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ARTIGOS

EFFECTIVENESS ANALYSIS OF WATERFALL AND AGILE PROJECT MANAGEMENT METHODOLOGIES – A CASE STUDY FROM MACAU'S CONSTRUCTION INDUSTRY

ANÁLISE DA EFICÁCIA DAS METODOLOGIAS DE GESTÃO EM CASCATA E DE PROJETOS ÁGEIS - UM ESTUDO DE CASO DA INDÚSTRIA DE CONSTRUÇÃO DE MACAU

ABSTRACT

The adoption of project management techniques is a crucial decision for corporate governance in construction companies since the management of areas such as risk, cost, and communications is essential for the success or failure of an endeavor. Nevertheless, different frameworks based on traditional or agile methodologies are available with several approaches, which may create several ways to manage projects. The primary purpose of this work is to investigate the adequate project management methodology for the construction industry from a general perspective and consider a case study from Macau. The methodology considered semi-structured interviews and a survey comparing international and local project managers from the construction industry. The interviews indicate that most construction project managers still follow empirical methods with no specific methodology but consider the adoption of traditional waterfall approaches. In contrast, according to the survey, most project managers and construction managers agree that the project's efficacy needs to increase, namely in planning, waste minimization, communication increase, and focus on the Client's feedback. In addition, there seems to be a clear indication that agile methodology could be implemented in several types of projects, including hospitality development projects. A hybrid development approach based on the Waterfall and Agile methodologies as a tool for the project management area may provide a more suitable methodology for project managers to follow.

Keywords: project management methodologies; agile; PMBOK; construction industry.

Joao Alexandre Lobo Marques
alexandre.lobo@usj.edu.mo
*Pós Doutor e Honorary Visiting
Fellow na University of Leicester
- Reino Unido. Associate
Professor na University of Saint
Joseph - Macau, SAR China.*

**João José Bragança dos Reis
Morais**
jrm.engwork@gmail.com
*University of Saint Joseph,
Macau, SAR China.*

José Alves
josealves@cityu.mo
*City University of Macau, Macau,
SAR China.*

Marcus Gonçalves
marcus.goncalves@nichols.edu
*Nichols College, Boston, United
States.*

RESUMO

A adoção de técnicas de gerenciamento de projetos é uma decisão crucial para a governança corporativa em empresas de construção, pois o gerenciamento de áreas como risco, custo e comunicações é essencial para o sucesso ou fracasso de um empreendimento. No entanto, diferentes estruturas baseadas em metodologias tradicionais ou ágeis estão disponíveis com várias abordagens, o que pode criar várias maneiras de gerenciar projetos. O objetivo principal deste trabalho é investigar a metodologia adequada de gerenciamento de projetos para a indústria da construção a partir de uma perspectiva geral e considerar um estudo de caso de Macau. A metodologia considerou entrevistas semi-estruturadas e uma pesquisa comparando gerentes de projetos internacionais e locais da indústria da construção. As entrevistas indicam que a maioria dos gerentes de projetos de construção ainda seguem métodos empíricos sem metodologia específica, mas consideram a adoção de abordagens tradicionais em cascata. Em contraste, de acordo com a pesquisa, a maioria dos gerentes de projeto e gerentes de construção concordam que a eficácia do projeto precisa aumentar, isto é, no planejamento, minimização de desperdícios, aumento da comunicação e foco no feedback do Cliente. Além disso, parece haver uma indicação clara de que uma metodologia ágil poderia ser implementada em vários tipos de projetos, incluindo projetos de desenvolvimento de hospitalidade. Uma abordagem híbrida de desenvolvimento baseada nas metodologias Waterfall e Agile como ferramenta para a área de gerenciamento de projetos pode fornecer uma metodologia mais adequada a ser seguida pelos gerentes de projetos.

Palavras-chave: metodologias de gerenciamento de projetos; ágil; PMBOK; indústria da construção civil.

1 INTRODUCTION

Located in southern China, Macau is a Special Administrative Region of the People's Republic of China, and it is known for its sumptuous casinos and luxury hotels (DSEC, 2018 a). Macau's population was around 648,500 by the end of the third quarter of 2017, with a slight increase of 100 people from quarter to quarter, in which the female population accounted for 53% of the total (DSEC, 2018b).

Since 2006, Macau has had the world's highest gaming revenue and is among the world's wealthiest regions. According to the World Bank, its gross domestic product (GDP) per capita was among the highest for many years (THE WORLD BANK, 2021). In 2018, the gaming industry had a total of 40 casinos operating under six gaming concessionaires: Sociedade de Jogos de Macau (S.J.M.) with twenty-two casinos; Galaxy with six; Sands China with five; Melco Crown with four; Wynn with two units and MGM with two casinos (DICJ, 2018).

Data from the Macau Gaming Inspection and Coordination Bureau (D.I.C.J.) shows that gaming revenue reached 22.7 billion Patacas (USD\$2.83 billion) in December 2017, 14.6% higher than the previous year. Despite such high revenue numbers, the industry continues to grow, with other resorts in the Cotai Strip area under construction, expected to be completed by 2022.

The gaming activities in Macau stretch back for more than three centuries. However, it was only in 2002, after the handover of Macau back to China, that the industry boomed. In that year, the Macau SAR government granted six gaming licenses, and since then, we have witnessed tremendous growth in the gaming and hospitality industry in Macau, becoming the most significant gaming center in the world in terms of gross gaming revenues. During the following years, all concessionaires developed significant construction projects.

Between 2004 and 2007, one of the gaming concessionaires, the Sands China

Company, initiated the first large-scale project on the Cotai Strip with the construction of the Venetian Macao. The construction area of the project was 614,500 m². Characterized as being a critical project with tight budgets and deadlines, the project managers introduced the role of the construction manager in addition to the traditional waterfall methodology. The aim was to work with the sponsor project team on a strategic level, directly connecting with the project design and the construction teams.

