

Identification of the Need for Agile Methodologies in Construction Projects Design Management

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Abstract

Recent studies showed that most employees occupy “Meaningless Jobs”, due to poor interaction and deprivation of sensing the working outcome of jobs, especially in the design phase of the construction and urbanism project. However, recent studies proved the need for employees’ engagement with different stakeholders to increase productivity and optimize work performance. Although various industries have adopted the Agile Project Management (APM) approach, the Engineering, Procurement, and Construction (EPC) industry might not be ready for APM, due to traditional Human Resources Management Systems. Thus, this research aims to identify the need for Agile Methodologies in the EPC industry and to propose APM philosophies and methodologies that might fulfill those needs. The methodology is based on two parts. The practical part includes performing a social survey on the design engineers of the EPC to quantify meaningless jobs. The second part includes a comparative analysis of the needs of the EPC industry against Agile adequacies, in addition to analyzing case studies where applying APM was a success in both EPC and Software industries. The analysis is based on reviewing relevant literature and its statistical findings. The research concludes that the majority of the survey subjects occupy a meaningless job. Meanwhile, their needs can be addressed by applying Agile Methodologies, similar to the shift that occurred in the Software industry. Finally, the paper discusses the high affinity and potential of the EPC industry to adopt APM in design phases.

Keywords

Section; Architecture and Urbanism, Agile, Construction Design Management, Project Management, Meaningless Labour, EPC

1. Introduction

Throughout history: anthropologists have been reminding the world of Marx’s theories, concluding that capitalism has separated workers apart from the value of their work, in a phenomenon called Alienation, which makes slavery out of employment according to Aristotle’s definition (D. Graeber 2006). One of the contemporary examples of that is Graeber’s theory proposed in 2013, stating that most employees believe their jobs are meaningless, which was clarified later on in his book in 2018 (David Graeber 2018). To verify that, Dahlgren has surveyed whether employees feel like they’re contributing to the world (Will Dahlgreen 2015). The results of the survey were that only half of the thousand-person sample could argue with the theory, believing they have a job that has a meaningful contribution to the world, as illustrated in **Figure 1-(a)**, which indicates how people feel severely disconnected from the value of the outcome of their work.

Graber has also elaborated on the resemblance between slavery and capitalism in main shared traits, including Separation in location between the workplace and the social impact of labor power (Mei 2019), such Alienation can be eliminated by reflective engagement of the project team (employees). However, recent studies in Europe show relatively positive results for meaningful jobs as shown in **Figure 1-(b)**, especially in fields with well-managed and controlled environments such as the medical field where the mean Meaningful Work Total score of the respondents reaches 80% (Duarte-Lores et al. 2023).

Yet on the contrary wider research confirmed Graeber’s theories as shown in **Figure 2** (Csordás et al. 2022). Such fluctuation in results across different countries and fields inspired the authors to conduct similar studies on the Egyptian market of Engineering, Procurement, and Construction.

In 2020, Sokrat’s study tackled the mentioned problem (Sokrat 2020), the findings of the study were that the engagement of employees of the Egyptian public sector enhances productivity and performance. Sokrat’s study suggests that employee engagement should be a part of the work environment to increase productivity, satisfaction, and loyalty and enhance performance as well. Employee engagement is mostly affected by five factors as illustrated in **Figure 2**.

However, recent researchers argue the validity of the mentioned theory (Soffia, Wood, and Burchell 2022), accordingly in 2022, Csordás et al. (Csordás et al. 2022) performed a test based on Work and Meaning Inventory (WAMI) (Snyder 2016), which showed that 64% of people had meaningful jobs (**Figure 3**). The results are relatively positive compared to Graeber’s assumption (David Graeber 2018) yet negative compared to Duarte’s WAMI results (Duarte-Lores et al. 2023), which indicates that awareness of the employees and their connection to their output increased over the past period in Europe, however, furthermore efforts need to take place to enhance their engagement with different stakeholders, reinforcing the ownership towards the outputs of daily tasks.

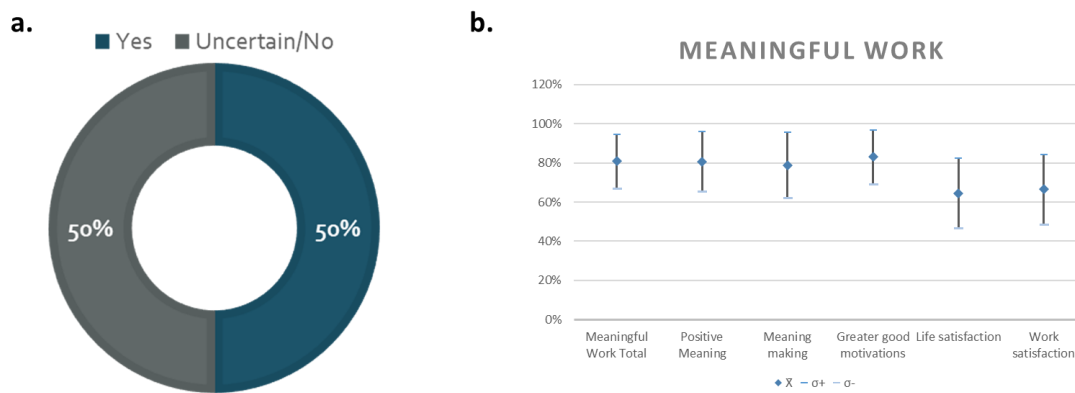


Figure 1-(a). “Is your job making a meaningful contribution to the world?”, Source: Authors after (Will Dahlgreen 2015);

