

The Effect of Delay in Construction Projects Timetables on the Building of Smart Cities

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Abstract

Smart cities leverage technology and data in order to improve the quality of life of their residents, the effectiveness and sustainability of municipal systems, and economic development. These cities offer varied technologies, such as sensors and data analysis for the purpose of collecting and analyzing data in real-time. Thus, they facilitate a rapid and efficient decision-making. Improvement of the quality of life is achieved by providing efficient transportation, clean energy, and high-quality public services, such as healthcare and education. Furthermore, smart cities enhance their sustainability by reducing the consumption of resources and emission of greenhouse gases, promoting their renewable energy, as well as creating durable infrastructures that can withstand natural disasters. Delays in the construction timetables considerably affect the development and implementation of smart cities. Various factors can account for such delays. For example: unexpected site conditions, disruptions caused by the weather, changes of design or scope of work, as well as lack of materials or manpower. Smart cities involve complex and connected systems, such as transportation, energy, and communication networks and, thus, delays in the timetables can compromise their timing and continuity. These factors entail increased costs and potential failures of the project. The delay in building a smart transportation network affects the branching out of the systems, the traffic management, or smart parking. Project managers should adopt proactive measures, e.g., risk management and contingency plans, as well as perform current monitoring and reporting in order to moderate the impact of timetable delays on the construction of smart cities.

Keywords: timetable delays; project management; smart cities; changing reality; construction industry.

JEL classification: R58

Introduction

The building of smart cities involves improvement of the residents' quality of life, by providing them with efficient transportation, clean energy, and high-quality public services, such as healthcare and education. Moreover, these cities strive to enhance sustainability by reducing the

consumption of resources and hothouse gases emission, promotion of renewable energy, and creation of infrastructures that can withstand natural disasters.

Construction timetable delays can crucially affect the development and implementation of smart cities. These delays might may be due to various reasons, such as: unexpected site conditions, weather-oriented problems, changes in the design or scope of the work, as well as lack of materials or workers. Smart city projects frequently comprise complex and interconnected systems, e.g., transportation, energy, and communication networks. Delays in construction might disrupt the timing and sequence of these systems, leading to increased costs and potential failures in the project. For example, if the construction of a smart transportation network is delayed, this can impact the spreading out of other systems, e.g., management of smart transportation or parking.

Project managers should adopt proactive measures, e.g., risk management, contingency plans, as well as current follow-up and reporting, aiming to mediate the effect of these timetable delays in the construction of smart cities. Risk management involves identification of potential risks and development of strategies for reducing them before they occur. Contingency plans consist of the development of alternative plans in case of unexpected delays or disruptions. Constant follow-up and reporting assist in the early identification of potential delays and in taking remedial measures for minimizing their effect. In addition to these measures, stakeholders of smart city projects should prioritize cooperation and communication. This implies the participation of all parties involved in the project - contractors, suppliers, designers, and government agencies – in regular discussions for the purpose of identifying and resolving potential problems as quickly as possible. Construction timetable delays can considerably affect the success of smart city projects by adopting proactive measures and prioritizing collaboration and communication. Stakeholders can minimize the impact of delays and guarantee the timely completion of projects.

Construction projects constitute an essential part of the global economy, since they provide the infrastructure and buildings required for supporting the growth and development of communities around the globe. From small-scale renovations and up to large-scale developments, construction projects can vary in size and complexity.

Smart cities use a diversity of technologies and applications in order to accomplish the following goals:

1. Smart transportation systems, including: smart traffic management systems, real-time information about public transportation, and autonomous vehicles.
2. Smart energy systems, including: use of renewable energy sources, smart networks, and energy-saving buildings.
3. Smart public services, including: smart waste management, public safety systems, and online governmental services.
4. Smart buildings, including: smart buildings management systems, energy-saving systems, and sensors that optimize the use of space.
5. Smart citizens' involvement, including: platforms that enable residents to participate in decision-making processes, provide feedback, and access services and activities in the city.

To sum up, smart cities are designed to use technology and data in order to improve the quality of life, sustainability, and economic development of urban areas, while enhancing the efficiency of municipal systems.

