The Impact of Industry Context on Project Management Methodological Decisions

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Abstract. Project management methodology (PMM) is an important part of today's project management. Choosing the right PMM plays a key role in ensuring the successful implementation of the project. However, the current selection of PMM tends to focus more on the detailed characteristics of the project itself, and less on the macro evaluation from the perspective of the industry context. Therefore, this study attempts to study the adaptability of PMM to different industries from the perspective of the industry's characteristics. Through case analysis and comparing the characteristics and the relevant selection tendency of PMMs in different industries, this article discusses its influence on the selection of PMM from four perspectives. The conclusion that can be drawn is that the faster the technology update speed, the more immature the industry environment, the higher the risk level and the more time-oriented product landing requirements will prompt the industry to choose a flexible PMM that supports the output of phased deliverables. This article helps managers quickly narrow down the scope of PMM selection from the industry context before digging into the unique limitations and needs of the project itself.

Keywords: Project Management; Industry Contex; Decisions Impact.

1. Introduction

In order to deal with projects with different characteristics, project management methodologies (PMMs) have been continuously proposed and improved. Previous research has given a lot of guidance for the specific situation of the project, such as considering the project scope, team performance, risks, duration, third-party attendance, etc. Based on the research of the previous work, an interesting fact is that certain methodologies are implemented extremely frequently in certain industries. For instance, Waterfall, Lean, and Critical Path Methodology (CPM) are always adopted in construction, while Agile, Scrum, and Extreme Programming are rarely used in the same situation, as they are designed for innovative industries such as software engineering. This fact indicates that the different industry contexts have a significant impact on the decision of PMM.

Existing literature tends to focus on specific cases and analyze their unique characteristics to guide the choice of PMM in a narrow field. However, these studies often ignore the common impact of industry context on different projects, which means the guidance based on the essence of the industry to which the project belongs is still lacking. Therefore, this article will discuss the impact on project methodological decisions from an industry contextual perspective.

Firstly, this article focuses on the frequency of technological innovation in the industry and discusses its impact on PMM from three perspectives: the tendency of technology selection to be stable or advanced, the product obsolescence rate, and the product life cycle. In the second part, the impact of industry maturity is introduced. This article shows the connection between industry experience, laws, standards, intra-industry interactions, and the choice of PMMs. Besides, an essential topic, risk, are discussed. Distinguishing between traditional and innovative industries and deciding their risk levels can help select the right PMM. This article also analyzes the impact of market structure, which mainly concentrates on monopolistic competition, oligopoly, and monopoly. Finally, this article compares the time-oriented industries and quality-oriented industries to find the appropriate PMM which can meet the safety requirements and remediation needs and be in line with the time-quality trade-off tendency. The impact of these factors on the selection of PMMs in the specific industry is explored in-depth in each section, and the conclusion is given at the end of this article.

2. Method

Repositories such as Science Citation Index (SCI) and Social Sciences Citation Index (SSCI) were carefully explored when searching for relevant literature. While searching for project management methodology, over 18,535 pieces of literature that were published in the past 10 years could be found on SCI. The same keyword was referred to by 11, 622 pieces of literature on SSCI. Another keyword, project management methodology selection, had 1, 770 pieces on SCI and 982 pieces on SSCI. To find the suitable situation and projects' characteristics influencing the selection of PMMs, the project management methodology comparison was searched. 1,491 results were found on SCI, while 578 results were on SSCI. The last keyword, project management methodology industry, had 2, 744 results on SSCI and 3,492 results on SCI. This article also examined trends in the publication of relevant literature on these two databases. The literature on PMM has increased significantly in the last 10 years. At the same time, the other three keywords have also accelerated their publication steadily, even after 2020, under the negative effect of COVID, their publications have also experienced a satisfactory increase. To indicate the trend more clearly, a chart is shown in Figure 1, presenting the pieces of each keyword published in a certain year.

