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A conceptual hybrid project management model for construction projects

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Abstract

The commonly adopted project management approach is the traditional plan-driven model, which sometimes is not the most appropriate approach to complex construction projects subject to successive changes, where more agile approaches might be more adequate. The objective of this paper is to provide a hybrid project management approach that not only draws on traditional project management approaches, but also on agile and lean ones, and that seeks to promote change, boost interaction with the client and increase project value, by using the agile approach component to increase the probability of success of construction projects; and to eliminate waste by embodying the lean approach component. The paper thoroughly reviews the available literature on different project management approaches and proposes a hybrid project management model for construction projects, presenting and discussing key traditional, agile and lean practices.

Keywords: Agile project management; Traditional project management ; Hybrid model; Construction projects.

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1. Introduction

Project management is the basis of any construction project, since projects are constantly evolving, a well-planned process to insure their success. Exceedances that may occur in a large construction project are very difficult to quantify due to the huge volume of variables involved [1].Failure of construction projects can be the result of cost overruns, schedule overruns or unreasonable growth in project content [2]and also by adapting a traditional project management methods.

This inevitable failure requires a different approach to construction project management. To foster a more effective approach, it is important to carefully review the management and implementation of projects to determine the most effective tools and techniques to adopt.

Due to these challenges posed by traditional project management methods, modern agile/lean techniques and methods are applied in several sectors, including the use of agile methods in the IT industry to improve communication, flexibility and reduction of unnecessary changes in order to increase the success rate of projects.

to better manage a project, we must first examine the "traditional", "agile" and "lean" methods. In order to explore how terms are interconnected and how approaches differ, then the main question is what can be done to combine the "waterfall", "agile" and "lean" approaches in order to develop a new hybrid management model suitable for construction projects. Where adaptation will always be necessary for each project in a specific context since, as we know, project management depends on the context.

The following section of this document provides the context for the appropriate literature for the development of the Hybrid Management Conceptual Model for construction projects. Section 3 illustrates the results of the research and the hybrid management model. Finally, the last section presents some conclusions, limitations and future work.

2. Project management approaches

2.1. Agile project management approach

The seeds of agile techniques have existed for a long time. In fact, agile values, principles and practices are simply a codification of common sense. The history of agile project management, dating back to 1930s, with Walter Sherwart's Plan-Do-check-Act (PDCA) approach to project quality.

In the 1970s, Dr. Royce published "managing the development of large software systems" and suggested that the waterfall method itself is ineffective, doing everything in one sequence is not realistic and would need to be repeated at least twice to succeed, [3] Mills Background discussion on the progressive development of IBM's Federal Systems Division is found in a volume published "Principles of Software Engineering", The notion of origin in 1980 "Visual Control" in the Toyota production system is an anticipation of "information radiators".

Boehm [4] did a first empirical study of projects using prototyping, in essence an iterative strategy, suggests that iterative approaches began to receive serious attention at that time, most likely due to factors such as the increase in personal computers and graphical user interfaces, 1984: The notion of "factoring", an anticipation of refactoring, is described in "Thinking Forth", where it is presented as the "organization of the code into useful fragments" that "occurs during detailed design and implementation". In 1985, Perhaps the first one explicitly named, incremental alternative to the "waterfall " approach is Tom Gilb Evolutionary delivery model, nicknamed "Evo". [5] Boehm presents "A Spiral Model of Software Development and Enhancement", an iterative model focused on identifying and reducing risks through appropriate approaches. [6] Takeuchi & Nonaka published an article entitled "New Product Development Game" in the Harvard Business Review. The article by Takeuchi and Nonaka described a rapid and flexible development strategy to meet the demand for ever-changing products and to manage the development process differently. To achieve speed and flexibility, companies must manage the product development process differently, [7] Abbas et al , in 1988 The "timebox" is described by Scott Schultz as one of the cornerstones of the "rapid iterative Prototyping production" approach in use at a spin-off Du Pont, Engineering Associates information.