Smart city projects often involve complex and interconnected systems, such as transportation, energy, and communication networks. Construction delays can disrupt the timing and sequencing of these systems, leading to increased costs and potential project failures. For example, if the

construction of an intelligent transportation network is delayed, it may affect the deployment of other systems, such as traffic management or smart parking.

Project managers need to adopt proactive measures, e.g., risk management, contingency planning, and regular monitoring and reporting to mitigate the impact of construction timetable delays in smart cities. Risk management involves identifying potential risks and developing strategies for reducing them before they occur. Contingency planning consists of developing alternative plans in case of unforeseen delays or disruptions - regular monitoring and reporting help in the identification of potential delays early, taking corrective measures for minimizing their effect.

Effective project management constitutes an essential factor in driving the success of industry-oriented projects, such as construction. The ability of the project managers to stick to timetables, remain within budget, and ensure project quality, all serve as indicators of a project's success (Isik, et al., 2009). The PMBOK® (Project Management Body of Knowledge) Guide was produced by The Project Management Institute (PMI) to provide outlines for the approaches and processes, tools, and needs for successful project management (PMI, 2021).

Many studies of project management have been conducted, as well as relevant research of project management and project management success (El-Razek, et al., 2008). However, little research has investigated the success of construction projects conducted according to the Waterfall model that has incorporated frequent changes. Since the 1990s, with the development of the online platform, the disadvantages of using the Waterfall model in construction projects has begun outweighing its advantages. The Internet facilitated daily updates, with processes such as software updates, user reviews, and troubleshooting requirements being received in real-time. The updated requirements and considerations generated frequent changes in the project, even during the execution phase. Hence, since the Waterfall model relied on complete characterization at the start of the project, any change request was likely to be costly and cumbersome.

This study focuses on managing construction projects in a changing reality and changing management during the planning or execution stages, most likely in the building Smart Cities.

1. Literature review

Nowadays, construction projects constitute a major contributor to the global economy, with the construction industry accounting for a considerable share of GDP in many countries. Construction projects can be found in virtually every corner of the world. They often collaborate with various professionals, including architects, engineers, contractors, and project managers. Nevertheless, construction projects can also be challenging, often subject to various risks and uncertainties, among them regulation changes, unpredictable weather, and unexpected site conditions. Managing these risks and ensuring that projects are completed on time and within budget, requires careful planning and coordination.

Despite these challenges, construction projects are a key driver of economic growth and development worldwide. As the world's population and urbanization rates continue increasing, the demand for new buildings and infrastructure remains high. This presents both opportunities and challenges for the construction, requiring the development of new technologies and approaches for supplying the growing demand for construction projects sustainably and efficiently.

Construction projects are executed in complex dynamic environments and changing reality, often characterized by uncertainty and risk. The literature presents ample evidence that many construction projects fail to accomplish their time, budget, and quality goals (Al-Bahar and

Crandall, 1990; Assaf and Al-Hejji, 2006; Mulholland and Christian, 1999). Ineffective planning and scheduling have been acknowledged as meaningful causes of project delay. Mulholland and Christian (1999), as well as Assaf and Al-Hejji (2006) argued that inferior planning was the third major cause of company bankruptcies in the Belgian construction industry.

Wei (2010) found that the most effective ways of reducing construction delays and staying within the scheduled time frameworks were exercising strict oversight and management, ensuring strategic planning, and maintaining clear and open communication channels.

Project Managers in the construction field are supposed to lead the respective projects in their lifecycles. Construction projects involve many risks and are unpredictable. It is not an easy task to manage them as a manager. According to Turner (2014), construction projects need flexible leadership and management to respond to changes during their execution.

To minimize the impact of changing circumstances on a construction project, the project team should have a flexible plan and be prepared to adapt to changes as they arise. Managers have used conventional project management methods, such as Waterfall, for dealing with construction project management challenges. However, due to weaknesses associated with conventional approaches to project management, the agile project management technique was designed for use in the construction industry (Turner, 2014). Nonetheless, its use has caused several obstacles. It is necessary to understand these challenges to improve their use in the future, for the purpose of enhancing the process of construction project management.

Only a limited number of studies have explored obstacles associated with the agile methodology in construction and design projects. Hence, many managers find it challenging to use this methodology in such projects. This study aims to address this problem by looking in-depth at the challenges of using agile methodology in construction projects, as well as the way these challenges may be resolved in the future.