Figure 1-(b). Descriptive statistics for Meaningful Work in Spain, Source: Authors after (Duarte-Lores et al. 2023).



Figure 2 Sokrat's Findings, Source: Authors after (Sokrat 2020)

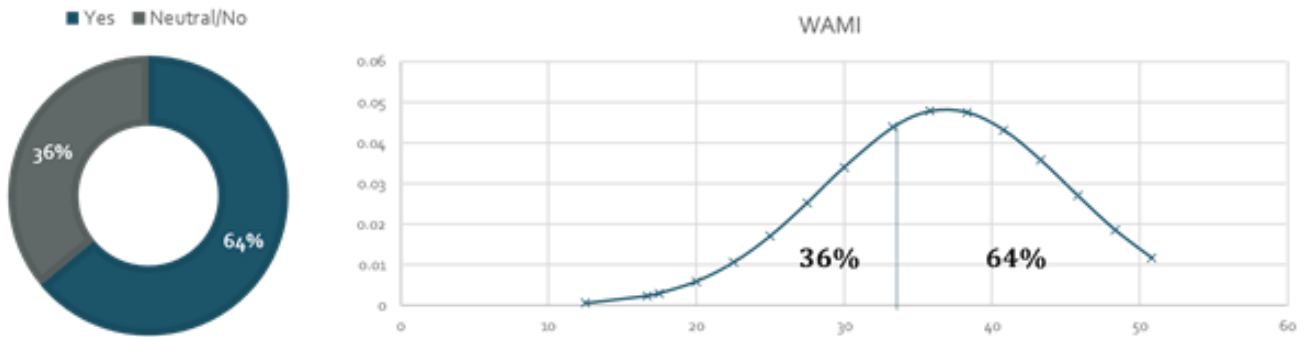


Figure 3. Meaningful work percentage among a sample of employees in Europe, Source: Authors after (Csordás et al. 2022; Snyder 2016).

Accordingly, engagement of the project team within the process became the main point of focus in various studies, as well as being the base for modern project management frameworks. One of the well-known approaches for project management that focus on Individuals and Interaction as the first of its four core values (Figure 4), is the Agile Project Management approach (Kent Beck et al. 2001; Project Management Institute 2017).

Agile Project Management (APM) has proven to be effective, not only in the software field but also in the construction field, especially in the design phase (Owen et al. 2006). In 2017, the PMBOK 6th Edition was released, introducing APM officially, and providing a separate practice guide, for project managers and Agile Certified Practitioners (ACP) (Project Management Institute (PMI) 2017). Agile values also include frequent delivery of working outputs, with diminishes the gap between micro-managed tasks and substantial deliverables.

Despite the success proven by applying APM to various industries, and studies showing its applicability to Engineering, Procurement, and Construction (EPC), the industry is not yet

Which Agile methodologies might fulfill DPM needs?

ready for APM. The main cause of the problem is that current EPC Organization Structures and Human Resources Management Systems cannot accommodate APM (Zavvalova, Sokolov, and Lisovskaya 2020). However, research shows a major negative cost variance, especially in the design phase, due to poor communication and limited customer involvement, which can be addressed by incorporating project management philosophies that support interaction with all project stakeholders, such as APM (Anita and Doloi 2015).

This research aims to identify the need for Agile Methodologies in the EPC industry and to propose APM philosophies and methodologies that might fulfill those needs, by addressing the following research questions:

- RQ1.** Do engineers working under Waterfall Project Management style suffer from meaningless labor phenomena?
- RQ2.** What are the needs of the DPM in the EPC industry?
- RQ3.** Why is Agile broadly applied in Software and not in DPM?
- RQ4.**



Figure 4. Agile Values, Source: (Kent Beck et al. 2001)

2. Research Methodology

The research fulfilled its purpose by performing qualitative analysis for various processes based on conducting a social survey, reviewing relevant literature, and formulating a set of approaches to be applied to the DPM to enhance its performance and efficiency, as summarized in Figure 5.

The social survey is based on the WAMI approach (Snyder 2016), targeting engineering employees in the Egyptian EPC industry, to identify the percentage of meaningless jobs according to Graeber’s definition (David Graeber 2018) amongst the industry.

