequently, the most productive and cited authors are shown in *Figure 2* and *Figure 3*, respectively.

Authors	Publications (n=70 | %)
Arashpour, M.	4 (5,71%)
Bai, Y.; Celebi, U. B.; de Lima, E. P.; Deschamps, F.; Hosseini, R.; Matt, D. T.; Turan, E.	2 (2,85%)
Rest of authors (n=151)	1 (1,42%)

Figure 2. Most productive authors (2011-2019)

Authors	Citations (n=186 | %)
Seo, Y.; Jia, Q.	34 (18,27%)
Elragal, A.; Haddara, M.	23 (12,36%)
Rest of authors (n=190)	19 or less

Figure 3. Most cited authors (2011-2019)

It is important to mention that the most productive authors are not included in the list of most cited and vice versa. This reflects two scenarios, the first one is related to productivity and the second one to themes that are interesting for both thematic.

The most productive countries related to Industry 4.0 and PM field are shown in *Figure 4*.

Country/Region	Publications (n=70 | %)
Germany	12 (17,14%)
Australia	7 (10,00%)
United States	6 (8,57%)
Spain	5 (7,14%)
United Kingdom	4 (5,71%)
Rest of countries/regions (n=32)	3 or less

Figure 4. Most productive countries and regions (2011-2019)

On the other hand, the sources with the largest number of documents published are *IOP Conference Series Materials Science and Engineering, Lecture Notes in Mechanical Engineering, Procedia Computer Science* and *ZWF Zeitschrift Fuer Wirtschaftlichen Fabrikbetrieb.* Finally, this supports the following research areas: Engineering, Computer Science, Business, Management and Accounting and Decision Science.

3.3. Most relevant publications according to h-index

Finally, the search query used in the database Scopus has an h-index of 7 [10]. Using as reference the h-index value, we could identify the following relevant publications to this research:

- (34 cites) Jia, Q., & Seo, Y. (2013). An improved particle swarm optimization for the resource-constrained project scheduling problem.
- (23 cites) Haddara, M., & Elragal, A. (2015). The Readiness of ERP Systems for the Factory of the Future.
- (19 cites) Arashpour, M., Bai, Y., Aranda-mena, G., Bab-Hadiashar, A., Hosseini, R., & Kalutara, P. (2017). Optimizing decisions in advanced manufacturing of prefabricated products: Theorizing supply chain configurations in off-site construction.
- (13 cites) Gentner, S. (2016). Industry 4.0: reality, future or just science fiction? How to convince today's management to invest in tomorrow's future! Successful strategies for industry 4.0 and manufacturing IT.
- (12 cites) Arashpour, M., Kamat, V., Bai, Y., Wakefield, R., & Abbasi, B. (2018). Optimization modeling of multi-skilled resources in prefabrication: Theorizing cost analysis of process integration in off-site construction.
- (11 cites) Chofreh, A. G., Goni, F. A., & Jofreh, M. G. (2011). Enterprise resource planning (ERP) implementation process: project management perspective.