While construction projects are undertaken daily worldwide, each project is unique because of aspects that are specific to the construction site and the construction activity circumstances. Construction necessitates coordination between the people involved and the materials needed, and depends on material supplies, available labor, and the conditions at the construction site. Other unpredictable factors, such as last-minute changes or unreliable suppliers, may also lead to difficulties in ensuring that construction projects are completed on time (Viles, et al., 2019).

Delay is one of the most common issues reoccurring in the construction industry, resulting in negative impacts on the projects' success in terms of time, cost, quality, and safety (Pourrostan and Ismail, 2012). Timetable delays may have critical financial implications for the project sponsors and substantial social costs to the public, justifying research focused on timetable delays (Padalkar and Gopinath, 2016). Although some research of timetable delays has been conducted worldwide over the last two decades, studies of this phenomenon in Israel have been limited (Rozenfeld and Yokle, 2011). Furthermore, little research has focused on the success of construction projects using the Waterfall model, which incorporates frequent changes during planning and execution.

Although extensive efforts are exerted, aiming to improve construction project controls in the US and the UK, a slight improvement in project performance associated with timetables has been noted. This study examines timetable delays in construction projects, suggesting a practical instrument for managing the timetable in construction projects while adapting to the changes that transpire during the project.

The existing literature has not successfully managed to address the problem of obstacles associated with the use of the agile methodology in the management of construction projects. Most of the

studies have focused mainly on the benefits of using agile methods and success factors associated with its application in project management (Cohn and Fredrickson, 2010). Consequently, it is necessary to conduct comprehensive research that focuses basically on the challenges associated with the use of construction project management.

The agile methodology in the management of construction projects involves considerable obstacles that result in the collapse or inefficiency of using the available resources. Thus, the application of the agile methodology in construction projects faces tremendous barriers in enhancing its ability to ensure that effective project management. Moreover, it reduces the chances of project timetable delays or the use of substantial financial, human, and technical resources, that would have otherwise been reduced. Solving this research problem experienced in construction project management. will in future render effective the management of projects that use the agile methodology.

In the past years, implementing the agile methodology has become prevalent in construction companies (Thesing, et al., 2021). However, quick changes primarily relate to the Information Technology industry. To better understand what is involved in such transformation, the main issues of “Feasibility in Applying Agile Project Management Methodologies to Building Design and Construction Industry” will be reviewed with respect of Agile adoption.

Different issues can arise while transforming conventional project management into agile processes. As it requires a meaningful fundamental cultural change in a company, it is essential to chart in advance the issues that can inhibit the generation of such a change. Understanding potential issues facilitates the outline of the proper measures that can be charted and pinpointed to assure the success of such reforms. The main focus ultimately is figuring out how to adopt the Agile project management structure in the building design and construction projects, the methodology and process. Several studies that have investigated the Agile method versus the Waterfall method have been conducted, yet they are not explicitly related to the construction industry. This study aims to create a technique and a modular process so that construction and infrastructure project managers can identify and manage changes during the project.

According to Dybå, et al. (2014), the existing literature on agile methodology only focuses on its positive aspects of project management. Hence, little attention has been paid to its weaknesses when applied to the management of projects, such as construction projects. The gap in the existing literature resides in the fact that there is no adequate information concerning the way of overcoming the current obstacles in agile construction projects (Vijayasarathy and Turk, 2008). Thus, there is a need for research that aims to bridge this gap in the literature dealing with the agile methodology in construction projects.

2. Data and Research Methodology

This study aims to point out the critical root causes of deviations from timetables of construction and infrastructure projects, following changes in the characterization of requirements during the planning and execution stages. The study focuses on an in-depth investigation of the phenomenon in a changing reality. The original timetable (as planned) is known, and the actual program (as-built) is known. What is unknown is the changes that occur during the project external and internal impacts that will affect the original or planned timetable. These root causes may indicate the source of the problem in order to cope with the root causes rather than coping only with the symptoms.