The qualitative analysis illustrated the EPC industry needs analysis analyzed the merits of APM, and the results of the application of Agile Methodologies in the Software Industry as well as analyzing several case studies of applying APM to the EPC industry. According to the analysis mentioned above, the research identified a set of APM approaches that might fulfill the needs of DPM.

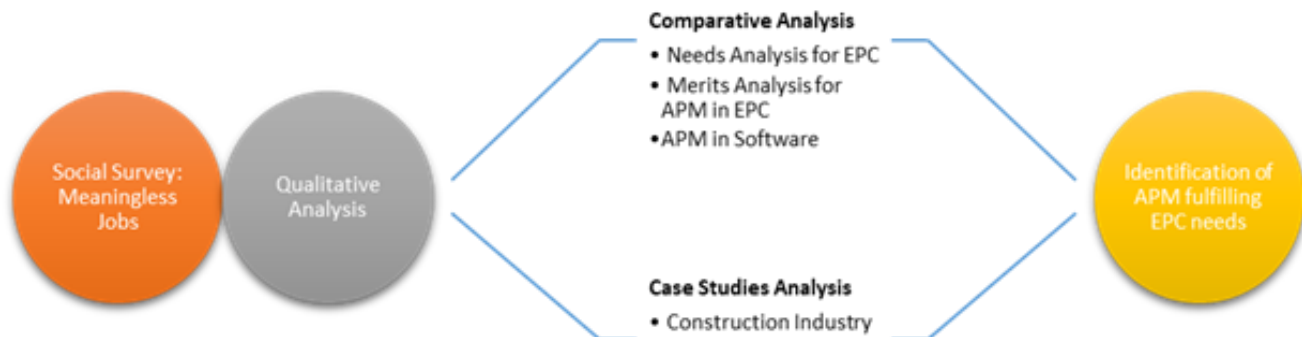


Figure 5, Summary of Research Methodology, Source: Authors.

3. Discussion

This section discusses imperial and theoretical studies performed to come up with research findings and results. The studies include a social survey, comparative analysis, and case studies analysis.

3.1. Social survey: Meaningless Jobs

In May 2023, the authors launched an online survey, based on the Work and Meaning Inventory (WAMI) (Snyder 2016) score sheet to measure the percentage of meaningless jobs amongst engineers in Egypt, covering three main domains as shown in Figure 6. The survey aims to identify whether the project management styles implemented in the EPC industry result in the phenomenon of meaningless jobs,

The survey consisted of the 10 WAMI test questions in addition to anonymous information about the subject, including current occupation, the management style they work under, and whether they consider their job to have a meaningful contribution to the world. The sample size reached 119 respondents, where 84 of them worked under the traditional project management style, 27 worked under the APM style and 8 were disqualified due to working in operation-based organizations. The sample of people working under APM style can resemble a control group to measure whether the application of agile methodologies has a positive impact on the WAMI score.

For the Waterfall Sample, 7% of the respondents have failed the test (<25/50), while 49% scored between 25/50 and 32/50 (Good), and only 44% scored above 33/50 (Very Good and Excellent). While for the APM Sample, all respondents scored over 32/50 and none of the sample has failed the test.



Figure 6, Three Main Domains of WAMI score sheet, Source: (Snyder 2016)

3.2. Needs analysis of EPC

The Design Project Management (DPM) process in the EPC industry faces various problems, reflecting the need to reconsider the conceptualization of the managerial framework governing different processes as researched by Pikas E. et al. (Pikas, Koskela, and Seppänen 2017; Pikas, Koskela, and Liias 2017; Pikas et al. 2018). The mentioned needs can be summarized as the need for technical excellence and meaning of work, effective communication, individual interactions, proper change management, flexibility, and iterative cycles.

The Need for Technical Excellence and Meaning of Work: A common problem facing the implementation of traditional project management frameworks in the industry is failing to address the dual nature of the design process between technical and social aspects. Despite that, studies show that the social aspect directly contributes to technical excellence (Pikas, Koskela, and Seppänen 2017; Pikas, Koskela, and Liias 2017; Pikas et al. 2018). Fulfillment of such a need is notably difficult in the shade of the phenomena of Alienation or Meaningless Labor.

Pikas et al. conducted a series of studies on the DPM processes implemented in the EPC industry. The studies identified “the problem of relevance”, and proposed a solution, shedding the light on the need for substituting the conventional construction design management conceptual foundations. The Case Study -of an Estonian Design Office-identified the problem of relevance as the poor conceptualization of the existing DPM approach results in delays and patching of unaligned work, let alone the deprivation of technical excellence (Pikas, Koskela, and Seppänen 2017). This aligns with other studies showing that major problems arise with the current management systems, leading to redesign and scope creep (Tauriainen et al. 2016).