In 2010, the development of hotels and casinos initiated a new construction period in Macau with the full-scale recruitment of more construction professionals. Most of the projects have been concluded by now, and the remaining developments are expected to be completed by 2019. As the construction of hotels and integrated resorts in Macau presents a significant percentage of the construction activity in the region (Lighthouse – 1, 2013), with most of such projects coming to an end, Macau has subsequently seen a significant slowdown in its construction industry (COLE, 2016).

According to the Statistics Bureau of Macau (DSEC), employment in gaming and construction industries represented around 18% of the labor market in 2019 and continued with this share even with the outbreak caused by the Covid-19 pandemic. In Macau, since 2013, the significant challenges in the construction environment are related to the lack of materials (including steel, concrete, and sand), equipment, specialized contractors, and project management staff. In addition, the availability of skilled and unskilled workers is precarious due to the high restraints imposed by Macau's government policies for hiring non-resident workers, which imposes a quota system (COLE, 2016).

There are, however, several public infrastructure projects in Macau. Although some of the projects have, to date, been completed successfully, others have presented several difficulties. An example of it is the Light Rail Transit System (LRT), a transportation

alternative between the Macau peninsula and the island, which includes over 20 stations and several kilometers of elevated track. The construction began in 2011 and is still under construction.

As a fact discussed at a Seminar on Opportunities and Sustainability of Construction in Macau, promoted by the Macau Construction Association, one of the major players in the local society, the project management methodology has brought significant benefits to the Macau construction industry, but, it is still not clear what project management methodology is best suitable for each project.

The main objective of this study is to determine the most suitable project management methodology applicable to Macau's construction industry, taking into consideration the local culture of the project organizations, communication, and project managers' skillset.

2 LITERATURE REVIEW

2.1 PROJECT MANAGEMENT FRAMEWORKS

According to the Project Management Institute (PMI), project management methodology is defined as “a system of practices, techniques, procedures, and rules used by those who work in a discipline.” (PMI, 2018, online).

There are methodologies with different principles, processes, frameworks, themes, and standards that provide different structures to deliver projects. Examples may include SCRUM, SCRUMBAN, and XP, typically associated with agile methodologies; waterfall-based methodologies, typically associated with the Project Management Institute's (PMI) Project Management Body of Knowledge (PMBOK), Kanban, Lean; and PRINCE2, all of which can be applied to different projects, and each with different themes, principles, and processes (PORTER; GONÇALVES, 2009; ASTON, 2017).

A project management methodology is a step-by-step method for managing a project. It provides the project manager with a proven framework, guiding principles, and standardized templates for managing a project. The idea is to be able to apply established methods for successfully managing a project. The processes among methodologies will differ, but the end goal remains the same; bring the project in on budget, in scope, and within the specified time frame while meeting all stated project goals and objectives.

Notwithstanding, project management organizations are developing skillsets and tailoring the approach to project tasks based on the project's unique characteristics and requirements (PMI, 2017). This study aims to assess when to use traditional (waterfall), agile, or hybrid methodologies in the construction industry projects in Macau while comparing it to other international project managers' approaches.

2.2 PROJECT MANAGEMENT IN MACAU

According to Von Schaper (2014), civil construction-related project managers in Macau face several difficulties, namely:

- a) the human resources market is minimal concerning quantity. In general, workers are not adequately prepared for their duties, and when demand is high, it is challenging to quickly get large numbers of qualified professionals, such as in a sudden rush job or aggressive deadline;
- b) the qualified workforce is around 30%, and most of them are related to other industries;
- c) contractors are not able to deliver projects on time, causing project closures to linger, resulting in project accounting and billing remaining unsettled for years;
- d) construction materials and equipment take a very long time to be delivered on-site;

- e) there are no warehouses in Macau to store materials and equipment. Contractors, therefore, are restricted to site storage, if at all available, or work with just-in-time deliveries of materials.

In fact, according to Sheng, Tang and Grydehøj (2017, online) "Macau faces critical challenges regarding traffic congestion, environmental pollution, and lack of space for housing and other urban functions," representing a considerable constraint on the construction industry, affecting the project's timeline and the resources allocation.

2.3 IMPACT OF ORGANIZATIONAL STRUCTURES ON PROJECT RESULTS

Project Management applies to all industries. However, it has a significant impact on industries with higher financial value, such as Aerospace and Construction (GRAHAM, 1999) [12]. High-stakes construction projects are characterized by better organizational structure, activities, and cost control, featuring a high degree of planning, regular meeting frequency, with the project manager as part of the upper management, a clearly defined project sponsor, and personnel with high interpersonal skills, especially an environment prone to conflicts.

The Macau construction industry is characterized by large-scale and complex projects, which means project managers have a profound impact on Macau construction projects and a strong influence on the financial value of these projects.

2.4 ADVANTAGES AND DISADVANTAGES OF WATERFALL AND AGILE METHODOLOGIES

According to Lotz (2013), the significant advantages of the usage of the Waterfall methodology are:

- a) agreement on the development of requirements early in the development lifecycle. Such commitment causes planning and designing to be more straightforward;
- b) progress execution can be more readily quantified;
- c) allows the project team to be more focused on their task as part of the whole project;
- d) sponsor and stakeholders' involvement is not so necessary after the requirements definition.

The significant disadvantages of the usage of the waterfall approach are:

- a) sponsor's difficulty in defining and gathering documentation for the requirements, especially in the construction industry;
- b) the sponsor is unsatisfied with the deliveries since the deliverables are based upon documented requirements, and at the end of the product development, changes can be difficult and expensive to implement (LOTZ, 2013).