This study proposed a causal model, based on the synthesis of the Agile models and empirical studies that have been conducted in the field of construction project delays. Unplanned changes in construction projects are common and lead to disruptive effects, such as project delays, cost overruns, and quality deviations. Reprocessing due to unexpected changes can cost 10-15 percent of the project value (Senaratne and Sexton, 2009). This study facilitates drawing the developers and project managers' attention to factors that have the most crucial impact on timetable deviations. Given the small number of publications on this topic, the findings of this study can also have implications from the international aspect. The publication of the results can enhance the comprehension of this phenomenon and its reduction. Moreover, the results can draw the attention of public construction clients, developers, project managers, planners, and contractors to the root causes, decreasing the extent of budget deviations in construction. The findings will also suggest a tool for minimizing this disrupting effect by managing these changes more effectively. The results will allow designing a new model for project management. This model integrates the techniques and flexibility of the Agile methodology with the spatial and comprehensive vision of the Waterfall model while meeting fast and changing timetables in construction and infrastructure projects.

This study focuses on managing construction projects in changing reality, defining the success or failure of the project, examining different, new, or conventional methodologies that affect project success, and building an intermediate method suitable for construction project management. It offers a different point of view on project management, namely project managers experience the integration of several methodologies for accomplishing the project goals. This examination raises difficulties in project management, i.e., project managers do not act by conventional management principles. Instead, they implement the Agile methodologies prevalent in various disciplines of project management, requiring business vision and strategic understanding beyond the managers' professional and technological capabilities.

The life cycle of a construction project consists of various phases and may require the generation of numerous information models (see Figure 1). The participants in the construction project are active during different stages of the project according to their skills. Delays may occur at any phase of the project, and this study will investigate the ways of preventing timetable deviations that affect many construction projects.

Most of the construction projects are managed according to the conventional Waterfall Model (see Figure 1).

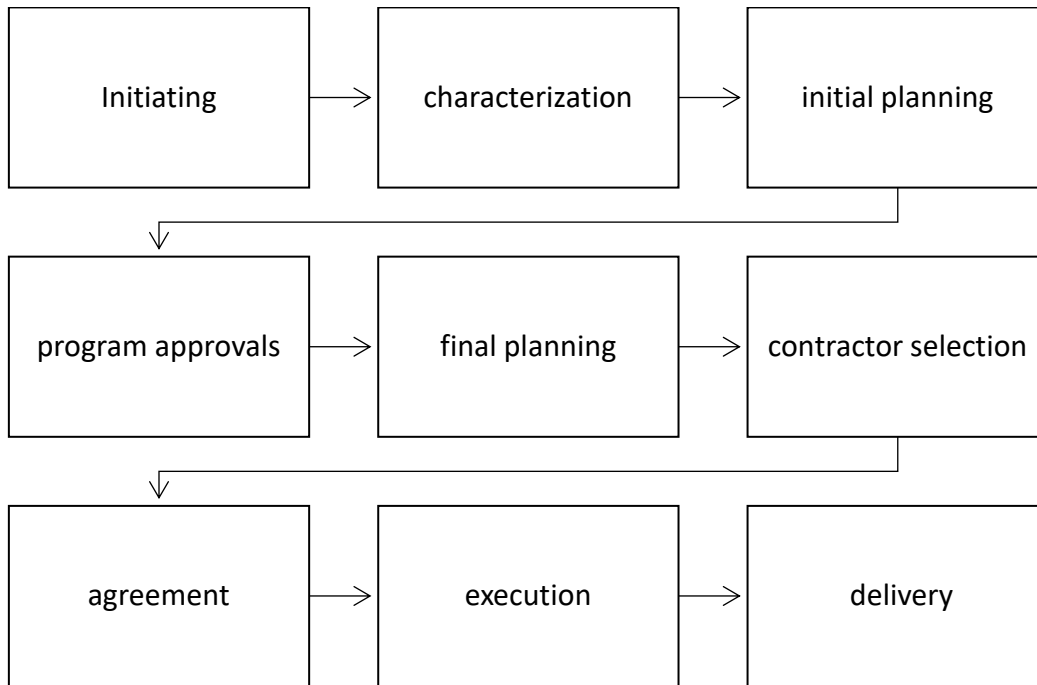


Figure 1: Construction project's process

Source: the author's diagram

This study examines the use of the Waterfall model in construction project management, as well as explores the number of deviations in the construction project timetables and their effect on the project's success. Moreover, it investigates compliance with the plans of a construction project using the Waterfall model when changes in the characteristics of the project are introduced during the planning and execution stages. The Waterfall model takes its name from its resemblance to the way a waterfall flows along with a series of cascades. The project phases are serial, and the model strongly emphasizes the characterization of all the project requirements as a preliminary step in the project planning. One of the main challenges that arise from the use of the Waterfall model is difficulties in making design and requirement changes from the initial plans without incurring additional costs and experiencing timetable deviations.