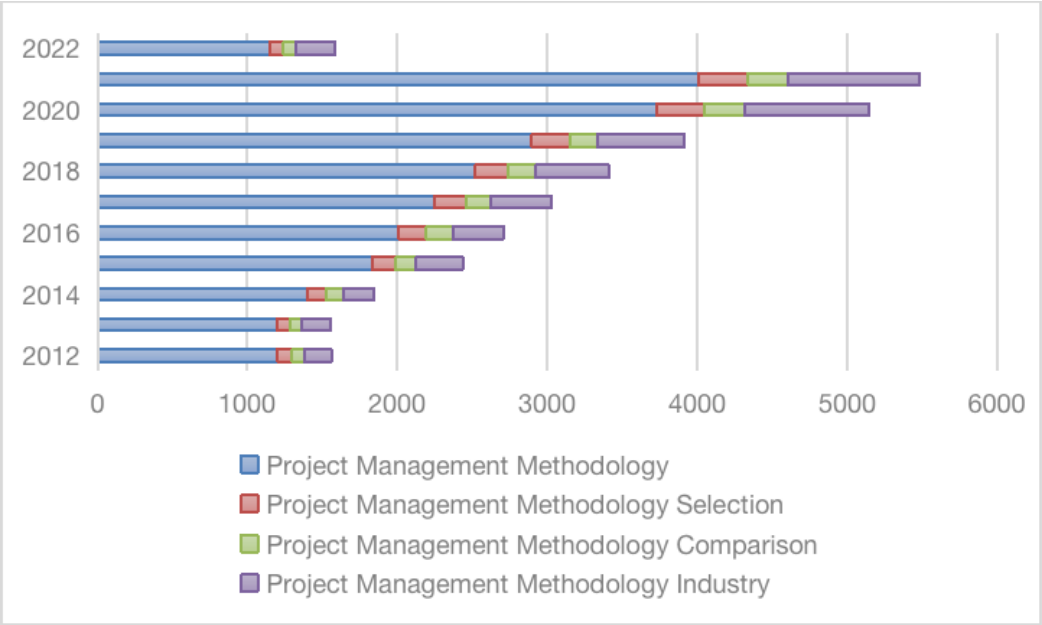

Figure 1. Pieces of keywords published in a certain year

However, even as the number of publications for the four keywords continues to grow, the proportion of project management methodology selection, project management methodology comparison, and project management methodology industry, which are subsets of PMM keyword search results are still extremely small. Therefore, it is feasible to conclude that gaps in the diversity of methodologies that are not sufficient to meet the needs of the project have been largely filled, but there is still limited guidance on the selection of PMM according to the characteristics of the industry. Based on this idea, this article was intended to find literature and case studies that would combine these three perspectives for discussion. In furtherance of filling in the gaps in this section of the literature, this article attempts to conduct an in-depth investigation by combining the industry contexts and the essential influencing factors that are often presented in selection and comparison literature.

3. Discussion

3.1 Frequency of technological innovation

From the past cases and experience, it is easy to tell the frequency of technological innovation in the industries influences the decision of PMMs. For instance, the PMMs oriented toward rapid iteration and delivery, such as Agile and Kanban, are always implemented on IT projects [1], while the construction projects always are built with a PMM oriented toward safety and service life. In the IT industry, which is representative of rapid updates, practitioners are constantly learning throughout their career lives. This has also led to a situation in the IT industry where the system needs to be updated to ensure compatibility with the external environment since it inevitably requires interaction with other systems which may implement cutting-edge technology. On the contrary, some industries which have slowed down the pace of updates, such as Material Engineering, Civil Engineering, and Mechanical Engineering, prefer the PMMs that value product stability over fast delivery, so a large number of projects are adopting plan driven PMM. To rule out the impact of COVID-19, this paper distinguishes the speed of technology updates in industries by the number of patents in each industry in 2019. Figure 2 is taken from the Australian Intellectual Property Report (2019), showing the top 5 technology fields in 2018, and Civil engineering's patent application has declined significantly [2].