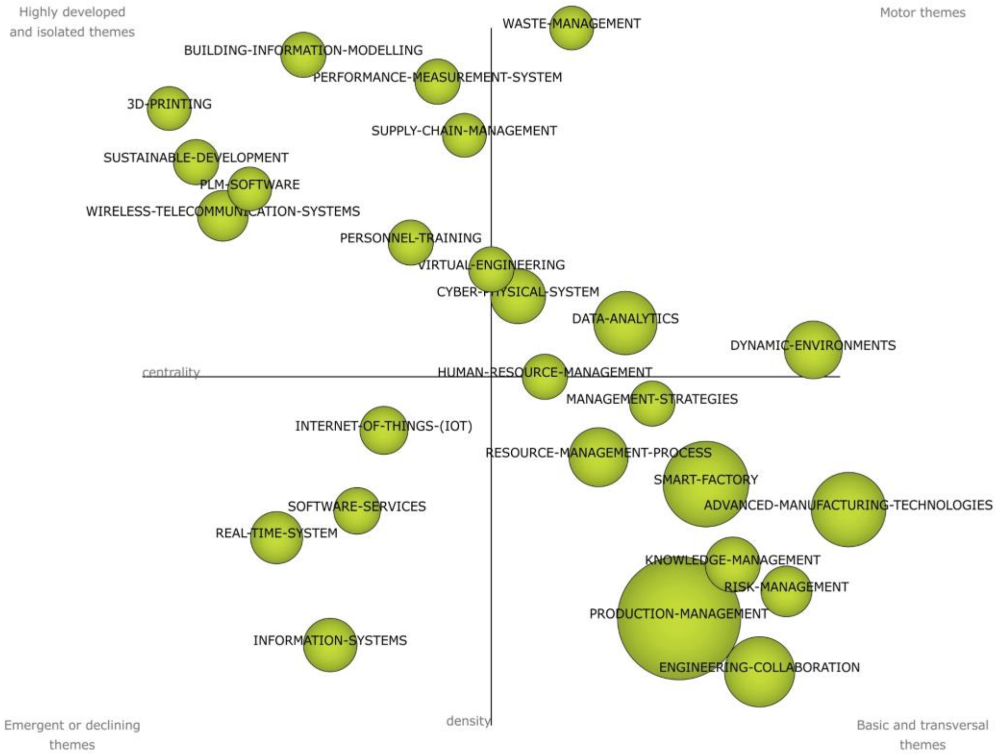

Figure 5. Main themes related to Industry 4.0 and Project Management

- (11 cites) Whyte, J., & Levitt, R. (2011). Information management and the management of projects.

To effectively analyze, the next step is to determine the main themes for both knowledge areas using SciMAT, software tool for constructing and visualizing bibliometric networks.

4. Network visualization map of Industry 4.0 in Project Management field

The main themes related to Industry 4.0 and Project Management from 2011 to 2019 are presented in the *Figure 5*. In this way, the most relevant and productive themes are: PRODUCTION-MANAGEMENT (59 publications), SMART-FACTORY (32 publications), ADVANCED-MANUFACTURING-TECHNOLOGIES (24 publications), ENGINEERING-COLLABORATION (21 publications) and DATA-ANALYTICS (16 publications).

The research themes are distributed in all four quadrants. With this in mind, the most relevant themes related to Industry 4.0 and Project Management are the themes included in the quadrant (i) and (iv). In this way, these themes are:

- Motor themes: DYNAMIC-ENVIRONMENTS, HUMAN-RESOURCE-MANAGEMENT, DATA-ANALYTICS, CYBER-PHYSICAL-SYSTEM, VIRTUAL-ENGINEERING and WATE-MANAGEMENT.
- Basic and transversal themes: PRODUCTION-MANAGEMENT, SMART-FACTORY, RISK-MANAGEMENT, ENGINEERING-COLLABORATION, RESOURCE-MANAGEMENT-PROCESS, MANAGEMENT-STRATEGIES and ADVANCED-MANUFACTURING-TECHNOLOGIES.

5. Conclusions

The size of literature related to Industry 4.0 in the Project Management field showed a noticeable increase in the last years. Given the large volume of citations received in this field, it is expected that the penetration of the Industry 4.0 and themes related to it in the Project Management field will continue.

Taking into account the main research lines of Project Management and the areas of action covered by the fourth industrial revolution, we have identified as potential common themes in the short term the following: PERFORMANCE-MEASUREMENTE-SYSTEM, SUSTAINABLE-DEVELOPMENT, PERSONNEL-TRAINING, DATA-ANALYTICS, DYNAMIC-ENVIRONMENTS, HUMAN-RESOURCE-MANAGEMENT, RISK-MANAGEMENT, MANAGEMENT-STRATEGIES, KNOWLEDGE-MANAGEMENT, INFORMATION-SYSTEMS and ENGINEERING-COLLABORATION.

Finally, some future work is necessary to provide a more in-depth examination of the use of Project Management in the fourth industrial revolution.