The mixed methods approach integrates quantitative and qualitative research in the research design, as shown in Table 1.

Table 1. Research Design

| Research Design | Research Aim | Research Instrument | Research Participants/ Source | Data Analysis Method |
|---------------------------------------|--|---------------------------------------|--|---|
| Qualitative & Quantitative | To identify the causes of delays in construction projects, examine the use of the Waterfall model in construction project management, and explore the number of deviations in the construction project timetables and their effect on the project's success. | Documentary research of reports | Construction project records from 20-30 projects | Content analysis Frequency analysis |
| | | Closed-ended structured questionnaire | Construction project managers | Correlations, regressions, structural equation modeling |
| Qualitative | To present guidelines for meeting timetables of construction projects | Interviews & focus group discussion | 15 construction practitioners | Content analysis |

Data collection from the field will yield qualitative data relating to deviations from construction project timetables. Outcome analysis of the construction project reports will be performed to obtain a preliminary estimate of the scope of construction project delays, and frequency analysis will support an initial analysis of the characteristics of the delays and their effect on timetable deviations.

3. Results and Discussion

Document analysis - sampling about 26 projects, the construction of which has been completed, to obtain a preliminary estimate of the phenomenon scope and an initial analysis of its characteristics.

The document will collect data from different companies and projects.

This document includes summary meetings, BOD reports, finance influences, and critical objects from the projects.

The results were analyzed by structural equation model content:

- Investigating the main causes for delay in a construction project – including those from literature review and actual projects (26 protocols and summaries from Israel) that are repeated in every project and recent research. Analyzing the projects, including delays from the original

schedule, budget exceptions, the number of changes during the project, and the reasons for the difference.

- Characterizing the common categories for delays in the construction project schedule.

Table 2. Perceptions of timetable delays in construction's projects: What factors will or will not cause a timetable delay in construction projects?

| No. | Executing Corporation | Project Description | Protocol Date | Protocol Type | Category |
|-----|-----------------------------|---|---------------|---|--|
| 1 | Contractor | Raw Material Warehouse Maytronics Constructing a 4000 m ² warehouse. | 16.3.2020 | Contractors' meeting on site concerning construction and budget deviations due to a problem on site – a crack between a new and an old building | Unexpected construction problem |
| 2 | Construction public company | Hod Hasharon Municipality Development Project | 29.12.2021 | Budget deviations due to content added throughout the course of the project | Changes during the project |
| 3 | Engineering – Contractor | Offices; 10,000 m ² | 27.10.2022 | The 20-day delay in foundation completion | Equipment supply |
| 4 | Engineering – Contractor | | | Timetable delays due to late supply of an elevator ordered from Switzerland | Equipment supply |
| 5 | Engineering – Contractor | | | Receiving a construction permit may delay settling, as may firefighting permit | Regulation |
| 6 | Engineering – Contractor | | | 20 workers shortage on Site | Shortage of workers on site |
| 7 | Engineering – Contractor | | 3.11.2022 | Rise of raw materials costs due to market recession; flattening of central wooden core | Raw materials Supply |