As for agile methodologies, some of the significant advantages include:

- a) sponsor's frequent involvement in making decisions and changes throughout the development project;
- b) sponsor's sense of ownership by interacting with the project team throughout the project;
- c) the ability to allow the production of a basic version for further improvement;
- d) the execution phase is more user-focused (LOTZ, 2013).

Some of the most significant disadvantages of adopting agile methodology include:

- a) since it requires a very high degree of client involvement, some of the customers might not be interested;

- b) the very high degree of customer involvement, while great for the project, may present problems for some customers who may not have the time or interest for this high level of participation;
- c) requires members of the development team to be completely allocated to the project;
- d) due to the Agile focus on time-boxed delivery and frequent reprioritization, some items set for delivery will not be completed within the timeframe, increasing the project's timing and cost;
- e) the iterative nature of agile development can lead to a redefinition of the scope and a consequent reduction in overall quality, mostly noted in larger-scale implementations or in systems that include an elevated level of integration (LOTZ, 2013).

2.5 THE USE OF WATERFALL AND AGILE METHODOLOGIES IN THE CONSTRUCTION INDUSTRY

The construction industry traditionally adopts sequential project management methodologies such as a waterfall. The project phases are usually divided into initiation (or definition), planning, execution, control/monitoring, and closure, and the internal structure of each phase follows a sequential framework.

As for agile methodologies, the software development industry is the most popular. There are many successful cases in the industry, not only concerning cost reduction but also in aiding project managers to increase productivity and achieve a better scope alignment with client expectations (GONÇALVES; HEDA, 2009; HASS, 2007).

Construction projects are traditionally classified as poor candidates for an agile approach, not only because of their sequential

task execution nature but also due to the fact it often is driven by a rigid scope, in consequence of high costs to mitigate changes during execution. One of the items in the agile manifesto argues that project managers and development teams should “welcome change requirements, even late in development,” which might not find adherence in construction projects. Nevertheless, other aspects of agile can be adopted by the construction industry, such as “the highest priority is to satisfy the customer through early and continuous delivery” and “daily cooperation between business people and developers” (STRAUSSER, 2015).

Any methodology, framework, or initiative to improve productivity in the construction industry should be welcome since, even with traditional methodologies and governance, it is common to find project delays and over-budget issues. Some initiatives are already in use, such as lean construction and what is known as integrated project management (IPM) or integrated project delivery (IPD) (STRAUSSER, 2015). Those innovative approaches and agile methodologies can be used for specific phases of the project and groups of deliverables in construction projects.

At this stage, hypothetically, it seems that hybrid approaches may be a feasible solution to improve construction industry projects. It seems feasible to ascertain that, by using a hybrid methodology, retaining the comfort of the waterfall while adding the benefits of agile, project managers may be able to increase their level of success, as well as the satisfaction of their sponsors and stakeholders. It also seems feasible to increase the level of confidence in the client team taking delivery of the final project after completion and potentially promote a reduction of the project costs by efficiently leveraging resource availability and contribution (PERFICIENT, 2012).

3 METHODOLOGY

Following the purpose of this study, which is to determine the most suitable project

management methodology applicable to Macau's construction industry, the researchers adopted both a quantitative and qualitative analysis based on data collected through semi-structured interviews with project managers and an online survey.

The semi-structured interviews were aimed at understanding the reasons, opinions, and motivations, exploring the meaning of concepts discussed (DE FRANZO, 2011), while in the interviewee's natural setting (LINCOLN; GUBA, 1985). The interviewed professionals were selected according to their considerable experience and expertise in managing construction projects. Three semi-structured interviews were performed, and the information collected was used to develop a more effective quantitative survey, which enabled a more thorough understanding of the results concerning the research question (GCU, 2018). While the results of this study cannot be generalizable, the researchers believe the insights it contains may serve to drive further research and shed some light on the issue, especially for international project managers operating in the South East Asia region of Macau.

The online survey was targeted at project managers in Macau. A total of 33 project managers responded to the questionnaire online, of which ten of them were directly involved in the construction of hotels in Macau. Comparative analyses were then performed between professionals with experience in hospitality projects and construction projects in other industries.

The data collected from both the semi-structured interview and the online survey were then triangulated in an attempt to test the validity of the gathered data.

3.1 SEMI-STRUCTURED INTERVIEWS

The semi-structured interviews allowed the interviewer to use a list of questions and topics to be covered during the conversation in a pre-determined order. A non-probabilistic sampling was adopted to select participants with experience in project management. The interviewees were presented with one

question only: “In your organization, how is it determined when to use traditional, agile, hybrid, blended, or other project managing models?” Considering that some might not be familiarized with the terms, the researcher provided a brief introduction to project management methodologies to facilitate participants in describing the existing practices within their organization. The responses were handwritten during the interview and typed within the next 48 hours. The content of the answers was then analyzed and compared to the other assumptions on the questionnaire.

3.2 ONLINE SURVEY

The survey was divided into five parts, in addition to questions for demographics. The first part of the survey focused on the strategy used in developing project definition and planning at the respondent’s organization. The second part was based on analyzing the importance of resources during the project’s execution phases. The third part focused specifically on construction projects and the experience of the respondents with this particular type of project. In the fourth part, the questions were about the awareness and openness respondents had toward agility methodologies applied to the construction industry. Finally, the fifth part asks about the kind of project management framework adopted in their projects.

The online survey included multiple-choice and open-ended questions and was administered online to reduce costs, increase data collection efficacy, and allow for flexibility during the data-gathering phase of the research. Although the respondents may not be representative of the entire population sample in Macau, they still provide valuable insights due to their distinctive characteristics. The population sampling was focused on professionals with extensive experience in the management of projects regardless of the project’s nature.