The Need for Effective Communication: In 2021, a survey was sent to 24 Tier-1 Australian contractors (Vaz-Serra, Hui, and Aye 2021), to highlight the current needs of the EPC industry and its expectations towards the new agile and lean construction approaches, to help the industry become more aware of these important new collaborative methods. The results of the analysis of the survey were that there is a pressing need to educate construction organizations that there are productivity tools such as lean construction.

The needs analysis shows that the construction industry needs enhanced communication skills. Aligning with the mentioned notion, various studies proved the crucial need for effective communication (Sagar et al. 2022; Shan 2013; Pikas et al. 2016), in addition to being an influential factor affecting the deliverables of the design process (Oladokun and Alshaikh 2018).

The Need for Individuals’ Interactions Among Different Stakeholders: A compilation of a survey questionnaire (Anita and Doloi 2015) to investigate the relationship between poor design management and cost over-run. The responses were analyzed using SPSS for action, attribute, and attitude through bivariate correlation, regression, rotation, descriptive, and factor analysis. The research concludes that it is very important to set appropriate strategies, processes, and an initial follow-up of design to avoid cost overrun. As Pre-design considerations have the highest percentage of variance explained, which illustrates the importance of proper consideration and accumulation of design elements and processing at the initial phase of design. An example of the mentioned considerations to achieve the desired optimizations in the budget is using Face to Face communications as the main channel for coordination and regular checking and feedback within smaller intervals of time.

Moreover, in 2013, research by Shan (Shan 2013) proposed a method of DPM and coordination, through the development of a methodology for design management throughout all project design phases. The developed methodology focused on the necessity to establish that a special design team must be involved in the process of developing the project’s design contract. Moreover, Design Managers shall be focused on engaging the designer in the coordination process with the owner, other consultants, works being executed by the construction team, and the contractor.

Furthermore, research in 2022 showed the need for more stakeholder involvement, especially end-users' requirements to be fulfilled in the design process (Sedhom, Khodeir, and Fathy 2022). More studies emphasized the need for enforced interaction among different project stakeholders, including clients, designers, engineers, etc. (Wang et al. 2016; Herrera et al. 2020; Pikas et al. 2016; Lawanga and Sandanayake 2021) Such involvement shall save a substantial interval of time excreted in traditional coordination and approval processes, leading to overall saving in project costs.

The Need for Proper Change Management Processes:

A social survey held in 2014 (Bowes 2014) shows that a major drawback of the traditional management system is rigidity against continuous changes. Furthermore, during interviews with design managers discussing three project case studies, 13 major and 6 average serious level problems were identified (Tauriainen et al. 2016). The main causes for the problems were as follows:

- Unclear sharing of responsibilities between designers in teams.
- Poor BIM experience of Design Managers and lack of communication with BIM experts in the team, resulting in inadequate BIM instructions.
- Major difficulties sharing information between different disciplines.
- Redesign and repetitive changes to the project.

The research recommends the implementation of modern to adopt design changes in a more structured manner, minimizing cost overruns.

The Need for Flexibility And Iterative Cycles: A case study with a mixed-method approach in 2018 (Savolainen et al. 2018) explained how the quality of the project outcome can be forecasted from the management style and procedures, by conducting a deductive analysis. The documentation of the case study included a user satisfaction survey, showing that the DPM processes need to be more flexible and would greatly benefit from the iterative designing methods. Various studies emphasized the concept of breaking down project phases into minute iterations (Albuquerque, Torres, and Berssaneti 2020; Singh 2019; Bahceci, Holmgren, and Gustavsson 2014). Not only such a concept is needed, but also it is already implemented in the industry under the umbrella of BIM or Lean methods (Williams 2017; M. Sakikhales 2022; M. H. Sakikhales and Stravoravdis 2017).

3.3. Merits analysis of APM

Research shows that Agile Project Management (APM) provides many merits to the teams adopting its methodologies, especially when using Building Information Modeling (BIM) technology (Styvold, Knotten, and Lædre 2019). Listed below are some of the relevant merits of APM in the light of the main values and principles of Agile Practice.

Agile Values and Principles: As previously shown in **Figure 4**, Agile values individuals and interactions, delivering working outputs frequently, customer collaboration, and welcoming changes. That's in addition to the main agile principles defined in the manifesto, as shown in **Figure 7**, (Kent Beck et al. 2001; Project Management Institute 2017).



Figure 7, Agile Principles, Source: Beck et. al, 2001

Technical Excellence and Motivating Employees (Meaningful Work): Attempting to develop the management framework used in the industry, Carlos et al. introduced and tested a continuous roadmap update that adopts principles from APM (Carlos, Amaral, and Caetano 2018). The results of their work showed an improvement in the information monitoring process, credibility, and making innovative decisions using the roadmap introduced. Testing the framework proved that using Agile saves a substantial part of the cost structure of the project, by operating teams in a self-driven motivated manner. Such manners increase the sense of responsibility and ownership, driving the team towards high levels of performance. An example of Agile Methodologies tested on the DPM with success in the EPC industry is “Scrum” (Demir and Theis 2016).