| | | | | | |
|----|--------------------------------|---|-----------|---|--|
| 8 | Contractor | Raw Material Warehouse Building 6, 2500 m ² | 10.6.2020 | Delay in installing rods within the floor due to inappropriate and incompatible work on site | Changes throughout execution |
| 9 | Shelf company | Raw Materials Warehouse Building 5 | 9.6.2020 | Timetable depends upon date of completion and submission of shelving rods | Raw materials Supply |
| 10 | Contractor | Electricity Production Hall | 9.3.20 | Tour with committee's superintendent delays beginning of work | Local government regulation |
| 11 | Contractor | Electricity Plant Building 4 | 9.6.2020 | Work stopped due to negligence related to work at height | Work safety |
| 12 | | Offices building, warehouse building, electricity plant | 15.3.2020 | COVID-19 restricting arrival of workers to the site and contractors' entering the plant; quarantines. | Shortage of workers on site |
| 13 | Contractor | Raw Material Warehouse | 7.2.2020 | Discovering a pipeline underneath the building following foundations excavation; transferring pipeline and performing a constructive change in the building | Changes throughout execution due to an unplanned proceeding |
| 14 | Israel Electricity Corporation | Laying a High-voltage line | 4.5.2020 | Laying a high-voltage line | Regulation, Israel Electricity Corporation |

| | | | | | |
|----|-----------------------------------|---|-----------|--|---|
| 15 | Contractor Engineering | Offices Building | 4.6.2020 | On 1 st June and on Monday, following two days of pole drilling and based upon the surveyor's poles' location scanning on the site, it was found that at that point, the eastern pole's distance (80 95 cm) from the B axis poles is not equal. Thus, it was impossible to put up the eastern posts according correspondence to the plan. Consequently, the final outcome would have been a narrower building | Changes throughout execution; measurement error, construction change |
| 16 | Supplier | Shelving Raw Materials warehouse | 11.6.2020 | Delayed arrival of rods from the Czech Republic, delayed installment of rods | Delay in raw materials supply |
| 17 | Contractor | Electronics Plant Building 4 | 3.6.2020 | A seven-month delay in the supply of elevators | Material supply delay; Products for Site |
| 18 | | Office Building | 17.3.2020 | Freezing of labor due to COVID-19 related instructions concerning avoidance of over ten workers' gathering | COVID-19 |
| 19 | Construction public company | Urban Renewal Agreement | 19.5.2020 | Delay resulting from delayed receipt of permit | Regulation; local Committee |

| | | | | | |
|----|--------------------------------|---|-----------|--|--|
| 20 | Construction public company | Residence Quarter Construction | | District committee's approval and urban building scheme certificate | Regulation; district committee, Israel Land Administration |
| 21 | Entrepreneur company | Residence Project in Bat Yam | | Ramot Shavey Zion signed three agreements with third parties for purchasing segments of a plot of land in southwest Bat Yam bloc 502, plots 115-116 held in partnership by a multitude of owners (Hereinafter: "The Plot of Land") | Legal issues involving the landowners |
| 22 | Contractor Engineering | 4900 m ² Mivneh Technologies | 7.11.2020 | Planning-related Changes | Changes throughout execution |
| 23 | Israel Electricity Corporation | Laying a high voltage line | 20.4.2020 | | Planning related changes with further planning alternatives; Dependence upon statutory parties; IEC |
| 24 | Contractor | Electronics Plant | 4.6.2020 | Further Maytronics request for enhancing hall's degree of lighting in building 4 to 750 lux, we examined the various pertaining issues; Planning update requires the following items; | Changes throughout execution – ordering party |

| | | | | | |
|----|--------------------------|--------------------------|----------|---|--|
| 25 | Contractor | Raw Materials Warehouse | 2.4.2020 | Information systems and infrastructure preparedness | Preparedness of intra-organizational interfaces – a recurrent problem |
| 26 | Energy company Public | Solar panel construction | 2019 | Energy's Periodical Report | Delay in raw Materials supply |

To sum up, a delay in project timetables is affected by various factors rather than by one element. The factors do not necessarily depend on each other and often there are several delay-cause criteria that affect the project schedule.

Regarding the content analysis, there are five main categories on which the questionnaire has been designed:

1. Manpower
2. Raw materials and electro-mechanic systems
3. Regulatory aspects
4. Legal aspects
5. Project's changes and complexity

Conclusions

In the construction industry, execution delay means exceeding the length of performance from the date specified in the contract, or beyond the agreed-upon date for delivery of the project. The uncertainty leads to financial implications (Lo, et al., 2006). Outstanding claims relating to time are a contractor's requirement for an extension during the project, or an extension for a particular activity beyond the agreed duration, defining the delay in executing the project and its cost. Delays in the project timetables directly affect the project's budget, and the issue may become political in public projects.