The population of interest was project managers working in the construction of hotels in Macau. Since there is no official information

concerning the total population of project managers working in the construction industry in Macau, researchers resort to LinkedIn.com as a source of prospective project managers working in Macau as the primary source for selecting the poll of candidates to be interviewed and surveyed. A total of 206 project managers working on hotel constructions in Macau were selected on LinkedIn.com, with a confidence level of 85% and a margin of error of 23%. The total size of the population sample was ten professionals.

4 RESULTS AND DISCUSSION

The results are presented in this section, firstly highlighting the qualitative analysis of the semi-structured interviews, followed by the data presentation and analysis regarding the surveys.

4.1 FINDINGS FROM THE QUALITATIVE RESEARCH

The interviews were performed with three senior project managers involved in projects of different types, managing construction, information technologies, and quality control, with different experiences and working environments. The semi-structured interview was based on an open-ended question, allowing the interviewees to express their opinion. The only question was: “In your organization, how is it determined when to use traditional, agile, hybrid, blended, or other project management methods?” Extracts from their answers are presented:

In my organization, we are involved in several kinds of projects. We are involved in projects from construction (including Civil, Mechanical, and Electrical) to Information Technologies. We are also responsible for developing several projects but also for guaranteeing the maintenance of the Airport infrastructures. Therefore, I can say that we use a Hybrid methodology since, for a project more related to the construction and develop-

ment of new facilities, we implement the Waterfall model for better control of the projects. For projects like Information Technologies and Communications, and corrective maintenance, we use a more practical and agile approach, to respond to a more volatile fast environment, reacting to constant change involved (Interviewee 1).

We are responsible for the quality control of most of the infrastructure construction works in Macau. In this kind of project, we respect the project phases from the design stage to the project's closure. Therefore, we take a more waterfall approach in the management of our projects according to the construction projects (Interviewee 2).

In the construction of the structure of a major hotel in Cotai, we had clear milestones and a very well-defined project phasing. However, we suffered from a lack of workforce and space. With such restrictions, the project planning was special for the achievement of our goals. The waterfall methodology was the most appropriate to be used in these conditions (Interviewee 3).

4.2 PROFILE OF THE SURVEY GROUP

The survey questionnaires were presented to project managers working in different areas and various parts of the world, allowing the comparison with the project managers from the construction area in Macau. The questions were related to the professional experiences and perception of project management methodologies and related topics. No personal information has been recorded to protect the identity of the respondents.

Two main groups were considered: the first one is the general group of project managers, which included all the respondents to the questionnaire, while the second group is focused exclusively on hotel construction project managers from Macau.

The survey was divided into open-ended questions, which require answers with an open

number of words, and closed-ended questions which focused on specific words or information.

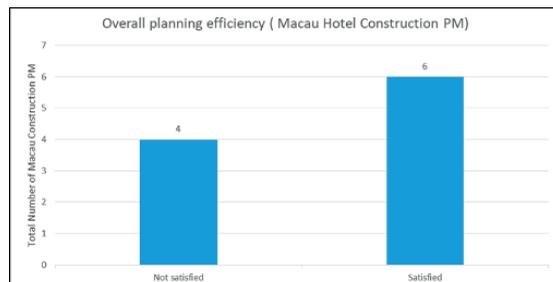
According to the analysis, it is noted that most of the participants are from the construction industry (12.3%), followed by IT with 6.2% of the overall population. It is noted that project managers working in the construction of Macau hotels represent 83% of the total construction population. Most participants are from Macau with 79%, followed by Brazil with 15%, and Portugal with 6% of the population.

In regards to the years of experience, 46% of the population has more than 15 years of experience as a Project Manager, meaning that experienced project managers majorly constitute the population. Most of the hotel construction project managers have around 10 to 15 years of experience (70%).

4.2.1 Summary of questionnaire responses

In general, the respondents are satisfied with the planning efficiency of the organization, according to Graph 1. In general, 60% of the respondents are satisfied with the planning efficiency of the organization,

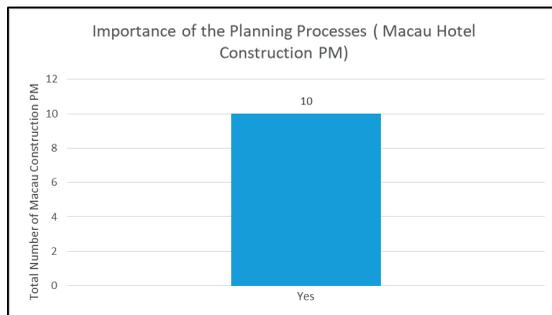
Graph 1- Organization overall planning efficiency (General Project Managers) and the project managers working in the Macau Hotel Construction industry



Source: research data.

Nevertheless, according to Graph 2, most of the respondents agree that the organizations have to improve the project’s planning phase, which is interesting since the majority is satisfied, although the majority agrees that there is a necessity for improvement.

Graph 2- Opinion regarding the necessity of better planning in the organization (General Project Managers) and the project managers working in the Macau Hotel Construction industry

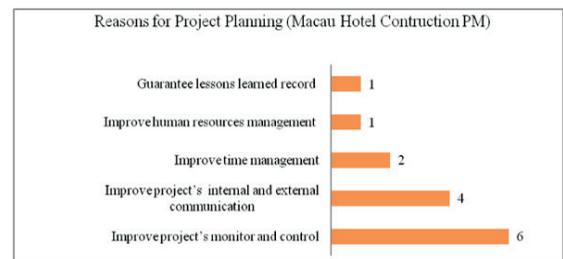


Source: research data.