Acknowledgment

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References

[1] L. M. Kipper, L. B. Furstenau, D. Hoppe, R. Frozza, and S. Iespen, "Scopus scientific mapping production in industry 4.0 (2011–2018): a bibliometric analysis," *International Journal of Production Research,* 2019.

[2] S. E. Lemões Iepsen, L. B. Furstenau, and L. M. Kipper, "Relações entre educação em engenharia e o desenvolvimento de habilidades para a indústria 4.0," presented at the II Simpósio de Engenharia, Gestão e Inovação, Brazil, 2018.

[3] L. B. Furstenau and L. M. Kipper, "Produção enxuta e indústria 4.0 com foco na demanda do cliente: desafios e oportunidades para o desenvolvimento de pesquisas aplicadas.," presented at the XXXVIII Encontro nacional de engenharia de producao, Brazil, 2018.

[4] J. R. López-Robles, M. Rodríguez-Salvador, N. K. Gamboa-Rosales, S. Ramirez-Rosales, and M. J. Cobo, "The last five years of Big Data Research in Economics, Econometrics and Finance: Identification and conceptual analysis," *Procedia Computer Science,* vol. 162, pp. 729-736, 2019.

[5] J. R. López-Robles, J. R. Otegi-Olaso, H. Robles-Berumen, H. Gamboa-Rosales, A. Gamboa-Rosales, and N. K. Gamboa-Rosales, "Visualizing and mapping the project management research areas within the International Journal of Project Management: A bibliometric analysis from 1983 to 2018," presented at the Research and Education in Project Management - REPM 2019, Bilbao (Spain), 2019.

[6] J. R. López-Robles, "La integración de los enfoques de Inteligencia para la promoción del desarrollo de ventajas competitivas científicas, tecnológicas e innovadoras en el Sector Vasco de Automoción," Tesis doctoral, Departamento de Expresión Gráfica y Proyectos de Ingeniería, Universidad del País Vasco/Euskal Herriko Unibertsitatea, Bilbao, Spain, 2019.

[7] Y. R. Wang, Q. J. Wang, X. Z. Wei, J. Shao, J. Zhao, Z. C. Zhang*, et al.*, "Global scientific trends on exosome research during 2007-2016: a bibliometric analysis," *Oncotarget,* vol. 8, pp. 48460-48470, Jul 2017.

[8] J. R. López-Robles, J. R. Otegi-Olaso, I. Porto-Gómez, and M. J. Cobo, "30 years of intelligence models in management and

business: A bibliometric review," *International Journal of Information Management,* vol. 48, pp. 22-38, 2019.

[9] M. J. Cobo, A. G. López-Herrera, E. Herrera-Viedma, and F. Herrera, "SciMAT: A new science mapping analysis software tool," *Journal of the American Society for Information Science and Technology,* vol. 63, pp. 1609-1630, 2012.

[10] M. A. Martínez, M. Herrera, J. López-Gijón, and E. Herrera-Viedma, "H-Classics: Characterizing the concept of citation classics through H-index," *Scientometrics,* vol. 98, pp. 1971-1983, 2014.

Exploring the use of Strategic Intelligence as support tool in the Project Management field using advanced bibliometric methods

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Abstract:

Strategic Intelligence is being seen as a core activity in business, science, education or any field in which the use of high-value data, information and knowledge are vital to achieve their goals. The SI concept is also multidimensional, and it can be defined as a process to gather, analyze, interpret and disseminate high value data and information at the right time for use in the decision-making process. In this respect, the project managers are seeking to develop a culture of result orientation, focused on an effective decision-making and collaboration. Thus, the main aim of this contribution is to develop a bibliometric analysis to evaluate the performance and conceptual evolution of the authors and publications that are directly related to Strategic Intelligence from the point of view of Project Management.

Keywords: Strategic Intelligence; Project Management; Bibliometric network analysis; Information Management; Competitive Intelligence; Business Intelligence; SciMAT.