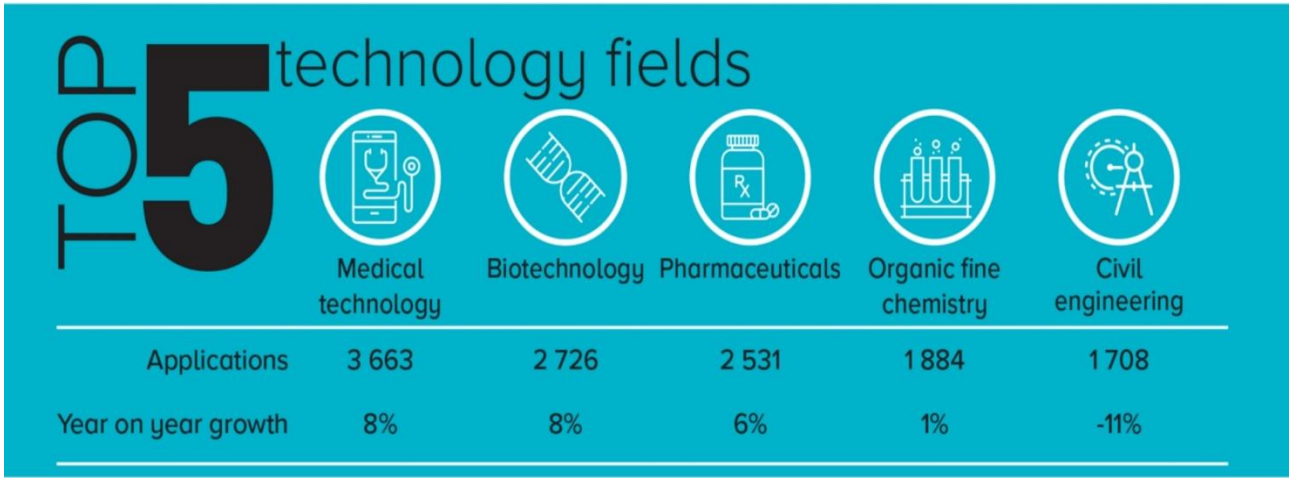

Figure 2. Top 5 technology fields [2]

From this perspective, it is reasonable to say that the projects in the rapidly developing industries are required to be built in a short period, as once a new technology is carried out, the old technology will be challenged and replaced by the new one with higher performance. To implement the advanced technology to differentiate from its competitors, the project needs to be pushed to the market as soon as possible. Besides, considering the adaptability of merging the old and new technologies, PMMs that embrace change is always selected, in case the technical requirements are changed, and the product needs to adopt the new technology. Moreover, the different safety requirements are another reason for the industries to have a different tendency toward PMMs selection. This is an essential factor that influences the update frequency too. To prevent the technology itself or its failure from being harmful to humans, it is necessary to test the technology thousands of times before being practically implemented. Likewise, the remedy for the failure needs to be considered. Industries that can remediate at a small cost tend to prefer to release projects first and then release patches later, such as iOS versions updated since 2007, which is converse with the construction industry. Between the mainline version updates of the iOS system, there are often nearly ten minor releases released to the released version to fix bugs. The one with the most intermediate versions is the current iOS 15, with 49 intermediate versions appearing as of May 18, 2022 [3]. The faults which occur in the construction projects are difficult to rectify, in such a manner it is meaningless to adopt a PMM focusing on

embracing change, such as Agile. This article discusses the effects of remediation in more detail in the risk section.

With further in-depth analysis, it is evident that the frequency of technical innovation also influences product obsolescence, in other words, the product lifecycle. The faster the technology update, the faster the industry product obsolescence, and the shorter the product life cycle. The comparison of the Windows operating system with some of the ancient buildings that are still in use is clear proof of this. Windows 3.0 was put into service in May 1990 with great success, but technical support was discontinued on December 31, 2001 [4]. The Pantheon, quite the contrary, has been used as a Roman Catholic church for two thousand years [5]. It is unreasonable to require a project with a shorter service life to be invested in the development phase for longer than it has been in service. Therefore, under the impact of the technical innovation, the projects with shorter product lifecycles will also tend to opt for more flexible and variable PMMs.

Many factors are driving technological innovation. The biggest impact is on political demand. During World War II, the world's arms development rate was at its highest in history. Forced by the threat of national defense, countries have invested heavily in the arms race - a period during which the atomic bomb was built and used. Secondly, the demand determined by national conditions is also an important influencing factor. While 16% of the world's population is still facing no electricity, China, a vast country, comprehensively solved the problem of electricity consumption in 2015. Its state-owned enterprise State Grid, as a super-large central enterprise engaged in transmission and power supply, has obtained over 23,300 patents in the past five years, even far surpassing the world-renowned Huawei. In the 2018 indicators released by the World Intellectual Property Organization, the State Grid of China ranked third with 21,635 intellectual property rights. A fact found from the above instances is that the more emerging disciplines are, the faster the technological innovation. Accordingly, the industry maturity is the next factor influencing the selection of PMMs in different industries' contexts this article is going to discuss.