According to Graph 3, the main reasons for improving planning are improving project monitoring and control, an increase in timing efficiency, an increase in communications, and an increase in the ability to adapt to changes. For the Macau construction project managers, the main

reasons for improving the planning are: to improve project monitoring and control and to increase the efficiency of internal and external communications.

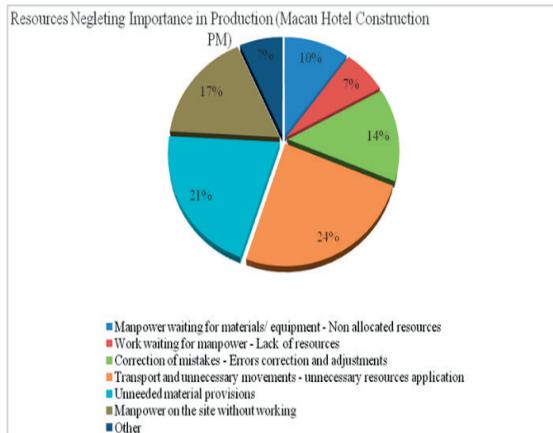
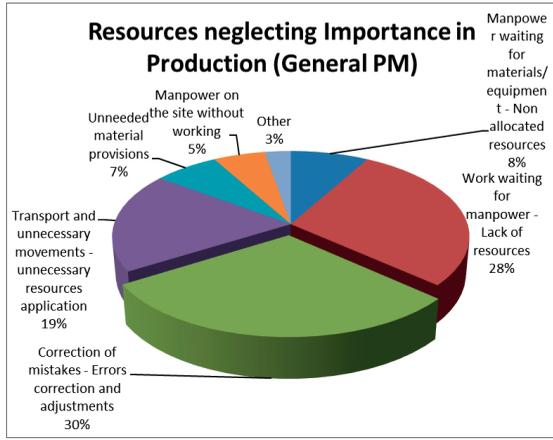
Graph 3 - Reasons for better planning (General Project Managers) and the project managers working in the Macau Hotel Construction industry



Source: research data.

From Graph 4, correcting mistakes (30%) and lack of human resources (28%) are the main reasons for the existence of waste in the production chain, which is related to the fact that the majority of this group is working in the Construction and IT areas. From the project managers working in the Macau Hotel Construction industry, transport and unnecessary movements (24%) and unneeded material provisions (21%) are the main reasons for waste in the production chain. According to Von Schaper (2014), it can be due to a lack of space for the storage of material and equipment on site.

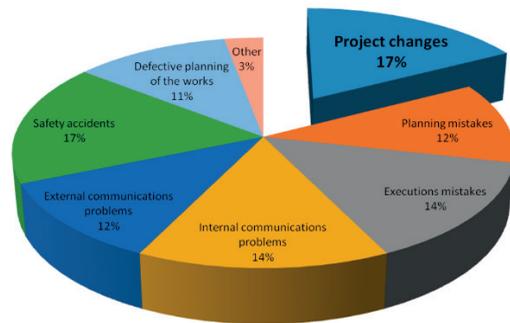
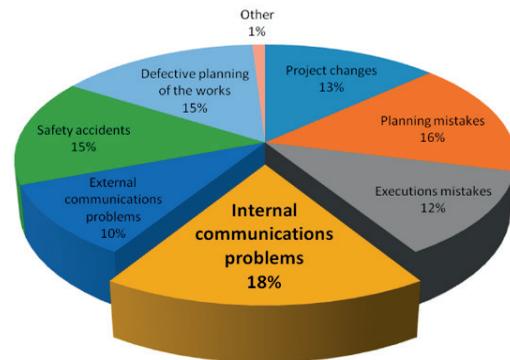
Graph 4 - Resources neglecting Importance in Production (General Project Managers) and the project managers working in the Macau Hotel Construction industry



Source: research data.

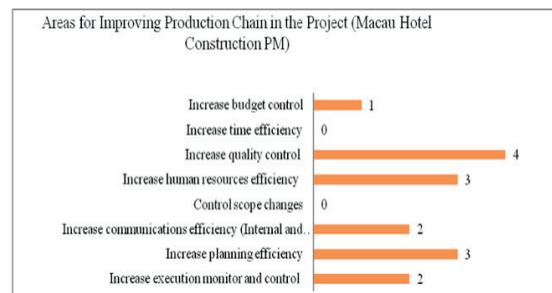
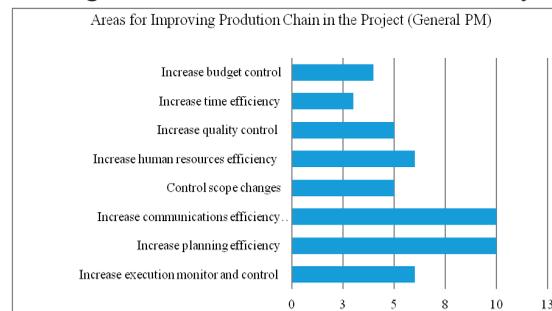
Graph 5 indicates that the central management problems during the project's execution are: internal communication (18%) and planning mistakes (16%). It is noted that there are poor communication and planning mistakes. For the project managers working in the Macau Hotel Construction industry, it shows that the central management problems during the project's execution are safety accidents (17%) and project changes (17%).

Graph 5 - Main management problems in the project execution (General Project Managers) and the project managers working in the Macau Hotel Construction industry



Source: research data.