Also, it was noteworthy that the integration between BIM and APM frameworks in the design phase had a positive impact on the optimization of the project (Tomek and Kalinichuk 2015). The study concluded that the proposed process model optimized the design process and overall quality, by achieving collaborative design, a high level of coordination, optimizing schedule and cost performance, and diminishing claims and disputes. One other factor increasing productivity is the connection between the team and their delivered output, thus emphasizing the meaning of work (Danijela and Danijela 2017).

Effective Communication and Individuals Interactions: Studies proves that the application of APM increases the effectiveness of communication and enforces the communication links and bonds between team members as well as other stakeholders (Danijela and Danijela 2017). Such enforcements increase the overall project’s performance, and assure client satisfaction, as they’re already involved sufficiently in each iteration (Demir and Theis 2016; Anita and Doloï 2015).

Welcoming Changes Responsively: Research shows that Agile methodologies successfully achieve the Agile Value of Welcoming Change, throughout each iteration, by involving different stakeholders in the process (Anita and Doloï 2015; Bowes 2014).

Flexibility of Processes: An article discussed the differences between Agile and Waterfall, using comparative analysis and social surveys (Bowes 2014). The results of the surveys show that among the entities choosing Agile over Waterfall, 23% choose APM to accelerate the overall process, while 16% choose it to manage changing priorities, and 15% find it more appropriate to their business objectives. The mentioned results align with the results of Bowes’ comparative analysis stating Agile merits as follows: frequent value delivery, closer collaboration between stakeholders, changes can be incorporated in late stages, welcoming continuous improvement, and it is highly transparent. The mentioned flow is illustrated in **Figure 8**.



Figure 8, Illustration for Iterations/Sprints, Source: (Bowes 2014)

3.4. Analysis of APM in the software industry

Literature collected from researching the Software industry, as proof of the applicability of Agile Methodologies of DPM, as both processes have common aspects.

Project Management Framework: Waterfall was discontinued in the software industry due to excessive documentation and deprivation of regular interactions, as opposed to Scaled Agile Frameworks (SAFe) (Ameta, Patel, and Sharma 2022). However, waterfall is still considered the main management framework in the EPC industry (Jethva and Skibniewski 2022). To date, the Software development industry does not have a structured practice for project management (Traini 2022), yet it applies various Agile Methodologies based on project needs, including Extreme Programming (XP), Scrum, and Hybrid XP/Scrum (Alyahya, Alqahtani, and Maddeh 2016), which emphasizes on including clients in the process is the key factor of cost optimization (Palopak and Huang 2022).

Performance Factors: Agile is not only oriented to client satisfaction but also offers flexibility in change management of clients' requests, up to the required quality. Accordingly, Performance measurement factors in the Software industry are teams, individuals, processes, and organizations (Beh et al. 2022). On the contrary, in traditional management techniques applied in DPM, the performance factors are delays (time), cost, and quality, which cannot be the sole triangle of performance governing such a creative activity (Ismail et al. 2022).

Communication and Interactions: In 2022, a questionnaire for agile practitioners and academics shows that team dynamic in the software industry is based on effective communication (Thanthony, Marnewick, and Marnewick 2022), as Agile includes periodic interactive activities such as retrospective sessions and stand-up meetings, which also contributes to managing the overall occurrence of conflicts (Przybilla, Wiesche, and Krmar 2018).

Complexity and Change Management: Software development processes support uncertainty and continuous changes (Bianchi, Marzi, and Guerini 2020; Shani et al. 2019). The responses of 176 IT employees demonstrated that Agile approaches facilitated handling more complex projects, as it simplifies complex projects into working deliverables in each iteration (Muhammad et al. 2021).

Project Planning: In 2016, Alyahya et. al conducted a survey (Alyahya, Alqahtani, and Maddeh 2016) to identify the most commonly applied management methodologies applied in the software industry, as well as the most utilized planning software such as VersionOne, Rally, Mingle, and One Time. On the other hand, the construction industry uses tools that focus on the critical path rather than project features such as Primavera P6 and Traditional Planning (Saibabu, Asadi, and Bhanu Prakash 2017). Also, studies show that the optimal iteration duration in the Software industry is two to three months, otherwise can cause cost overrun or declination in quality (van Oorschot, Sengupta, and van Wassenhove 2018). While in average, a construction design project elapses 8 months as per studies on mid-sized infrastructure design projects (Shin, Jung, and Kim 2022).

3.5. Analysis of case studies

This section shows the results of the analysis of previous case studies, selected based on the relevance of objectives and methodologies alignment with the purpose of this research. The selected case studies belong to the EPC industry, as proof of the applicability of APM methodologies in the industry, including the following:

Agile project management concepts applied to construction and other non-IT fields (Straçusser 2015): The study analyses two case studies, to translate the main Agile concepts based on the Agile manifesto to match the construction projects' nature. The case studies include a Nuclear Plant and the RD&D project for Centrus Corp. Six main principles were evaluated from the study achieving very beneficial results and outcomes from the case studies providing proven examples of the success of the application.