[8] Griswold & Opdyke in 1990 , Bill Opdyke has coined the term "refactoring" in an ACM SIGPLAN document with Ralph Johnson, "Refactoring: An aid in designing application frameworks and evolving object-oriented systems"; In 1991 RAD, perhaps the first approach in which time-boxing and "iterations" in the more flexible sense of "a repetition of the complete software development process" are closely associated, is described by James Martin in his

"Rapid Application Development". This book also describes the details of the time-box in one of its chapters. The term "agility" was first observed in the manufacturing sector [9], under the name of "agile manufacturing", even before the term became popular in the field of agile project management. In 1992: A complete description of "refactoring" is presented in Opdyke's thesis," "Refactoring object-oriented frameworks" , [10] Bjørnvig & Coplien writes the original StandUp Meeting pattern template. [11] Turner & Cochrane noted that "Frozen objectives become an integral part of defining project quality, and project managers are said to succeed if they deliver them on time and within budget, regardless of whether the product is useful or beneficial to owners and users. "(p. 94) , This highlights the advantages of the methods that formalize the re-planning of a project during the execution phase, [12] in 1995 Schwaber K. write 'SCRUM Development Process' among the first to introduce the notion of 'sprint' as an iteration, although its duration is variable.

These different methods, without being called "agile", have all inspired the methodology, state of mind and agile philosophy currently used in the field of software development. [13], Beck et al a group of software and project experts met to discuss the commonalities of their successful projects. This group created the Agile Manifesto, a statement of values for successful software development, [14], Poppendieck "Lean Programming", draws attention to the structural parallels between Agile and the ideas known as Lean or "Toyota Production System". [15] Kerth in his book published in 2001 , the term "Retrospective Project" is introduced in the book of (Project Retrospectives: A Handbook for Team Reviews); in 2002 the Scrum community adopts the practice of measuring "speed or velocity" , this new approach has appeared under different names. The name most often used is the agile approach [16], while the same principle and approach are found under the names lean [17], extreme [18] and adaptive [19]. [20] M. Poppendieck et al.describes the Agile task table as a "kanban software system" in the book of "Lean Software Development ; [21] Cohn explained that Poker Planning technique and planning techniques are popularized in the Scrum community, in "Agile Estimating and Planning". [22] Derby et al. the publication of "Agile Retrospectives" ends the codification of heart rate retrospectives; in 2011 The practice of "backlog grooming" becomes an "official" element of Scrum through its inclusion in the Scrum Guide. On the other hand, opponents of the agile approach generally note that these approaches are only an excuse for not using the basic and necessary principles of software development and project management [23], and that there is still a lack of empirical evidence of successful application agile methods. But recently, empirical research shows that agility has proven its worth [24]; [25]. One of these studies [24]found that the appropriate use of agile methods, a highly skilled project team and an appropriate delivery strategy were key success factors for the agile approach, while management processes, organizational environment and customer participation were appropriate. [26] Crispin & Gregory established a definition of the Agile test, marking the first brief definition of this topic.

According to [27] "Lean" and "agile" are exclusive concepts. According to them, the lean software development should be used in a stable, predictable and linear. In contrast, the agile approach would benefit from being used in a dynamic, unpredictable, uncertain and non-linear environment. In short, the Lean approach has greater potential in a repetitive environment, for example, for an organization's operations [27]. [28] Tarne indicates that several assumptions are not accurate or erroneous in the agile manifesto, [29] Fernandez & Fernandez , express that the project team may be forced into a path of wasting resources because the solution or final deliverable is unclear, [13] Beck et al add that an emerging design in agile could discourage any initial design that could affect subsequent execution

2.2. Traditional project management approach :

Traditional project management is often associated with well-planned projects, defined content, carried out in accordance with predetermined guidelines. This section aims to provide the support necessary to determine which aspects of this approach are most beneficial for project performance in construction projects. Currently, project management is applied to several types of projects that are different in nature. The basic idea behind the traditional approach is that projects are relatively simple, predictable and linear, with well-defined content, allowing for detailed planning and monitoring without too much change [30]; . In order to follow the initial detailed plan and finalize the project on time, within the predefined schedule , budget and scope [18]; [31]. In traditional project planning, a formal process is followed based on identifying activities and identifying appropriate sequences, building a network diagram with the associated critical path and determining the duration of activities [32]. The division of functions into specific tasks is done from the outset, as it is the planning and scheduling of projects [33]. The traditional approach allows

activities to be scheduled and planned in a well-defined order, often with intensely limited interdependencies, and is considered a static approach [34]. The principle of the (traditional) waterfall approach is based on the correct definition of each phase, with future steps being fed into the previous steps [32]. A project that adopts a traditional approach in the process of execution and control requires extensive documentation [35]. Although the waterfall approach is presented as a robust approach by applying the methods and practices to all projects, it is mentioned as one of the drawbacks of this approach, several authors have indicated that "one size does not fit all" [36]; [31]. The construction project environment is characterized by complex interrelationships with a high number of interfaces, whereas the traditional approach is based on linear relationships that do not reflect the full complexity of projects [37].