Graph 6 - Areas for improving the production chain (General Project Managers) and the project managers working in the Macau Hotel Construction industry

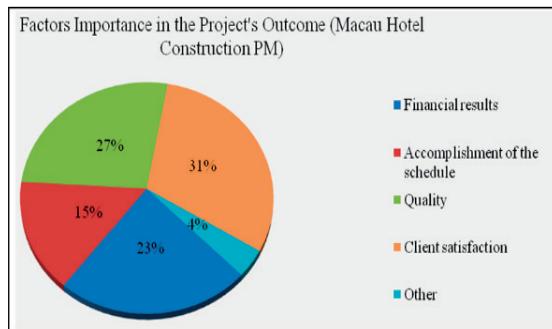
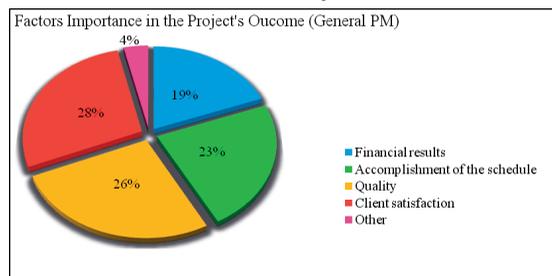


Source: research data.

In Graph 6, it is presented that the principal areas for improving the production chain are: increased communication efficiency and planning efficiency. For the project managers working in the Macau Hotel Construction industry, the focal areas for improvement in the production chain are quality control, human resources, and planning efficiency.

The main factors for achieving the project goals are presented in Graph 7. It is noted that Client satisfaction (28%) and Quality (26%) are the most significant topics. For the project managers working in the Macau Hotel Construction industry, it is noted that Client satisfaction (31%) and Quality (27%) are the main factors for achieving the project goals.

Graph 7 - Factors Importance for achieving the project goals (General Project Managers) and the project managers working in the Macau Hotel Construction industry

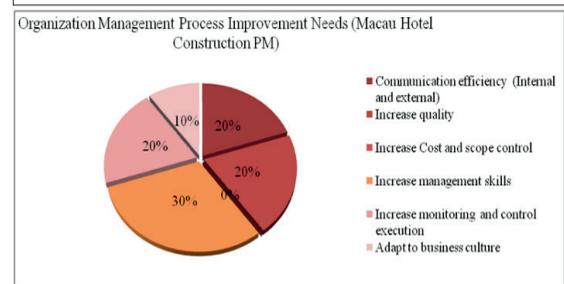
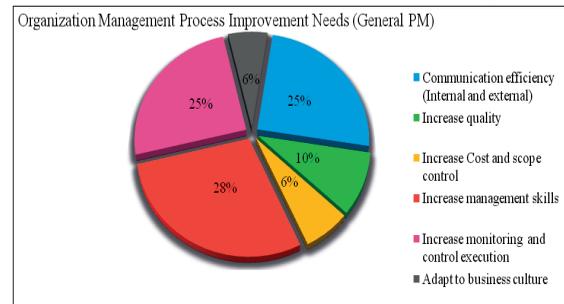


Source: research data.

According to Graph 8, the organization management should increase management skills (28%); Project monitoring and control, and internal and external communication (25%). For the project managers working in the Macau Hotel Construction industry, the organization management should: increase the management skills (30%); increase the

monitoring and control of the projects (20%); and increase quality (20%).

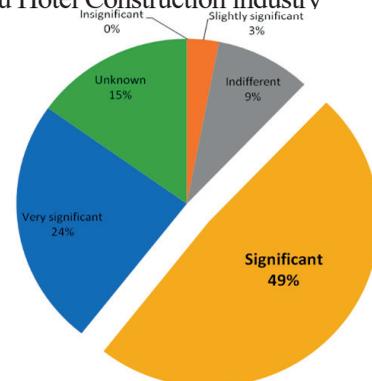
Graph 8 - Management process organization improvements needs (General Project Managers) and the project managers working in the Macau Hotel Construction industry



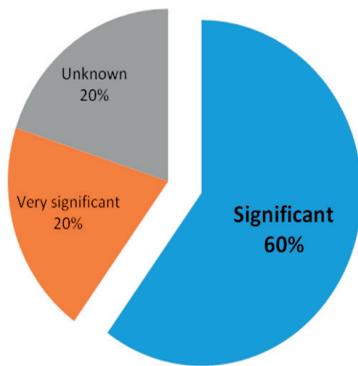
Source: research data.

The impact of changing the defined scope on the project's execution deadline is presented in Graph 9 and is considered significant for 49% of the first group and 60% of the Macau Hotel Construction industry project managers.

Graph 9 - Impact of changing on scope definition on the project's execution deadline (General Project Managers) and the project managers working in the Macau Hotel Construction industry



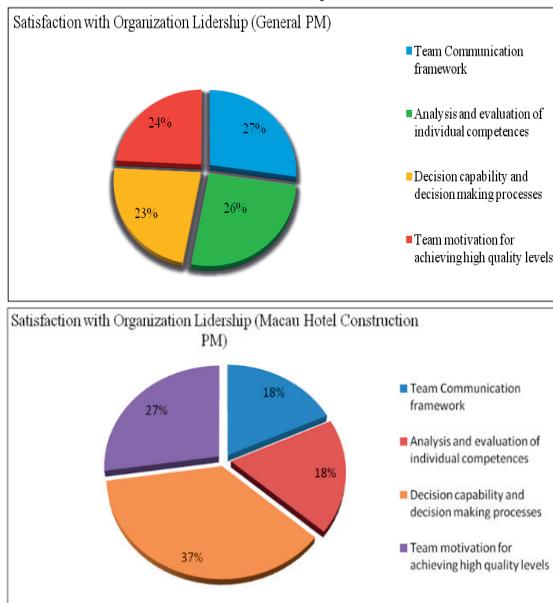
Source: research data.



Source: research data.

In Graph 10, the project managers are very satisfied with the organization’s communication framework (27%) and evaluation of individual competencies (26%), while for the Macau Hotel Construction PM group, the main satisfaction is related to the decision capabilities and decision making (37%) and team motivation for achieving high-quality levels (27%).