In continuation to the above-mentioned concept, Agile Principles need to be translated to fit the EPC industry, instead of applying it as it is. Therefore, there's a need for a new framework for the DPM using Agile Methodologies.

Agile Design Management – The Application of Scrum in The Design Phase of Construction Projects (Demir and Theis 2016): The Case Studies verified the success of the adaptation of the scrum approach into the design phase of construction projects over Waterfall Project Management. Implementing APM resulted in the following achievements:

- Transparency of in-progress and completed tasks and work packages.

- Collaborative planning of design, and joint prioritization of work packages.
- Better identification and communication of problems and risks, integration of users and technical departments, and coordination of various design disciplines between themselves.
- Rapid escalation of problems through recurring coordinated meetings, and increased team motivation through the transfer of greater responsibility, especially to junior and inexperienced designers.
- Reduction of employee workload and better deployment of resources.

In conclusion, traditional Agile Scrum can be used to increase project team productivity by focusing on individuals and interactions.

Using Agile Project Management and BIM for Improved Building Performance (M. H. Sakikhales and Stravoravdis 2017): This case study explained the advantages of APM through an extended literature review and analyzed the potential benefits of the adoption of this methodology in the construction industry and sustainable design process. The explanation took place by testing the developed iterative design framework, using agile principles. The mentioned framework supports incremental development in each iteration to achieve higher building performance, each iteration has three phases: design, analyze and adapt which allows for exploring, evaluating, and developing design alternatives, as illustrated **Figure 9**. BIM facilitated the implementation of this approach, by providing a prompt accurate data transfer of documents, ensuring collaboration, and facilitating communication among the project team.

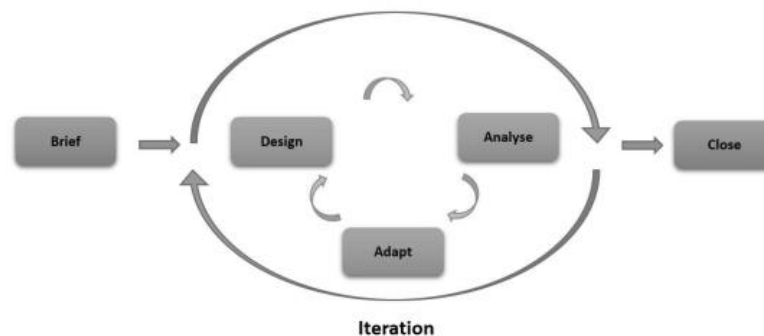


Figure 9, Iterations Diagram, Source: (M. H. Sakikhales and Stravoravdis 2017)

The outlined framework will form the basis for a series of case studies to furthermore analyze the effectiveness of this framework in different types of projects.

4. Results and Findings

Based on the discussions above, it came to light that the application of Agile Methodologies in the EPC industry at the design phase would be beneficial and satisfactory to the main needs of the industry. Moreover, it was clarified that such an application might be feasible.

4.1. Analysis of Survey Results

The results of the survey shown in **Figure 10** elaborate that the population working under the APM style has relatively high WAMI scores compared to the population working under the traditional project management style, thus the application of agile methodologies contributes to resolving the meaningless job phenomena, especially in the greater good motivation domain.

4.2. Comparative Analysis

A comparison between EPC Needs and APM Merits is formed based on reviewing and analyzing relevant literature covering both aspects as shown in **Table 1**. The first column of the comparison resembles the needs of the Engineering, Procurement, and Construction (EPC) industry, especially during the design phase. The second column resembles the adequacies of implementing APM to the EPC with the potential to fulfill the mentioned needs.

The analysis was based on the review of literature data collected, through research of specific keywords related to the area of study, as illustrated in the matrix (**Table 2**). The statistical findings of occurrence for keywords were illustrated in **Figure11**.



Figure 10. Survey Results, Source: (Authors, May 2023)