3.2 Industry maturity

The first thing to be explored in this topic is whether there are already complete industry-related laws, regulations, agreements, evaluation systems, and standards. The first statement is whether the laws and regulations related to the industry are globally convergent or regionally stable. Comparing the civil engineering projects which are one field of the oldest engineering branches with pharmaceutical engineering which has its root in the second half of the 19th century supports this viewpoint. One of the most distinctive features of construction projects is that in most cases the project is constructed and traded in the same area, while products of the pharmaceutical industry are not. This difference makes the construction project always definitely knows the laws and regulations the project needs to obey in advance. However, pharmaceutical products in different areas always have diverse regulations and evaluation systems. Just as during the COVID-19 pandemic, the list of vaccines recognized by countries varies greatly [6]. But thankfully, the presence of the World Health Organization can serve as a guideline for assessment. In the case of the Australian Therapeutic Goods Administration, for example, the vaccines approved by it are all from the WHO [6]. To avoid being hindered by regulatory authorities when entering the market, engineering projects such as food engineering and chemical engineering similar to pharmaceutical engineering often need to take into account that they may need to make certain modifications to their products to local laws and regulations. Even during special periods when approval is rushed [7], vaccine producers may submit approvals first when production or their testing is not completed and may update products based on audit feedback. Being able to do so also benefits from its Agile PMM [8], so projects are constantly producing deliverables. Another instance showing the importance of globally convergent regulations is software engineering. In this industry, internet protocols are universally accepted, such as HTTP, SSL, TCP, etc, which removes the obstacles to industry cooperation in the Internet environment. Therefore, the network transport protocol generally does not become a module of concern for enterprises when manufacturing software products, and even when considering the involvement of the

cybersecurity discipline, it does not want to tamper with the communication protocol of the Internet. Interestingly, in the same industry, updates to development frameworks and languages tend to be counted as the factors influencing the selection of PMM. Still, communication protocols rarely or never are involved. The underlying reason for this is that a unified protocol can smooth the product development process without thinking too much about the changes that may need to be made after consultation.

The next factor which can influence the selection of PMMs is whether there are sufficient industrial experience and past cases that can be used as a reference. To keep the plan as close as possible to the potential development roadmap of the project, managers tend to draw on development examples of similar projects when formulating management solutions. In areas with a long history, managers are more able to draw inspiration and references from previous cases when faced with PMM decision-making. Exploring whether the PMM of its choice is compatible with the project from similar cases in the past can help troubleshoot erroneous options or prove their existing choices. This is also why the PMM adopted in the industry will always gradually converge, and even begin to develop more industry specific PMMs derived from popular PMMs. For instance, a PMBOK-based PMM called SCPM 4.0 was proposed in 2021 specifically for supply chain project management in the Age of Industry 4.0 [9]. Another thing that can have an effect is whether there is close cooperation and exchange between enterprises in the industrial field, as the exchange of experience can help companies get first-hand feedback from competitors and collaborators. Moreover, similar projects can reduce the uncertainty of the current projects, which means managers can think less about changes in the project, so they can choose a PMM that is more inclined to stability to reduce management difficulties.

To conclude, industry maturity affects the selection of PMMs a lot. According to the Maturity Comparison Diagram below [10], the maturity of the industry can even influence the maturity of PMM development in the field. In addition to the factors already mentioned in the statistics, another potential reason is that the existing PMM is not well suited enough to the immature industrial system. That said, a more industry specific PMM may be needed, just as Agile methods emerged during the software delivery crisis of the 1960s [11]. What is clear is that a more industry specific PMM will promote the healthy development of the industry. Therefore, when the maturity of the industry is low, the projects in the industry tend to be more discrete in the choice of PMM; as the maturity of the industry gradually rises, the demand for PMM adaptability will promote the emergence of PMM for the industry, and in this way, it will promote the industry to reach maturity at a higher speed; in the end, Eventually, the choice of PMM for projects in the industry will tend to be the same direction.