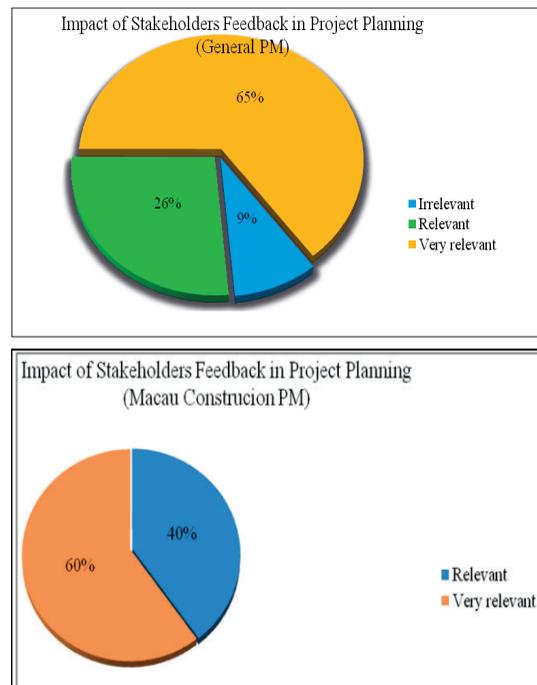
Graph 10 - Satisfaction with the project’s characteristics (General Project Managers) and the project managers working in the Macau Hotel Construction industry



Source: research data.

The impact of the stakeholder’s feedback on the project planning is very relevant, according to Graph 11. For the project managers working in the Macau Hotel Construction industry, the impact of stakeholder feedback in project planning is very relevant.

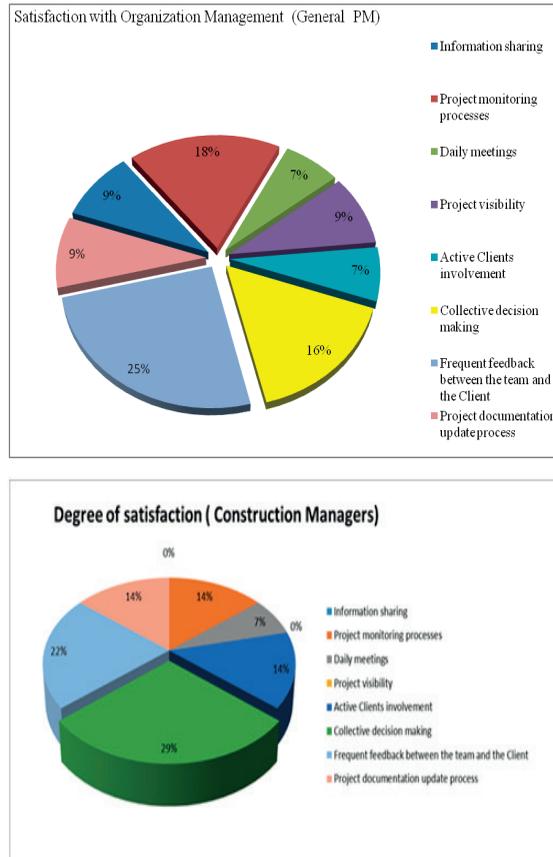
Graph 11- Impact of stakeholder feedback on the improvement of the planning process (General Project Managers) and the project managers working in the Macau Hotel Construction industry



Source: research data.

Concerning the organization management activities, as per Graph 12, general project managers are very satisfied with the frequent feedback between the team and the Client (25%). The Macau Hotel construction project managers are very satisfied with collective decision-making (29%).

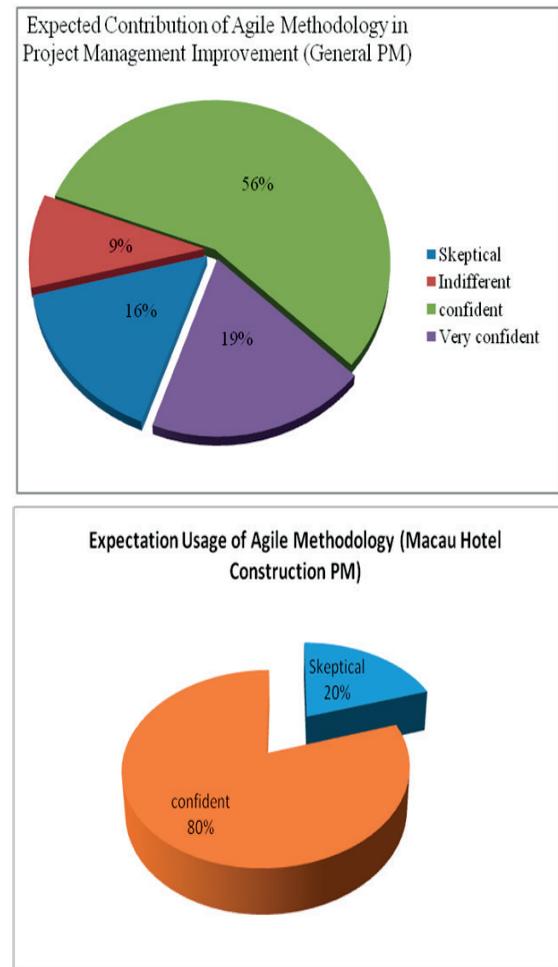
Graph 12 - Satisfaction with the organization activities (General Project Managers) and the project managers working in the Macau Hotel Construction industry



Source: research data.

The analysis of the perception of project managers in agile methodologies can be found in Graph 13. Most general project managers (56%) are confident that agile methodologies will present an improvement in project management. In the other group, also there is a perception that agile methodologies will present an improvement in project management (80%). The data may suggest that Macau’s project managers in the construction industry expect that using a structured methodology based on agility may facilitate the bureaucratic part of the projects in which they are involved.