Table 1. Comparative Analysis between EPC Needs and APM Merits, Source: Authors

| # | EPC Industry Needs in the Design Phase | Corresponding APM Merits (3.3) | Corresponding Agile Values and Principles |
|----|--|--|--|
| A. | The Need for Technical Excellence and Meaning of Work. | Technical Excellence and Motivating Employees (3.3.2) | <ul style="list-style-type: none"> Agile Values: Delivering Working Software Agile Principles: Technical Excellence; Progress is the Working Value; Motivated Teams; Sustainable Development; and Self-Organizing Teams. |
| B. | The need for effective communication | Effective Communication and Individuals Interactions (3.3.3) | <ul style="list-style-type: none"> Agile Values: Individuals & Interaction Agile Principles: Face to Face Communication; Business and Technical Collaboration; and Reflection on being more effective. |
| C. | The need for individuals interactions among different stakeholders | Effective Communication and Individuals Interactions (3.3.3) | <ul style="list-style-type: none"> Agile Values: Customer Collaboration and Individuals & Interaction Agile Principles: Business and Technical Collaboration; Face to Face Communication; and Sustainable Development. |
| D. | The need for proper change management processes | Welcoming Changes Responsively (3.3.4) | <ul style="list-style-type: none"> Agile Values: Responding to Change and Customer Collaboration Agile Principles: Welcoming Change; Simplicity; Value Delivery every couple of months; and Customer Satisfaction. |
| E. | The need for flexibility and iterative cycles | Flexibility of Processes (3.3.5) | <ul style="list-style-type: none"> Agile Values: Delivering Working Software and Responding to Change Agile Principles: Simplicity; Value Delivery every couple of months; Motivated Teams; and Technical Excellence. |

Table 2. Cooccurrence Matrix for Keywords in collected literature, Source: Authors

| Keywords | A | B | C | D | E | F | G | H | I |
|--|---|---|---|---|---|---|---|---|---|
| Individuals and interactions (Communication) (A) | 0 | 5 | 2 | 2 | 5 | 5 | 4 | 4 | 0 |
| Working software (Iterations) (B) | 5 | 0 | 3 | 2 | 5 | 5 | 3 | 4 | 1 |
| Customer collaboration (C) | 2 | 3 | 0 | 1 | 2 | 2 | 2 | 1 | 1 |
| Responding to change (D) | 2 | 2 | 1 | 0 | 1 | 2 | 2 | 1 | 0 |
| Waterfall Incompetence (E) | 5 | 5 | 2 | 1 | 0 | 4 | 3 | 4 | 1 |
| BIM (F) | 5 | 5 | 2 | 2 | 4 | 0 | 3 | 4 | 0 |
| Lean (G) | 4 | 3 | 2 | 2 | 3 | 3 | 0 | 2 | 0 |
| DPM (H) | 4 | 4 | 1 | 1 | 4 | 4 | 2 | 0 | 0 |
| Obstacles facing APM in DPM (I) | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |

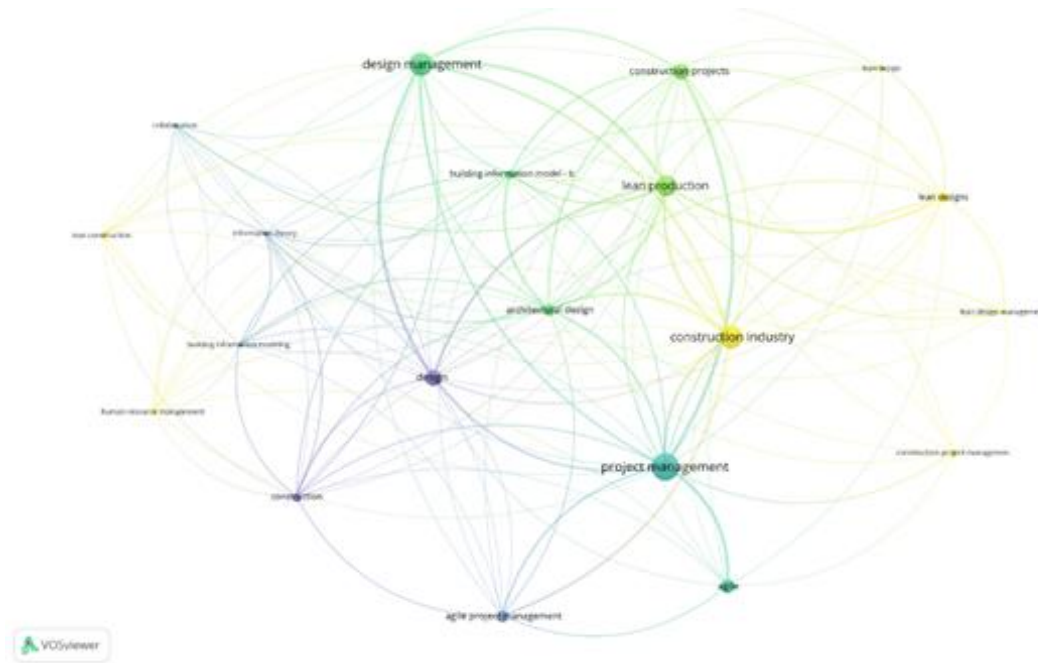


Figure 11, Statistical Findings for Keywords Occurrence, Source: (Authors, 2023)

4.3. Results of applying APM

As discussed in section (3.4.): APM has been successfully applied in the Software industry, which is similar in nature of the process to DPM to an extent. The following **Table 3)** shows a comparison between different project management aspects of both industries.

As discussed in section (3.5.): Researches show the need for developing a new framework for the DPM using Agile Methodologies. The mentioned framework can be developed by translating existing Agile Principles and Methodologies into more suitable terms to fit the EPC Industry.

