MINISTRY OF EDUCATION AND TRAINING MINISTRY OF CONSTRUCTION
HANOI ARCHITECTURAL UNIVERSITY

NGUYEN QUANG VINH

APPLICATION OF JUST-IN-TIME MANAGEMENT FOR CONSTRUCTING HIGHRISE BUILDINGS IN VIETNAM

MAJOR: BUILDING AND INDUSTRIAL CONSTRUCTION
CODE: 9580201

ABSTRACT DOCTORAL THESIS
BUILDING AND INDUSTRIAL CONSTRUCTION

Hanoi - 2023

The thesis has been completed at:

Hanoi Architectural University

Science instructor: **Associate Professor. Dr. Dinh Tuan Hai**

Reviewer 1: **Associate Professor. Dr. Bùi Ngọc Toàn**

Reviewer 2: **Dr. Trịnh Quang Vinh**

Reviewer 2: **Associate Professor. Dr. Nguyễn Ngọc Phương**

This thesis is defended at the doctoral thesis review board at the Hanoi Architectural University.

At …… hour - June ….st, 2023

The thesis can be found at:

1. National Library
2. Library of Hanoi Architectural University.

PREAMBLE

1. Urgency of the topic

The construction industry is one of the major contributors to the GDP of the national economy, playing an important role in the process of creating physical - technical bases and fixed assets for all sectors of the country. . Many high-rise buildings have been and will be built across the country, especially in large cities with quite high density to meet the needs of society. However, besides development, high-rise construction projects still have many problems regarding quality, implementation progress, environmental pollution, labor safety, etc. , in addition to the waste of the production process, the waste of time, labor, machinery, equipment, materials, etc. has contributed to reducing the effectiveness of the project.

Around the world, the concept of Just in Time Management (JIT) is very commonly applied in industrial production and manufacturing. In the construction industry, the JIT concept has also been applied in certain stages such as transportation and supply of raw materials; Construction and assembly; Optimize storage facilities; Arrangement of total construction site, ... , although not yet common and not yet systematic.

In Vietnam, high-rise construction investment projects are growing strongly in number and scale. However, in the process of constructing high-rise buildings, current popular construction methods still have certain difficulties and limitations. Meanwhile, the Just in Time Management (JIT) concept has been successfully applied in a number of industrial production fields with many advantages that are limitations or disadvantages of the construction field in general. general and high-rise building construction in particular. Researching and applying appropriate construction organization and management methods to increase quality, reduce time and minimize waste in production, etc. is an urgent requirement.

From the above practice, the choice of research topic: "**Application of Just-In-Time Management for Constructing Highrise Buildings in Vietnam**" is necessary, contributing to improving the capacity to manage and organize the construction of high-rise buildings for managers, consulting and construction contractors, thereby improving the quality of work and minimizing waste. costs, ensuring investment efficiency, bringing the project to a successful destination with a faster schedule.

2. Research purposes and objectives

- Research purposes: Applying instant management theory in high rise building construction in Vietnam to find solutions to appropriately apply some basic principles of on-time management to high-rise building construction in Vietnam in general. general and Hanoi city in particular. Thereby aiming to increase quality, reduce time and minimize waste in production, ... in the construction of high-rise buildings in Hanoi in particular and Vietnam

in general.

- Objectives of the study:

+ Complete the theoretical basis for applying immediate management theory in high-rise building construction in Vietnam.

+ Assess the current status of high-rise building construction in Vietnam in recent times

+ Eliminate wasteful factors in high-rise building construction

+ Proposing to apply a number of appropriate solutions in practice, in order to prove the feasibility and benefits of immediate management theory in high-rise building construction in Vietnam.

3. Subject and scope of research

- *Research subjects :* Just in Time Management (JIT) theory in construction in general, applying the concept of just-in-time management to streamline some construction work of high-rise buildings in general, high-rise apartments floor in particular.

- *Scope of research :* Research is carried out for tall buildings in urban areas in Vietnam in general - Case studies of high-rise apartment construction investment projects being implemented in the city Hanoi.