1. Introduction

The Strategic Intelligence are precisely what make managing projects efficient and more effective. These can be described as the ways that we gather information, communicate, and generally get things done. With this in mind, it is interesting to analyze the use of Strategic Intelligence as support tool in the Project Management field using advanced bibliometric methods to understand the full impact of these in the Project Management Process: Initialing, Planning, Executing, Monitoring and Controlling and Closing [1-4].

In this way, the main objective of the present article is to analyze the role of the Strategic Intelligence in the Project Management field considering the PMBOK 6 Knowledge Areas *(Project Integration Management, Project Scope Management, Project Schedule Management, Project Cost Management, Project Quality Management, Project Resource Management, Project Communication Management, Project Risk Management, Project Procurement Management and Project Stakeholder Management)* using advanced bibliometric methods.

To do that, we target to quantify the main indicators related to bibliometric performance: published publications, received citations, most cited articles, most cited authors, data on geographic distribution of publications, among others. Lastly, using a bibliometric analysis software based on a bibliometric network, we will review the connections.

Bibliometrics can be defined as a set of methods and tools for evaluating and analyzing academic publication and citation in order to explore its impact on a specific field and how it contributes to the progress of science in the main areas of research [5].

Furthermore, Strategic Intelligence is the result of an organization's effort to define, identify, gather, analyze, update and disseminate value added information about itself and its environment that support decision making process. Finally, Strategic Intelligence supports organizations sustain their competitive advantage by providing actionable insights and reliable input to decision makers at operational, tactical or strategic levels. [6-9].

2. Methodology and Dataset

Based on a prior review of the state of the art, we focused the analysis according to the terms related to Strategic Intelligence and the Project Management as knowledge area. In addition to carry out the bibliometric performance and network visualization map analysis, the publications related to the Strategic Intelligence and Project Management have been collected.

The data pertaining to Strategic Intelligence and Project Management were retrieved from Web of Science™ Core Collection using the following advance query: *TS=("project management") AND TS=("strategic intelligence" OR "business intelligence" OR "competitive intelligence" OR "market intelligence" OR "technology intelligence" OR "organizational intelligence").*

In addition, the knowledge base was further refined and limited to Articles, Proceedings and Reviews published in English. This advance query retrieved a

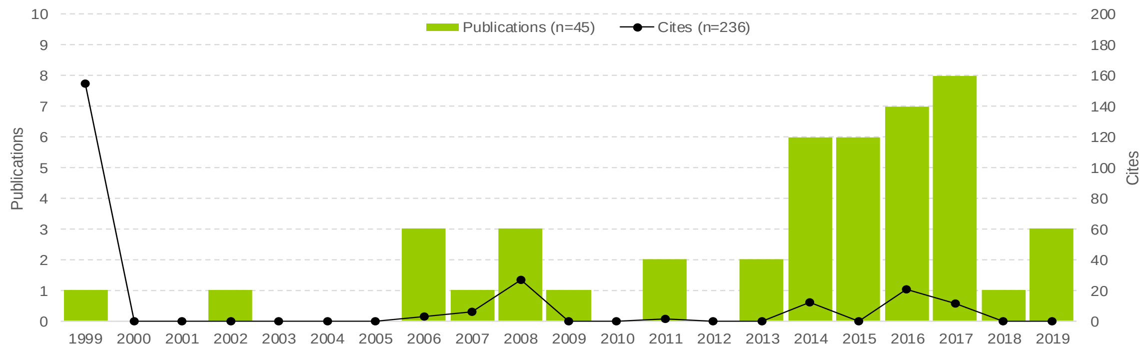

Figure 1. Distribution of Publications by year (1999-2019)

total of 46 publications, of which 45 are directly related to use of the Strategic Intelligence. To accomplish this, we downloaded all the publications and reviewed each abstract.

The bibliometric methodology used here classified the main Strategic Intelligence research themes in the PM field in four categories: (i) Motor themes, (ii) Highly developed and isolated themes, (iii) Emerging or declining themes and (iv) Basic and transversal themes. Furthermore, the research themes within are represented as spheres, and its size is proportional to the number of publications associated with each research theme [10].