Another disadvantage of the project's isolation from its environment is that change is the reality of current construction projects that are inevitable due to unplanned, i.e. unpredictable, changes in the conditions of the project itself [38] ; [39] , due to sequential practices, delays in change control could negatively influence the progress of the project, [40] Williams explains that projects that have been characterized by structural complexity and uncertainty in the definition of time constraints are inadequate to the traditional approach.

2.3. lean project management approach :

The construction industry is highly characterized by the generation of waste, uncertain safety conditions and a high variability of its construction process [41]; [42]. The lean construction come as a result that's aim to create sustainable customer value by eliminating waste through all company processes, and approach the site in a different way by eliminating all waste, from the storage of materials to the acceptance of the structure. The Lean concept can be best described as an efficient production process which is a combination of concepts such as Just in Time (JIT), Total Quality Management (TQM), supply chain management and others, all which can be tracked to the famous and well known TOYOTA experience [43]; [44], A light and collaborative method that leads all the actors of the company to ask the same question: how to work more effectively, individually and together. Lean design, in its most radical application, aims to meet clients' spatial needs by exploring the potential inherent in their existing facilities to see whether their requirements can be effectively accommodated without any major building work [45]; [46]. lean design doesn't have a clear common definition , lean design has been used for a variety of work applying known lean construction tools as the last planner system to construction design management [47], many works has discussed the coordination of design and site activities through the application of lean tools . Ideally, lean design achieves space requirements within the minimum floor area, which results primarily in smaller volumes to heat and ventilate; lower maintenance; and reduction in circulation of the building users through reduced distance between parts of the facility [48]. the Lean construction involves ways of designing production systems to minimize waste in time , efforts , human and materials in ordre to generate maximum cost-effective value [49]; [50], The use of lean construction by AEC firms is still in a transition phase [51] , due to multiple factors like the lack of understanding about lean thinking concepts and its implementation in construction, in addition to that the traditional approaches present significant barriers to adopt the lean construction and other innovative approaches [52]. more empirical evidence is needed to align the lean construction theory to maximise the benefits of lean thinking concepts [53].

2.4. Hybrid approach waterfall/agile/lean :

The "right" project management methodology may be the first and most important choice a project manager most make [34] , The aim of a hybrid approach from waterfall , agile and lean approaches is to take advantage of the benefits of the approaches and eliminate their weaknesses, in a hybrid approach all functions should work together to become more agile [54] , while keeping the predictability of the traditional approach. Both traditional and agile approaches have their advantages and disadvantages, so it is not possible to choose or confirm the best approach between the two [38]; [30]. In order to meet the specific needs of a project, it is often necessary to use both the agile and traditional approaches, a hybrid of the latter two approaches may be the most advantageous path. Many traditional tools and techniques still remain in the model even if some comparisons show them in the wrong context [54]. In a hybrid approach, being flexible is the most important principle to emerge a good model that is appropriate to the project requirements. In a project, the need for a different approach might be clear depending on the characteristics and