- *Scope of content :* Technological issues and organization of high-rise apartment construction within a specific construction process such as: Production of precast reinforced concrete structures; Transportation and installation of components; Entire reinforced concrete construction; Construction completed ... Clarified with some basic characteristics of immediate management theory .

- *Time scope:* Investment projects to build high-rise apartments according to the general planning of Hanoi capital until 2030 and vision to 2050.

4. Research Methodology

To achieve the proposed research goals, the thesis approaches the problem according to the following research methods:

+ Qualitative research method is mainly deductive method.

+ Expert methods are also used by the author for research. Through surveys, interviews and discussions with experts a.

+ Quantitative research method, The thesis uses quantitative research method to test the model and research hypotheses. Data collected from the survey will be analyzed through quantitative analysis techniques processed with SPSS20 software.

The thesis uses experimental methods to measure work lines in practice

5. Scientific and practical significance of the topic

- *Scientific significance:*

The thesis provides a theoretical and practical basis for the theory of immediate management in the field of construction

- *Practical significance:*

proposed thesis solutions contribute to perfecting the professional construction organization and management system, improving the level of construction management and organization for managers, investors, consulting contractors and contractors. construction contractor.

6. New contributions of the thesis

(1) Completing the theoretical basis for applying immediate management theory in high-rise building construction in Vietnam.

(2) Proposing a model of waste factors in high-rise building construction in Vietnam, including 08 groups of factors, specifically: Overproduction; Wait; Unnecessary travel; Processes and ways of working are not necessary; Inventory; Excess movement; Wrong, construction error; Staff capacity is not used.

(3) Proposing solutions to apply immediate management theory in high-rise apartment construction in Vietnam.

7. Concepts and terminology

- Highrise building construction: includes construction activities and equipment installation for newly built housing and public buildings with a number of floors greater than 9. In particular, construction activities Construction is a production activity on the construction site to create structural parts (underground construction - rough parts), architecture (complete construction) and technical systems (technical system construction) of construction.

- Just in Time Management: Just in Time (JIT) management is " **a manufacturing philosophy based on the intentional elimination of waste and on continuous improvement of productivity** ". In other words, JIT is a production operating system in which the flows of raw materials, goods and products circulating in the production and distribution process are planned in the most detailed step by step, so that the process The next process can be executed as soon as the current process terminates. Thereby, no item in the production process falls into a state of idleness or waiting for processing, no workers or equipment have to wait for input to operate .

- Waste: According to lean production theory, waste in production can be understood as any activity or process that does not bring added value [69]

8. Thesis structure

The thesis consists of three parts: Introduction, Content, Conclusion and recommendations. The thesis content includes 4 chapters:

- Chapter 1. Overview of instant management theory in construction
- Chapter 2. Scientific basis of immediate management theory and construction construction management
- Chapter 3. Research to identify wasteful factors in high-rise building construction
- Chapter 4. Solutions to apply instant management theory in high-rise construction

CONTENT

CHAPTER 1: OVERVIEW OF JUST-IN-TIME MANAGEMENT IN CONSTRUCTION

1.1. Overview of Just-In-Time Management

Just in Time (JIT) management is “a manufacturing philosophy based on the intentional elimination of waste and on continuous improvement of productivity”. . Just-in-time management is also known as 'Pull' Production, Pull production is master of the following stages, so each workshop only produces according to the requirements of the next stage. *The preceding process must always do what the subsequent process says,* which is the most meaningful term in Just-in-Time. JIT is the tool that businesses use to provide customers at the end of the process with exactly what they need, at the right time and in the right quantity they want. Replenishing auxiliary materials as required is the main principle in JIT.

Positive results from applying JIT in the construction industry (Akintoye, 1995; Bertelsen, 1995; Low and Chan, 1997; Low and Mok, 1999) include: (1) enhancing the competitive advantage of businesses on consistently and continuously meeting customer requirements, (2) improving the quality of construction materials and (3) improving productivity, (4) reducing costs in terms of minimizing inventory levels warehouse, (5) improve supplier relationships, (6) complete work ahead of schedule, (7) improve job site tidiness, and (8) eliminate site congestion and irregularities. causing harm to surrounding areas. However, the benefits of JIT cannot be achieved without initial investments (Waters, 2009). For example, reduced setup time may require more sophisticated equipment and more skilled personnel which will result in higher training costs (Waters, 2009; Polat and Arditi, 2005).