3. Performance Bibliometric Analysis of the Strategic Intelligence in the PM field

To understand how the Strategic Intelligence has evolved in the Project Management field in terms of publication, citations and impact, we evaluated their performance through analysis of the following bibliometric indicators: published publications, received citations, most cited articles, most cited authors, data on geographic distribution of publications and h-index.

The bibliography performance analysis is structured in two parts: (1) evaluation of the publications and their citations with the aim of testing and evaluating scientific growth; and (2) analysis of the authors, publications, journals and research areas to assess the impact of the publications.

3.1. Publication and Citations

The distribution of publications and citations related to Strategic Management in the Project Management field per year are shown in *Figure 1*. It shows that the number of publications has increased in the last years.

Since the first publication related to the use and application of Strategic Intelligence, we can highlight three milestones in the use of the Strategic Intelligence in the PM knowledge area. The first was on 1999, when the first research was published. The second milestone was on 2006, where the publications of research started a continuous process. Finally, like the previous milestone, the third was on 2013 when the publications were continuous. This evolution reveals the growing interest in the Project Management knowledge area and use and research of Strategic Intelligence.

On the other hand, the distribution of citations per year is shown in the *Figure 1*. As with the case of the publications, the citation distribution showed a positive developmental trend in the period 1999-2019. Based on the results of the advance query applied in the Web of Science™ Core Collection, the citation performance is summarized in the following indicators: Average citations per publication: 5,24; Sum of Times Cited (without self-citations): 236 (233) and Citing articles (without self-citations): 235 (232).

3.2. Most Productive and Cited Authors, Geographic Distribution of Publications, Research Areas and h-index (Citation Classics)

It is also important to know which are the most productive and cited authors, along with the geographic distribution of publications and research areas. It complements the bibliometric performance analysis of the use of Strategic Intelligence as support tool in the Project Management field and allows for an evaluation of where developments have occurred within these fields. Consequently, the most productive authors are shown in *Figure 2*.

Authors	Publications (n=45 | %)
Bach, M. P., Celio, A., Gawdiak, Y., Hamranova, A., Jrad, R. B. N., Marsina, S., Pondel, J., Pondel, M., Putz, P., Shamshurin, I., Sundaram, D., Zoroja, J.	2 (4,44%)
Rest of authors (n=95)	1 (2,22%)

Figure 2. Most productive authors (1999-2019)

Along these years, the most cited authors are shown in *Figure 3*.

Authors	Citations (n=236 | %)
Robey, D., Lyytinen, K.	155 (65,68%)
Sen, A., Ramamurthy, K., Sinha, A. R.	17 (7,20%)
Rennolls, K., Al-Shawabkeh, A.	10 (4,24%)
Habjan, a., Andriopoulos, C., Gotsi, M.	9 (3,81%)
Hahn, A., Saltz, J. S., Austing, S. G., Strickmann, J.	6 (2,54%)
Muller, L., Ashish, N., Batra, D., Bell, D., Hart, M., Maluf, D.	3 (1,27%)

Figure 3. Most cited authors (1999-2019)

It is important to mention that the most productive authors are not included in the list of most cited. It is important mention that these authors are related to the query used to obtain the publications and these don't have to be prominent authors in the PM field.

The most productive countries related to use of Strategic Intelligence as support tool in the Project Management field during the last 20 years are shown in *Figure 4*.

Country/Region	Publications (n=45 | %)
USA	10 (22,22%)
China	3 (6,67%)
Poland, Herceg-Bosna, Croatia, England, Finland, Germany, India, New Zealand, Servia, Slovakia, South Africa, Spain	2 (4,44%)
Rest of countries/regions (n=11)	1 (2,22%)

Figure 4. Most productive countries (1999-2019)

On the other hand, the sources with the largest number of documents published are *International Conference on Information Intelligence Systems and Applications, Advances in Production Management Systems Innovative and Knowledge Based Production Management in a Global Local World, Advances in Information and Communication Technology,* and *Lecture Notes in Business Information Processing*. It highlights that host the main publications, covering knowledge areas as: *Computer Science Information Systems, Management, Engineering, Electrical & Electronic, Telecommunications* and *Business and Finance.*