requirements and demands, it is important to keep the right approach thinking [55], as an inappropriate approach can make the project fail [56]. [57] Karlstrom & Runeson indicate that some managers are very interested in using agile practices, provided that they can coexist with the existing business model in their companies. The traditional approach is appropriate much more that have a low level of uncertainty and a well-defined content according to the customers' requirements [31], the final customer is not necessarily involved in the project [58], with a low variation of needs [19]. Typical construction projects include operational actions with predictable and already verified means to achieve objectives [36]. However to achieve a certain balance, waterfall and agile methods must be combined, the choice of processes should be chosen according to several criteria depending on the field of application, the priority and importance of the project, the number of workers in the project and the degree of innovation[59]. [60] Vinekar Expresses the need to have a double structure that combines the two approaches because it has their specific advantages, as one cannot replace one method with its opposite. [61] Al Behairi , What is new in a hybrid methodology is not the practice but the application of the practices in a new way, what is necessary before starting the project activity is to introduce the new hybrid approach and the acceptance of the project team which is a little judicious and increases the risk of failure of the project [62]. In summary , the traditional approach is robust when the project is large, the content is well defined and the requirements are stable, that it has a high level of complexity and a low level of uncertainty, on the other hand the agile approach is presented as an asset when the project contains many risks which makes a lot of change, and a high level of uncertainty, therefore there is no specific methodology or way to manage a project, both approaches can be beneficial depending on the requirements of the project or the project team.Many researchers have also begun to explore the application of agile management in construction. [63] combine the concepts of agility and lean to present a new framework, called "AgiLean PM", which illustrates how a project can respond to change through agile management, agility and lean have many similarities, but also differences, lean focuses on reducing waste, agile focuses on being attentive to opportunities to make changes quickly [64]. In the construction literature, agility was generally mentioned along with lean, as lean-agile paradigms [65]. [66] explained that agile project management may be provisionally appropriate for the design phase of construction, which involves greater client involvement, conflicting requirements and constant trade-offs, as the approach allows for the adoption of change for continuous improvement and the provision of creative solutions, particularly for complex requirements.

3. Hybrid approach in construction project

The review of the literature already established provides a basis for analysis to highlight an hybrid approach, understanding the evolution, failure and good practice of agility helps to exploit them in the new hybrid approach to construction projects and analysing the traditional approach used in the construction industry makes it possible to highlight specific failures and to facilitate finding out where the failure is located, thus keeping and working on the strong points that guarantee the success of the project, correcting the failures in the different phases of the project increases the chances of success of the project, coordination and collaboration with the client is a very important factor in the elimination or reduction of project failures. The agile approach is mainly oriented towards software applications, but several practices can be applicable in a construction project [61].

This model aims to extract best practices from the three traditional, agile and lean design and construction approaches, the benefits that flow from the structure and predictability of traditional methods, adaptability and waste reduction to an agile model based on lean design and construction tools and methods and agile practices.

The model is decomposed into the project life cycle consisting of four essential phases: initiation phase, planning and design phase, re-planning, execution and control and closure phase, each phase includes proposed practices to better manage each phase.