The construction industry is an important economic sector for most developing countries. However, major infrastructure projects experience extensive timetable delays in the operational process. This study aims to identify the causes of timetable delays in the construction sector to assess and communicate their importance to all project stakeholders, the owner, the contractor, the consultant, etc. The literature has been extensively reviewed for the purpose of identifying the causes of delays and methods of minimizing timetable delays, while maintaining the quality, safety, and budget.

In a dynamic world that is changing from day to day, reality is the change. It is the incessant change. In this world, we have to manage construction projects with flexible methodologies that facilitate a change of the planning throughout the project execution. Research enables us to understand what are the main and meaningful factors that cause delays in the project timetables and are affected by changes to the project, whether these are global external factors, or changes due to customers' constraints.

This study outlines the problems that cause delays and the need to make construction projects flexible, fast, and suitable for frequent changes. Delaying timetables in construction projects is global and relevant worldwide, from India, Malaysia, Europe, the United States, to Israel. According to the literature, the main reasons for timetable delays in construction projects are frequent changes associated with the order of work, an estimate of cost, and lack of budget in the project, the problem of raw materials and supply chains, and resource management in the project. Managing projects by conventional methodologies, such as the Waterfall, is insufficient for coping with the changes. Moreover, the Agile methodology is not necessarily suitable to construction projects. Nevertheless, the global trend of delays in the delivery of projects indicates the need for a methodology that integrates both the Waterfall and Agile methodologies, providing a response to a quick decision-making in the field. A reality that changes every day, entails many challenges to the owners, contractors, consultants, and project managers. It is necessary to make quick decisions in short intervals, rather than expect the project's initial planning to be relevant even after a long, often years' long execution.

The findings of this study will leverage the development of a new model for construction projects management. The model will integrate the techniques and flexibility of the Agile methodology with the spatial and comprehensive vision of the Waterfall model to meet fast and changing timetables in construction and infrastructure projects. Moreover, the findings will support a different form of project management for construction projects, whereby project managers integrate several project management methodologies to accomplish the project goals. Project managers do not depend on the conventional Waterfall model for construction project management, but rather implementing and integrate Agile methodologies prevalent in the world of project management in other disciplines. Hence, the business vision and strategic understanding required from the managers may be beyond the managers' professional and technological capabilities.

With a critical path network, it is possible to determine compensation in time, and to some extent in cost, for the delays arising from any eventuality. The literature has often recommended the critical path method, but writers usually fail to discuss the problem of concurrent delays. Delays may be caused by several parties, contracting parties, or others. Consequently, the effects and remedies vary from case to case. Concurrent delays are two or more co-occurring delays and their resolution has always been challenging. The primary aim of this study is to present a method for dealing with this type of delay by means of the Agile methodology. An example will demonstrate the process effectiveness in determining the contracting parties' responsibility for project timetables.

Organizations are widely adopting agile methodologies to increase speed and provide flexibility for software development. The Agile methodology has numerous positive focuses. Although companies that considerably focus on the conventional project management process fear the complete adoption of this method, it may encompass a potential risk. It is not a "one-fits-all" arrangement, and, thus, we regularly see businesses utilizing a mix of methods and hybrid solutions. When organizations that have followed the Waterfall model have switched to pure Agile methodology, the transition has given rise to many issues.

The reason resides in the adaptability to a different approach and the incompetence to establish a suitable combination of a hybrid approach for construction projects that may lead to added unnecessary complications. This will help the organizations' transition from conventional PM (project management) methodologies to the Agile methodology. As with any other change, growth to a new process involves several issues. Hence, careful planning and study of the transition

impacts of the transition, such as quality, timetable, budget and resources can help execute the change itself.

The mixed methods approach (conventional and Agile) allows companies to benefit from the agile methodology and to eliminate the issues with the conventional model. "Agile" is the most recent popular expression. Numerous organizations need to "put a finger in the water", checking whether the agile methodology is suitable, without really changing their entire organizational structure to be flexible in a blaze-cut situation.

The cost of smart cities constructions with electromechanical systems and sophisticated technologies is very high, so it is important not to exceed the pre-defined timetables. Thus, by properly managing the activities, understanding the factors that affect schedule delays, and managing frequent changes and changing needs, construction projects can be kept ahead of them.