Finally, the search query used in the database Web of Science™ Core Collection has an h-index of 6 [11]. Using as reference the h-index value, we could identify the following relevant publications to this research:

- (155 Cites) Learning failure in information systems development (Lyytinen, K; Robey, D).
- (17 cites) Data warehousing infusion and organizational effectiveness (Ramamurthy, K.; Sen, Arun; Sinha, Atish R.).
- (10 cites) Technology Acceptance Model for Business Intelligence Systems: Preliminary Research (Bach, Mirjana Pejic; Celjo, Amer; Zoroja, Jovana).
- (10 cites) Formal structures for data mining, knowledge discovery and communication in a knowledge management environment (Rennolls, Keith; AL-Shawabkeh, Abdallah).
- (9 cites) The role of GPS-enabled information in transforming operational decision making: an exploratory study (Habjan, Andreja; Andriopoulos, Constantine; Gotsi, Manto).
- (6 cites) Big Data Team Process Methodologies: A Literature Review and the Identification of Key Factors for a Project's Success (Saltz, Jeffrey S.; Shamshurin, Ivan).

To effectively analyze, the next step is to determine the use of Strategic Intelligence as support tool in the Project Management field using SciMAT, software tool for constructing and visualizing bibliometric networks [12-14].

Figure 5. Main Strategic Intelligence themes in the Project Management field

4. Network visual

ization map of Strategic Intelligence in Project Management field

The main Strategic Intelligence themes in the Project Management field from 199 to 2019 are: DATA-ANALYTICS (72 publications), AGILE-METHODS (14 publications), PERFORMANCE MEASUREMENT-SYSTEM (12 publications), INFORMATION-MANAGEMENT-CAPABILITY (8 publications) and PROJECT-MANAGEMENT-TOOLS (6 publications). The research themes are distributed in all four quadrants. The most productive quadrants are the (ii) Highly developed and isolated themes and (iv) Basic and transversal themes. It is important to mention that the quadrants (i) Motor themes and (iv) Basic and transversal themes concentrate the most important themes to development of the PM field. In this way, these themes are: DATA-MINING-(DM), PERFORMANCE-MESAUREMENT-SYSTEM, PROJECT-MANAGEMENT-PROCESS, INFORMATION-MANAGEMENT-CAPABILITY, AGILE-METHODS and DATA-ANALYTICS.

5. Conclusions

The size of literature related to use of Strategic Intelligence as support tool in the Project Management field showed a noticeable increase in the last years. Given the large volume of citations received in this field, it is expected that the use of Strategic Intelligence in the PM field will be seen as part of the projects.

Strategic Intelligence as support tool in the PM field needs to be encouraged, particularly in the new industrial sectors and collaborative projects. In this way, Strategic Intelligence is related mainly to the *Project Integration Management, Project Scope Management, Project Procurement Management* and *Project Stakeholder Management*, but has interaction with all of the knowledge areas of PM. Keep in mind that the focal point of reference for all the items are the Strategic Intelligence as support tool in the Project Management field, the following research themes highlight DATA-ANALYTICS, INFORMATION-MANAGEMENT-CAPABILITY, AGILE-MEHTODS and PROJECT-MANAGEMENT PROCESS.

Finally, some future work is necessary to provide a more in-depth examination of the use of Strategic Intelligence in the PM field. This work should include an identification of common process and tools, and the integration of new project management strategies.

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References

[1] J. R. Otegi-Olaso, J. R. López-Robles, and N. K. Gamboa-Rosales, "Responsible Project Management to face urgent world crisis and regional conflicts," presented at the Birzeit University - Project Management, Birzeit, Palestine, 2019.

[2] J. R. López-Robles, J. R. Otegi-Olaso, H. Robles-Berumen, H. Gamboa-Rosales, A. Gamboa-Rosales, and N. K. Gamboa-Rosales, "Visualizing and mapping the project management research areas within the International Journal of Project Management: A bibliometric analysis from 1983 to 2018," presented at the Research and Education in Project Management - REPM 2019, Bilbao (Spain), 2019.