In the following years, there were many studies on JIT in the construction industry such as Just in time concept used in construction projects (Vihar Patel1, Jayraj solanki, 2020), finding factors that affect project performance, causes construction delays. And later studies have shown that to some extent the JIT system is capable of solving the problems of low quality and low profits.

1.2. *Current status of high-rise construction work in Hanoi city*

Current status of progress management/work execution time **:** Through an actual survey by PhD, it was found that up to 78% of high-rise projects were completed behind schedule and only 6% of projects were completed. over the progress. There are many reasons why a project is completed behind schedule such as errors or differences in construction drawings; Waiting for materials and equipment to be delivered to the construction site...

Current status of material supply/warehousing: Through surveys, it has been shown that at present, on construction sites of high-rise buildings, material supply is still carried out according to the model of push production system. (Push System):

In addition, the survey of the researcher showed that most of the supplies and materials of the projects were transported in advance with a relatively long time from 10 ÷ 20 days, accounting for 52% (equivalent to 78 people paying word); from 20 ÷ 30 days accounts for 36% (equivalent to 54 respondents); and advance shipping time from 7 ÷ 10 days only accounts for 12% (equivalent to 18 respondents) shown in the following table:

Current status of safety and environmental hygiene : In recent times, occupational accidents have tended to increase, in the period 2021-2022, the number of accidents increased by 23.98%, the number of seriously injured people increased by 19.6%. % .

Current status of site organization/work flow:

Current status of error control/work quality: Through the actual survey of NCS, it shows that construction quality is increasingly improved, but projects have to adjust the design, as well as encounter problems during the process. The construction process accounts for a significant proportion.

1.3. Domestic and foreign studies on the theory of immediate management in construction

Relevant research works in the world: Including 14 studies on the theory of immediate management in construction

Related research projects in Vietnam: Includes 4 research articles on immediate management in construction.

General assessment: Many studies have shown the benefits JIT achieves in the construction field such as: Reducing inventory costs; Reduce space and time for production; Increase product quality; Reduce waste and environmental pollution; Building long-term production relationships; Improve team spirit, motivation as well as corporate culture; The goal of completely eliminating waste is unattainable, but the goal of minimizing it is very positive. These are the values the thesis will inherit.

Identifying the research gap of the thesis **:** Research and authors (both domestic and foreign) have not directly studied wasteful factors in construction. In particular, there has been no research on applying JIT in high-rise building construction in Hanoi city.

Conclusion of chapter 1

From the overall analysis of research on Immediate Management Theory and

application of Immediate Management Theory in the field of construction in the world and Vietnam, the PhD student found that the topic "Application of Immediate Management Theory **" in the construction of high-rise buildings in Vietnam** "is very necessary and the JIT system is capable Ability to solve problems of low quality and low profits. Implementing JIT in construction seems unclear because of inconsistencies Any application of any method is not just taking the entire method from another industry and then simplify its deployment into the industry build.

CHAPTER 2: SCIENTIFIC BASIS OF IMMEDIATE MANAGEMENT THEORY AND CONSTRUCTION CONSTRUCTION MANAGEMENT

2.1. Scientific basis of immediate management theory

Concept of immediate management theory

=> The concept of JIT (Just in time) is: *"The right product - in the right quantity - at the right place - at the right time needed"* .

Characteristics of immediate management theory

The nature of the JIT system is that a steady flow of products passes through the system with the smallest amount of inventory. The JIT system has the following main characteristics: Even and fixed level of production; Low inventory; Small batch size; Low cost and fast installation; Reasonable layout of premises; Periodic repair and maintenance; Employ multi-functional workers; Manufactured with high quality levels; Cooperative spirit; Choose a trustworthy seller; Use a “pull” system; Quickly resolve problems during production; Continuous Improvement and the 5S Approach.

Conditions and benefits of applying immediate management theory

Condition: The built by a pressure - bending business use _ _ JIT wall she does not _ _ Right Have _ potential _ c _ _ beside in , but thing to sue background terrible _ _ international but _ joint active career dynamic in It also _ _ must be relatively where standardization activities are at a high level .