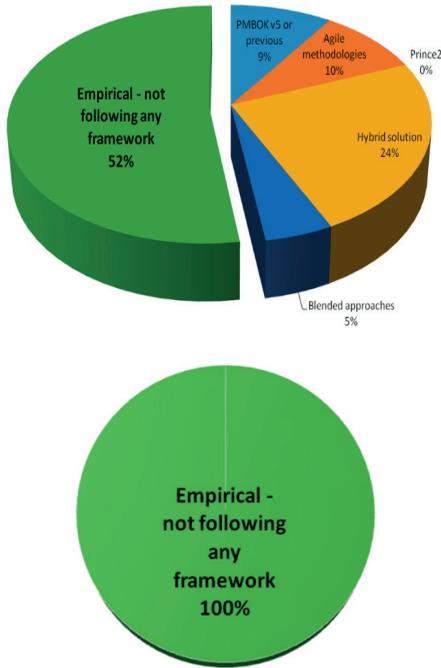
Graph 13 - The Expected contribution of Agile Project Methodology in project management improvement (General Project Managers) and the project managers working in the Macau Hotel Construction industry



Source: research data.

The methodology adopted by most organizations is an empirical methodology, with 52% not following any framework. Hybrid methodologies come in second place with 24%, as can be seen in Graph 14. For the project managers working in the Macau Hotel Construction industry, the answers presented all of them, i.e., 100%, do not follow any specific framework, managing the projects empirically.

Graph 14 - Project management framework that is adopted (General Project Managers) and the project managers working in the Macau Hotel Construction industry



Source: research data.

5 CONCLUSIONS AND RECOMMENDATIONS

This work aimed to determine which project management methodology (Waterfall or Agile) is more adaptable to managing a construction project in Macau. It was based on the findings from interviews and a survey group compared to secondary research. According to the findings, to increase efficiency and achieve the project's goals, it is imperative to establish and define a project-managed methodology, avoiding potential hazards to the project.

Regarding the semi-structured interviews with the Macau Construction industry professionals, it is a fact that the majority were following the waterfall methodology for managing the projects. However, project managers responsible for Information and Technologies and construction projects were also using the Agile approach due to the nature

of software projects and the constant change of the requirements. Therefore, a hybrid methodology between Waterfall and Agile would be an advantage.

The survey showed that there is a difference between general project managers and Macau construction project managers. It was noted that, in general, many project leaders are managing projects using an empirical methodology. However, hybrid methodologies are also being used. As for Macau hotel construction project managers, these are using the empirical methodology, not following any framework. In other words, the project management framework adopted in Macau construction is less standardized than the study group. Most of the Macau construction group even responded that they were not familiar with the concepts, although having the perception that some common procedures were being followed by every project.

The projects' waste on the production chain is essential because it allows an understanding of the different natures of the projects. Acknowledging the existence of waste opens room for the necessity of improvement of the production chain, minimizing the construction wastes, suggesting that constant project monitoring during the execution and feedback from agile methodology may increase the efficacy of the production chain. Agile in construction is defined by working practices focused on frequent, iterative deliveries facilitated by multi-functional, self-organizing inter-communicative teams (OWEN; KOSKELA, n.d.).

Regarding agility, for both groups, the probabilities of avoiding change occurring during execution are rare, the impact of changing the scope definition during the project execution deadline is significant, and the impact of the Client's feedback in the project planning is very relevant. Both groups are confident that the Agile methodology will present an improvement in project management which can indicate that groups feel that the process is bureaucratic and there is a need to facilitate communication by lightening the processes.

The Macau hotel construction industry group referred to the necessity of planning, monitoring the execution, and controlling the changes performed during the project's duration, which makes essential the usage of this methodology. The agile methodology would increase planning, efficiency, and project control and monitoring.

According to the agile methodology, feedback from the stakeholders, project monitoring during the execution, and the improvement of communication are essential in the managing process. Most of the respondents were not familiarized with the agile methodology. However, they are confident with its contribution to managing projects which means that there is a necessity for agile processes for the project, from a strict and bureaucratic management frame to a more flexible and adaptable one to changes.

In significant conclusion, it is imperative to establish a project management methodology to increase the efficiency of the project, increase the communication between stakeholders and allow flexibility of changes during the project execution.

As the output of the data analysis, some recommendations can be provided for the companies and project management environments in Macau. At first, it is possible to see that Macau hotel construction managers have a different approach than the majority of other project managers groups that were studied here. The methodologies used for managing projects are empirical without any specific framework. However, it is noted that the Macau hotel construction project managers believe that an improvement can be performed on the project's planning, improving the agility of the processes. On the one hand, it is noted that agile represents an essential improvement to the project management process since it increases the Clients' feedback on the scope requirements, allows changes to the performance more efficiently, and minimizes the waste in the execution phase. On the other hand, Macau's hotel construction environment is characterized by distinct phases, tidy

budgets, and schedules, suggesting that a more conservative approach to project management like the Waterfall methodology should be followed.

One alternative to implementing the benefits of any project management framework is investing in project management training and professional certification with a plan that could focus on a diverse range of methodologies (waterfall or agile) to implement processes and tools for measuring, monitoring, and controlling the project. Besides, the management structure should create effective communication plans during the project initiation to increase the efficiency of the production chain.

A hybrid methodology is a possibility to join the best of both worlds, and it could be achieved by following as suggested in the new PMI's PMBOK Version 6, in which the agile execution will assume an essential advantage for project managers in the construction industry within the Macau environment.

As a future work of this research, to have a broader point of view, it would be necessary to have a larger population of Macau's hotel construction industry as part of the survey.

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