[3] J. R. López-Robles, J. Otegi-Olaso, R., I. Porto-Gómez, H. Gamboa-Rosales, and N. K. Gamboa-Rosales, "Intelligence: origin, evolution and trends," presented at the VISIO 2018 Conference, 2018.

[4] J. R. López-Robles, "La integración de los enfoques de Inteligencia para la promoción del desarrollo de ventajas competitivas científicas, tecnológicas e innovadoras en el Sector Vasco de Automoción," Tesis doctoral, Departamento de Expresión Gráfica y Proyectos de Ingeniería, Universidad del País Vasco/Euskal Herriko Unibertsitatea, Bilbao, Spain, 2019.

[5] Y. R. Wang, Q. J. Wang, X. Z. Wei, J. Shao, J. Zhao, Z. C. Zhang*, et al.*, "Global scientific trends on exosome research during 2007-2016: a bibliometric analysis," *Oncotarget,* vol. 8, pp. 48460-48470, Jul 2017.

[6] J. R. López-Robles, J. R. Otegi-Olaso, I. Porto-Gómez, and M. J. Cobo, "30 years of intelligence models in management and business: A bibliometric review," *International Journal of Information Management,* vol. 48, pp. 22-38, 2019.

[7] J. R. López-Robles, J. R. Otegi-Olaso, N. K. Gamboa-Rosales, H. Gamboa-Rosales, and M. J. Cobo, "60 Years of Business Intelligence: A Bibliometric Review from 1958 to 2017," in *New Trends in Intelligent Software Methodologies, Tools and Techniques: Proceedings of the 17th International Conference SoMeT_18*, 2018, p. 395.

[8] J. R. López-Robles, J. R. Otegi-Olaso, R. Arcos, N. K. Gamboa-Rosales, and H. Gamboa-Rosales, "Mapping the structure and evolution of JISIB: A bibliometric analysis of articles published in the Journal of Intelligence Studies in Business between 2011 and 2017," *Journal of Intelligence Studies in Business,* vol. 8, 2018.

[9] J. R. López-Robles, J. R. Otegi-Olaso, I. Porto-Gómez, H. Gamboa-Rosales, and N. K. Gamboa-Rosales, "Understanding the

intellectual structure and evolution of Competitive Intelligence: a bibliometric analysis from 1984 to 2017," *Technology Analysis & Strategic Management,* pp. 1-16, 2019.

[10] M. J. Cobo, A. G. López-Herrera, E. Herrera-Viedma, and F. Herrera, "SciMAT: A new science mapping analysis software tool," *Journal of the American Society for Information Science and Technology,* vol. 63, pp. 1609-1630, 2012.

[11] M. A. Martínez, M. Herrera, J. López-Gijón, and E. Herrera-Viedma, "H-Classics: Characterizing the concept of citation classics through H-index," *Scientometrics,* vol. 98, pp. 1971-1983, 2014.

[12] J. R. López-Robles, J. R. Otegi-Olaso, I. Porto-Gómez, N. K. Gamboa-Rosales, H. Gamboa-Rosales, and H. Robles-Berumen, "Bibliometric Network Analysis to Identify the Intellectual Structure and Evolution of the Big Data Research Field," in *International Conference on Intelligent Data Engineering and Automated Learning*, 2018, pp. 113-120.

[13] J. R. López-Robles, J. Guallar, J. R. Otegi-Olaso, and N. K. Gamboa-Rosales, "El profesional de la información (EPI): bibliometric and thematic analysis (2006-2017)," *El profesional de la información,* vol. 28, p. e280417, 2019.

[14] J.-R. López-Robles, J. Guallar, N.-K. Gamboa-Rosales, J. R. Otegi-Olaso, and M. J. Cobo, "Mapa de la estructura intelectual de El profesional de la información de 2014 a 2018," *Hipertext. net, 2019, num. 19, p. 115-125,* 2019.

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