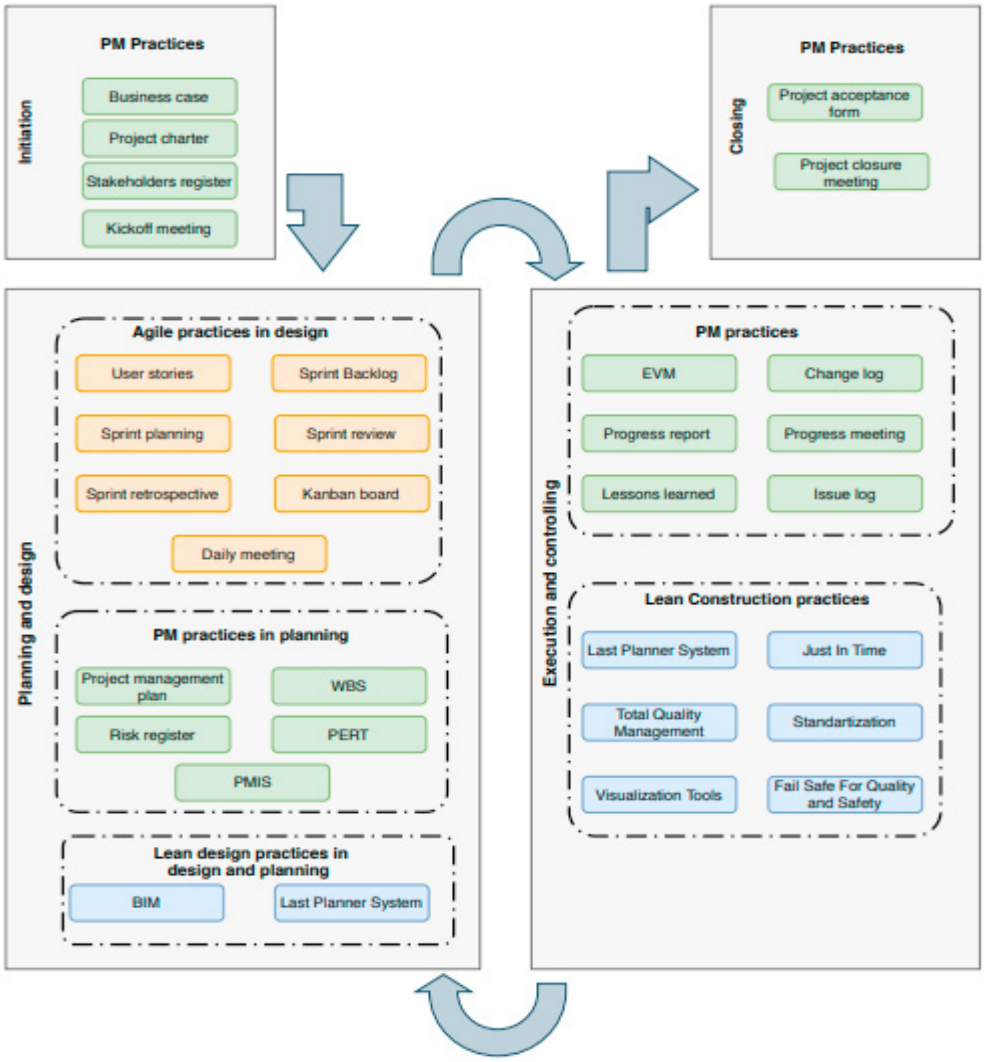

Fig. 1. Hybrid Construction Project Management Model

4. Discussion :

Starting with the initiation phase, after the decision to start the project, the need to start with a business case in construction projects is to present the reason for the investment of the project, to justify it and to obtain the commitment and authorization of the management to proceed [67] , according to Tarne, the launch of a project should start in much the same way as that prescribed in Pmbok 6 [68]with a project charter and stakeholder register [69],the project charter containing costs, tasks, deliverables and schedule [70]. Moreover, the involvement of stakeholders at the beginning of any project is essential to initiate project activities [71] , These practices are considered among the most useful in the initialization phase according to a study by C. Besner et al [72]and G. Fernandes et al [73], which are also useful in launching a construction project.

Following the kick-off meeting, the design and planning phase is completed. This phase includes the application of traditional methods based on the PMBOK guide, lean design and agile methods, starting with agile practices used in design, understanding customer requirements by breaking down the work into "user stories"[74], this agile practice invites strong customer involvement by prioritizing tasks according to the value perceived by the customer, in terms of agile methods, the most used method in construction projects is the Scrum method.

Some practices are essential and useful in the design phase 'Sprint planning ' 'Sprint Backlog ' 'Sprint review ' 'Sprint retrospective ' [69]; The Scrum software development method cannot be applied directly to the design phase of construction projects, adaptations are necessary to maintain the fundamental principles so that the approach is adapted to the design phase of construction projects [75]. Some adjustments are needed according to what is appropriate for the project, working on continuous improvement through "daily meetings" (periodic reviews) to detect changes as soon as possible. Based on an agile management approach, a daily meeting, where the project team reviews the entire cycle, assesses what has already been done and what can be improved [76]. The aim is for all participants in the design process to hold a "daily meeting" to take stock of their progress and the obstacles they encounter that prevent them from moving forward [77]. In order to promote collaborative work and visual management, the Kanban Council presents a workflow visualization tool [78], after understanding the customer's requirements in the design, we will move on to the second part, Project planning using traditional project management practices. The first part is the elaboration of a project management plan that is fundamental to the success of any project [79], To properly determine the scope of the project, the project breakdown structure (WBS) breaks down the work into smaller elements. A product-oriented family tree subdivides the materials, services and data needed to achieve the final product [79], In order to better manage the project risks. The implementation of a risk management process is the key element of reliable project control measures using the 2019 risk register [80], Traditional methods of project representation are based on network planning techniques. The most widely used method in construction is the PERT method, which is a network planning technique that applies critical path analysis to reveal interdependencies and problems that are not evident with other planning methods. In this way, the PERT method determines where to make the most effort to meet the schedule of a project [79].