Benefits: Reduce inventory at all stages: raw material supply, production and product consumption ⇒Reduce the need for premises, factories, warehouses ; Reduce the need for indirect labor in general, save costs and lower product prices and increase product quality, reduce waste and rework.

Advantages and disadvantages of applying immediate management theory

Applying JIT significantly reduces costs for manufacturers, helps businesses improve productivity and product quality, and employees have the opportunity to develop capabilities. However, when applying JIT, businesses depend heavily on suppliers. If the relationship with

suppliers, supply chain management, and material handling levels are not good, the possibility of JIT failure is very high. At the same time, there are potential risks if the company does not have accurate and regularly updated sales forecasts.

2.2. Scientific and practical basis for construction management of high-rise buildings

high-rise buildings

Concept of high-rise buildings : According to the International High-Rise Building Committee: "A building is considered a high-rise building if its height determines design, construction or use conditions different from conventional houses."

Classification of high-rise buildings includes : Classification by purpose of use; classified by shape; classified by house height; Classified according to basic materials used to construct load-bearing structures and classified according to type of load-bearing structure

Dividing work groups in high-rise building construction in Vietnam: Using a work breakdown structure (WBS) to divide a project into work parts that can be well managed according to cost aspects and cost, budget, time and progress, quality, ... With the breakdown of projects according to WBS, tasks can be divided into 4 levels as follows: Entire project *;* Main parts of the project *;* Work and Job Components

Construction organization methods : 3 main methods are: sequential, parallel and chain method.

Progress plan in construction: When drafting a progress plan, it is necessary to comprehensively consider the factors affecting the construction progress. Use scheduling methods such as horizontal diagrams; line diagram (oblique diagram) and network diagram.

Construction site: MBTC is like a "Production system" including technical facilities, raw materials, facilities and people in a certain space and time, in order to Carry out a construction production process, including before, during and after the construction period .

Types of waste in JIT construction

There are many methods to approach and eliminate waste in businesses. However, the approach to eliminating waste under lean manufacturing is relatively simple and straightforward. According to the above approach, waste in production in general and construction in particular is classified into seven types, including: overproduction; wait; unnecessary movement; unnecessary processes and ways of working; inventory; construction errors; excess movement.

Perspectives on JIT implementation in construction

This method adopts 4 main elements:

- Quality assurance: reduce rework, do it right from the beginning;
- Focus on customers: eliminate non-value-added activities

for customers;

- Minimize waiting: supplier participation in planning

planning;

- Create a continuous flow: have the necessary resources and components available, in a pull system.

Experience of countries around the world

Japan: Material distribution facilities have been established so that materials can be delivered to JIT construction sites. In addition, a JIT material distribution network has been established to link site offices, branch offices, and material distribution facilities.

Denmark : In Denmark, using Byggelogistik for planning, every plan is carefully made, day-to-day management is carried out from the construction sites - not the main office - and is immediate and direct Handle all the mistakes.

China: Great emphasis is placed on training in skills to eliminate waste, standardize operations and other engineering principles, and cultivate the right attitude among employees. For construction managers, training should include their commitment to JIT implementation.

Lessons learned for Vietnam

Construction businesses need to recognize and fully understand waste at the root, not just from direct costs. At the same time, there needs to be close and effective cooperation in construction logistics.

Conclusion Chapter 2

In this chapter, we focus on understanding the main issues surrounding the scientific basis of immediate management and construction organization of high-rise buildings, and experiences in applying JIT in construction in some of the above countries. world and lessons learned for Vietnam.

A lot of time during construction is wasted on ineffective activities; that is, anything that does not contribute to the overall work or add value to the project. Using JIT will optimize the values of productivity, quality, cost, time and customer responsiveness while still ensuring safe production conditions.