3.3 Risk

Different industries tend to have different levels of risk. Innovative industries, such as advanced manufacturing, aerospace, bioscience, electronics, and information technology, are always complicated and with higher risks than the traditional industries. The factors influencing the risk level of the industry have been discussed above. The more emerging the discipline, the more it is experiencing frequent technological innovations; The shorter the development of the industry, the lower its maturity and the fewer means of production that can be referenced; Unique products are more likely to emerge in immature industries, and their uniqueness can also make project development unpredictable. All these factors increase uncertainty in the development of industrial projects. In addition to increasing its administrative costs, it also increases its planned budget for remediation and change management, as well as an accurate estimate of delivery time. This means that in high-risk industries, projects are more likely to time out, overrun, or even simply fail.

In high-risk industries, projects tend to focus less on the one-time molding of the product, and more on iterative development. Iterative ways of working can be more effective in risk management and change management, and they can also help companies avoid facing greater sunk costs. To illustrate this point, this article will use the FBI Sentinel Project as an example [12]. The Sentinel program was the FBI's second attempt after trying to build a VCF system [13], costing $170 million and declaring it a failure in 2005. But it's clear that the FBI hasn't learned its lesson from its last failure: They're still

using the waterfall model to build the Sentinel program. In the early days of developing the waterfall model, the project faced the same dilemma as it had encountered in a VCF project [14]. By 2010, the project began to face six years of delays and nearly $350 million in overruns - nearly doubling development costs from the initial budget. But in September of that year, after the project switched to scrum methods for development, the situation improved significantly. The FBI wasted more than a decade on two projects because of its use of waterfall, and $5.97 million was wasted without receiving any operational products. However, after the adoption of Scrum, the project was successfully delivered three years later at a cost of only $990 million. The success of agile methods proves its superiority in a changing environment of requirements. From another perspective, adopting a plan driven PMM in a high-risk project environment is also more likely to result in high sunk costs. Because plan-oriented PMM, such as the waterfall model listed above, and methodologies such as PMBOK that focus on the management process, tend to receive deliverables only at the end of the project. Non-modular outcomes are difficult to reuse, cannot lighten the burden on the next project, and can only consume the budget pointlessly and ultimately get nothing. Assuming that the project starts with agile development, even if it fails equally, it will fail much earlier than a plan driven PMM, preserving more budgets and reusable production.

Conversely, in the construction industry, waterfall modeling, lean framework, and CPM are often adopted. As a well-established traditional industry, construction projects need to consider far fewer risks than innovative industries. The four public risks that a construction project faces include productivity issues, health and safety hazards, subcontractor default, and change orders, which can be fully identified and assessed at the beginning of the project. Another interesting feature of the construction industry is that it usually tends to invest a lot of money in the preparation phase, with as much detailed planning as possible, with strict regulations on the future development path. This is because there are relatively few types of risk in the construction industry, but the risk level is higher. It can be easily identified, but it cannot be remedied at a lower cost. Therefore, in the construction industry, it is unreasonable to think too much about continuous optimization solutions. The history of CPM is a shred of evidence for this statement: CPM was first adopted by construction projects in 1959, and its use rate has grown rapidly to 98% by 2003. On the one hand, this is due to the excellent performance of CPM in terms of resources and personnel allocation. On the other hand, its limitations also determine that it is more suitable for application in industries with low risk or risk can (or can only) be ignored, and the management cost of maintaining the CPM is high, because when uncertainty occurs, the critical path changes and the entire plan needs to be updated. Therefore, there is no need for industries with lower risk management needs to choose more flexible PMM to increase the difficulty and cost of unnecessary project management.

In brief, industries that are more inclined to make corresponding risks need to choose flexible, value oriented PMM, while industries with lower risks or negligible risks that arise in the middle path are more likely to follow the plan and not pay too much attention to possible changes. Because the plan driven PMMs are more expensive than other PMMs in the preparation phase, and to maintain the plan, there may be a rework of the plan during the project, which means its characteristics also determine that it is difficult to get the appropriate application in industries with high uncertainty.

3.4 Time Orientation Versus Quality Orientation

In an industrial environment, companies always need to position themselves between time-oriented and quality-oriented, and how to make a trade-off between these two. In addition to the three factors already discussed above, two other important factors need to be taken into account.