References

Al-Bahar, J.F. and Crandall, K.C., 1990. Systematic Risk Management Approach for Construction Projects. *Journal of Construction Engineering and Management*, 116, pp.533-546. [https://doi.org/10.1061/\(ASCE\)0733-9364\(1990\)116:3\(533\)](https://doi.org/10.1061/(ASCE)0733-9364(1990)116:3(533))

Assaf, S.A. and Al-Hejji, S., 2006. Causes of Delay in Large Construction Projects. *International Journal of Project Management*, 24, pp.349-357. <https://dx.doi.org/10.1016/j.ijproman.2005.11.010>

Cohn, M.A. and Fredrickson, B.L., 2010. In Search of Durable Positive Psychology Interventions: Predictors and Consequences of Long-Term Positive Behavior Change. *The Journal of Positive Psychology*, 5, pp.355-366. <https://doi.org/10.1080/17439760/2010/508883>

Dybå, T., Dingsøy, T. and Moe, N.B., 2014, Agile Project Management, September 2014. In: G. Ruhe and C. Wohlin, ed. *Software Project Management in a Changing World*. Publisher: Springer-Verlag. Ch.11. DOI: 10.1007/978-3-642-55035-5_11

El-Razek, M., Bassioni, H. and Mobarak, A.M., 2008. Causes of Delay in Building Construction Projects in Egypt. *Journal of Construction Engineering and Management-ASCE*.134.

Işik, Z., Arditi, D., Dikmen, I. and Birgonul, M., 2009. Impact of corporate strengths/weaknesses on project management competencies. *International Journal of Project Management*, 27, pp.629-637. <https://doi.org/10.1016/ijproman.2008.10.002>

Lo, T.Y., Fung, I.W. and Tung, V.C., 2006. Construction Delays in Hong Kong Civil Engineering Projects, *Journal of Construction Engineering and Management*, 132(6), DOI: 10.1061/(ASCE)0733-9364(2006)132:6(636)

Mulholland, B. and Christian, J., 1999. Risk Assessment in Construction Schedules. *Journal of Construction Engineering and Management*, 125, pp.8-15. [http://dx.doi.org/10.1061/\(ASCE\)0733-9364\(1999\)125:1\(8\)](http://dx.doi.org/10.1061/(ASCE)0733-9364(1999)125:1(8))

Padalkar, M. and Gopinath, S., 2016. Six decades of project management research: Thematic trends and future opportunities. *International Journal of Project Management*, 34, pp.1305-1321. PMI 2021. *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)* (7th edn.). Project Management Institute.

Pourrostan, T. and Ismail, A., 2012. Causes and Effects of Delay in Iranian Construction Projects. *International Journal of Engineering and Technology*. 4(5).

Rozenfeld, Y. and Yokle, S., 2011. *Root causes of budget overruns of construction projects*. Technion National Institute for Construction Research, Technion. Ministry of Construction and Housing. [Hebrew]

Senaratne, S. and Sexton, M. G., 2009. Role of knowledge in managing construction project change (February 2009). *Engineering Construction & Architectural Management* 16(2), pp.186-200, DOI: 10.1108/09699980910938055

Thesing, T., Feldman, C. and Burchardt, M., 2021. Agile versus Waterfall Project Management: Decision Model for Selecting the Appropriate Approach to a Project January 2021. *Procedia Computer Science*, 181(30), pp.746-756. DOI: 10.1016/j.procs.2021.01.227 License CC BY-NC-ND 4.0

Viles, E., Rudeli, N. and Santilli, A., 2019. Causes of delay in construction projects: a quantitative analysis. *Engineering, Construction and Architectural Management*, 27(4), pp. 917-935.

Vijayasathya, L. and Turk, D., 2008. *Agile software development: A survey of early adopters* (January 2008). <https://doi.org/10.1016/j.infsof.2011.08.003>

Wei, B. and Yang, L., 2010. A Review of Heavy Metal Contaminations in Urban Soils, Urban Road Dusts and Agricultural Soils from China. *Microchemical Journal*, 94, pp.99-107. <http://dx.doi.org/10.1016/j.microc.2009.09.014>