Case studies have succeeded in applying traditional Agile Scrum to increase project team productivity by focusing on individuals and interactions. In addition, other outlined frameworks were developed and were expected to be followed by projects to furthermore analyze the effectiveness of such frameworks.

Finally, it is worth noting that APM offers considerable potential for application in predesign and design phases (Owen et al. 2006). Moreover, it was noted during the needs analysis and data collection that the EPC industries already informally use Agile. However, the functional organizational structures and the existing relationships between firms caused an internal cultural resistance to adopting APM approaches formally (Albuquerque, Torres, and Berssaneti 2020).

Table 3. Comparison Between Software and EPC Industries, Source: (Authors, 2023)

| # | Point of Comparison | APM in Software Industry | DPM in EPC Industry |
|----|----------------------------------|---|--|
| 1. | Project Management Framework | Project-Based Organizations with Agile Project Management Systems (XP & SCRUM). | Project-Based Organizations with Traditional (Waterfall) Project Management Systems. |
| 2. | Performance Factors | Teams, Individuals, Processes, And Organizations | Cost, Time, and Quality |
| 3. | Communication and Interactions | Team Dynamic is based on Effective Communication (retrospective sessions and stand-up meetings) | Formal Correspondences |
| 4. | Complexity and Change Management | Subdivided into Small Iterative Cycles. | Subdivided into Major Project Phases. |
| 5. | Project Planning | Short Projects, Iteration average duration of 2.5 months. Planned using VersionOne and Rally. | Medium-Long Projects, Phase average duration of 8 months. Planned using Primavera P6 and Traditional Planning. |
| 6. | Cultural Acceptance of APM | Waterfall was officially discontinued, and APM is widely accepted. | Organizations favor Waterfall and APM is not well known. |
| 7. | Challenges | The industry does not have a structured practice for project management to date. | Applying APM would face resistance from organizations. |

Conclusions

The paper provides a detailed analysis of the needs of the EPC industry and its corresponding APM methodologies, and that's through a social survey and literature review. The analysis has covered the following research questions:

RQ1. How many engineers working under Waterfall Project Management style suffer from meaningless labor phenomena in Egypt? 56% of the population working under Waterfall Project Management style had less than ideal results, which is below 32/50 on the WAMI test, whilst none of the population working under APM scored such low results.

RQ2. What are the needs of the DPM in the EPC industry? The needs of the industry can be summarized as follows: Meaning of Work & Technical Excellence; Effective Communication; Interaction amongst Stakeholders; Proper Change Management; and Flexibility & use of Iterative Cycles. The research shows that the above-mentioned needs can be fulfilled by APM Principles, Values, and Methodologies.

RQ3. Why is Agile broadly applied in Software and not in DPM? The Software industry has welcomed the shift to Agile, transformed its organizations to accommodate smaller iterative cycles, and focused on Individuals, Teams.

Meanwhile, in the EPC industry, the shift is facing cultural and organizational resistance, relatively long project phasing strategies, and failure to address the needs related to individuals and interactions.

RQ4. Which Agile methodologies might fulfill DPM needs? Research and case studies show that SCRUM-related methodologies can fit the industry, however, it is more recommended to tailor frameworks to fit the exact needs of the DPM process.

Accordingly, Agile Methodologies can fulfill DPM needs in the industry. It is also noteworthy that the DPM process has already organically adopted Agile philosophies. Lean/Agi-Lean practices are more welcomed in the market. However, the application of a complete framework was not introduced to the Egyptian market, and it would be a substantial achievement to continue based on this research developing and testing a viable APM framework for DPM in Egypt.

Recommendations

In light of the overlap between the needs of the EPC industry and the merits of APM; it is recommended to start formulating and tailoring an Agile Framework for the Design Management process of the industry. Applying and testing such methodologies may have a positive impact on the efficiency of the

related firms, especially the consultant, and might present an opportunity from a Value Engineering point of view.

The research focuses on the design phase of the project, rather than the construction and site support phases, and is based on foreign research, as local studies on the matter are scarce and limited. It is recommended to research this area of study in Egypt furthermore, as many industries with similar behavior have successfully shifted to Agile in Egypt and worldwide. The continuation of this study as recommended by the authors shall cover the following:

- An Agile framework for Design Management of EPC Projects.
- Applying and Testing Agile methodologies in Egyptian EPC firms.
- The application of agile methodologies in the construction and site support phases.
- The effect of applying lean and agile methodologies from a Value Engineering point of view.
- Overcoming the organizational behavior and HRM systems obstacles facing the application of Agile in Egypt.

Finally, the authors find that some agile methodologies might not be suitable for the criticality and size of construction projects, however, future research shall include Scaled Agile Methodologies such as Scrum of Scrums (SOS), Large Scaled Scrum (LeSS), etc.

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