One factor influencing a company's choice between time-oriented and quality-oriented is whether the company's services are terminated after the project is over. Here is an example of tourism. Unlike civil engineering and most IT projects, in the tourism industry, the sale of a tourism product does not mean the end of the project [15]. Based on this feature, in 2019 Burukina combined Waterfall, Scrum, PMBOK and its derivative PMM called EMBOK to develop an industry specific PMM called TMBOK. During the development of TMBOK, it was possible to see the impact of the four PMMs on it.

Waterfall and PMBOK focus on process management to ensure quality, Scrum promotes rapid development to occupy the market, and EMBOK conducts risk management to ensure product safety. Products that continue to generate value after the project has ended must take into account the difficulty of providing follow-up services and factor this into project management methodological decisions, which is reflected in the addition of EMBOK. Therefore, when the project's services will not be marked as terminated by the sale of its products, it is reasonable for the project to pay more attention to long-term risk management when choosing a PMM, that is, instead of only considering traditional PMMs such as PMBOK and waterfall, it is better to adopt a hybrid PMM and increase the proportion of event driven PMM.

Besides, it is worth mentioning that when making decisions, enterprises should not take "the benefits of favoring it are greater" as the key factor but should take "the loss of abandoning it is acceptable" as the core. To express this view more clearly, this article uses the film industry in China as an example. According to Douban, China's largest film book sharing platform, in the decade from 2007 to 2017, the average rating of Chinese costume dramas fell from 7.0 to 5.7, but compared with the declining ratings, the number of costume dramas produced each year has steadily increased. It all started in 2008 when a Qing Dynasty costume drama called "Gong Suo Xin Yu" exploded. The film and television industry has been incentivized by its success, leading to more and more low-cost, short-production cycles of the same type of TV series entering the market. Order to seize the outlet and abandon the quality of the product did not meet the expectations of the producers to bring huge benefits but led to the flood of homogeneous and inferior products on the market, so that the audience appeared aesthetic fatigue. But the " Empresses in The Palace", launched in 2011, is a perfect counterexample. Compared with the production cycle of other costume dramas with an average of less than half a year, " Empresses in The Palace" did not choose to be time-oriented to seize the market but chose to use a production cycle of more than one year to improve quality. So far, the rating of this TV series is still high at 9.3 points, with nearly 550,000 people commenting on Douban, and it has been played more than 100 billion times across the streaming media. It can be seen that in an industry that attracts consumers with quality, it is more harmful than beneficial to abandon quality and pursue rapid production. But in industries related to "fashion" and "trend", such as the fashion industry [16] and the short-video industry [17], quality is less important. In this type of industry, as long as they keep up with the trend, they can get public attention and consumer traffic, and the shelf life of the product itself is extremely short, so managers do not need to consider follow-up maintenance.

When all is said and done, the industry's orientation between time and quality can lead to the use of very different PMMs. Industries that expect the product to continue to generate value after the project is over will be more inclined to give up time flexibility, maintain the rigor of the project process, and choose a plan driven PMM that puts quality first. The opposite is true in industries that seek to rapidly update products.

4. Conclusions

Through in-depth research, this article found that the tendency of projects to choose PMM is not only affected by its characteristics, but also by the characteristics of the industry in which it is located. It is precisely for this reason that with the development of the industry, the PMMs selected by the project will gradually become unified, and there may also be more industry specific improved PMMs. Therefore, this article discussed the guiding role that the industry context can play as a factor influencing the choice of PMM for a project from the frequency of technological innovation, industry maturity, risk and comparison of time-oriented industry and quality-oriented industry. The conclusion that can be drawn from the case analysis is that the faster the technological innovation, the more immature the industry, the more the risk needs to be paid attention to, and the more time efficiency is emphasized over high quality, the industries tend to use flexible PMMs to ensure they can respond to the unstable development environment promptly; in the opposite situation, projects tend to use plan-driven PMMs to ensure quality and reduce administrative costs.

The main contribution of this article is to explore the guiding value of the industry's characteristics for project PMMs selection from a macro perspective and help project managers narrow the selection range, reducing the preparation cost before considering the detailed characteristics of the project. However, the current study still has shortcomings in that it does not quantify the proportion of the four industry characteristics when considering their impact and fails to combine the four factors to form a matrix. In addition, it is still relatively naïve to divide the industry by only four factors.

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