The use of the Project Management Information System (PMIS) has played an important role in construction management processes. While this is not enough to ensure the success of projects, the use of PMIS to manage projects has therefore become a necessity [81],the move towards lean practices through the use of BIM as a lean design tool to reduce the cost and delivery time of projects and increase the productivity and quality of projects [82]. The use of the integration of information technologies and building information modelling (BIM) to synchronize information in the project and reduce design errors and conflicts are good examples of tools used to facilitate communication in the construction sector [83], the second tool used is Last planner system - LPS is a planning and control improvement tool used to monitor the construction process, based on commitments through the consistent use of techniques such as on-demand planning, prior planning with stress analysis, weekly work planning based on reliable promises, and learning based on planning system analysis [84], the latest planner's system includes a series of tools, it is used both in the planning phase and in the execution and control phase of the project.In the implementation and control phase, construction projects need measures and indicators that can ensure the progress and control of this phase, such as progress measures through progress reports [69]and progress meetings [69]; In order to measure the performance of the project in terms of cost and schedule, the management of acquired value (EVM) Integrates cost and schedule control to provide performance indicators that help the project team anticipate project cost overruns and delays [85].This tool measures performance and progress using the scope, cost and delay that present the three core project constraints [86].The use of a change management process is an essential element to improve the reliability of the measures used to assess the progress and performance of the project using the change log [69]; All information and lessons required during this phase will be documented in a log that will include lessons learned [69]. The lessons learned and the problem register [69]are considered best practices in the implementation phase.

Concerning the use of lean construction practices, the use of the last planner process as described above in the planning and design phase, this method is common to both phases, After the operational phase of a construction project, this may be the main reason for the emphasis on last planner in the implementation of lightweight construction in the execution phase [87].In order to reduce waste in the supply chain, the "just-in-time" is considered one of the most widely used methods in lean construction, which means that any change in the project occurs exactly when it is needed, This makes it possible to make decisions with the most accurate and up-to-date information possible [33], which guarantees a reduction in flow times: Total quality management (TQM) is considered one of the pillars of lean, which is a construction management tool used to identify and assess potential problems, develop and implement new solutions and evaluate results [88]. For a well-managed organization at the project level, visualization tools are used to convey specific instructions to workers at the site. This may involve the use of signs or posters in designated areas on construction sites. [89]; many different practices are used in projects to improve safety at the construction site,

"Fail Safe for Quality and Safety" which is a lean construction tool that maintains in case of specific failures [90], for the following tool which is considered as one of the principles of lean construction which is standardization, it can be defined as a series of analytical tools which lead to a set of standard operating procedures, it is considered the best technique for designing an effective means of establishing construction techniques in the shortest possible time with minimum effort [91],the use and choice of tools vary according to the context of the project and the company, the last phase, which is the closing phase, This phase also requires the completion of all outstanding items related to a checklist or incomplete contractual activities. The project team and the client must work together during this phase to ensure that all last minute elements of the project are completed, contracts are concluded and the project is completed, The project closure must be accompanied by an acceptance form and a project closure meeting [69].

5. Conclusion

This research presents the development of a hybrid project management model for construction projects based on lean, agile and traditional approaches.the use of best practices from these approaches to increase the chances of project success by reducing costs, shortening project schedules, optimizing results, eliminating waste and increasing project satisfaction. As this topic is still little explored within the scientific community, the literature review focuses on the most frequent failures of construction projects around the phases of the project, the strengths and weaknesses of these approaches, the evolution of agile practices in order to extract the tools and methods that can be useful in a hybrid model for construction projects.

The proposed hybrid project management model remains general, several other practices can be applied to develop this model, exploring different lean design practices in the design phase, lean construction tools and methods in the execution phase, integration of integrated project delivery (IPD) practices into the project lifecycle and exploitation of collaborative agility tools and techniques, maintaining the best practices of the traditional approach underlying this model, the rate of use of the tools and practices of the approaches in the hybrid approach varies from one project to another depending on several project-related parameters, because the management of a project depends heavily on, adopting an agile mindset increases productivity and maximizes results, agility training can develop collaboration and flexibility within teams, In practical terms, the model should be effective and will only increase the efficiency of project teams and overall customer satisfaction.The proposed tools and techniques can be developed by studying the adaptability of each tool and technique to the construction context, a verification of this model will be necessary in order to confirm the results obtained in this research

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