CHAPTER 3: RESEARCH TO DETERMINE WASTE FACTORS IN HIGH RISE BUILDING CONSTRUCTION

3.1. Research Methods

The thesis uses a combination of qualitative and quantitative research methods

3.2. Propose research model and research hypothesis

Research framework (research process)

The research framework of the thesis is implemented in 7 steps:

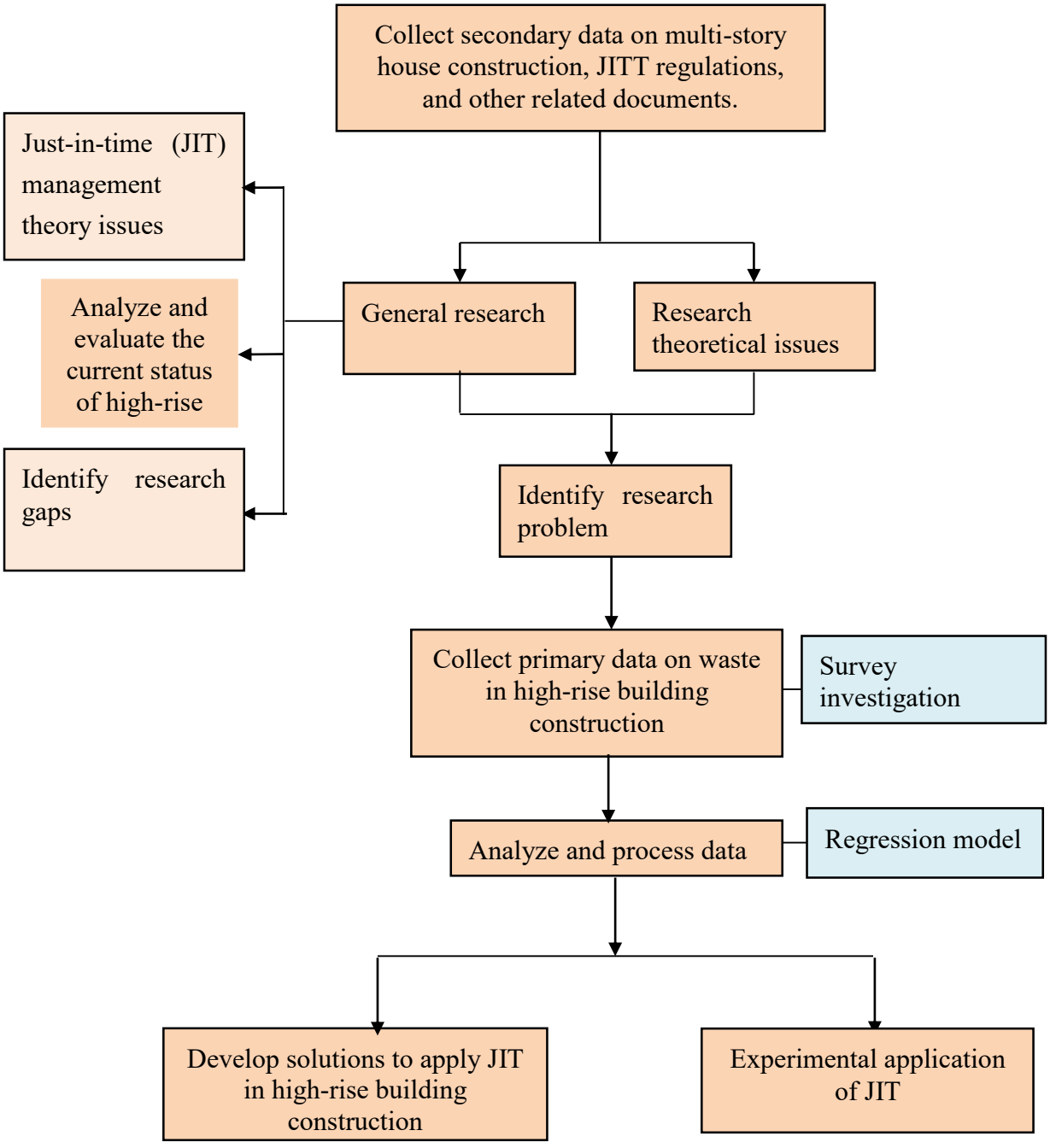

Figure 3.1. Research framework of the thesis

Through an overview of research works related to the thesis, the current status of

high-rise building construction in Hanoi city, and consultation with experts, the author has identified 08 groups of wasteful factors in construction. high-rise building construction in Hanoi city.

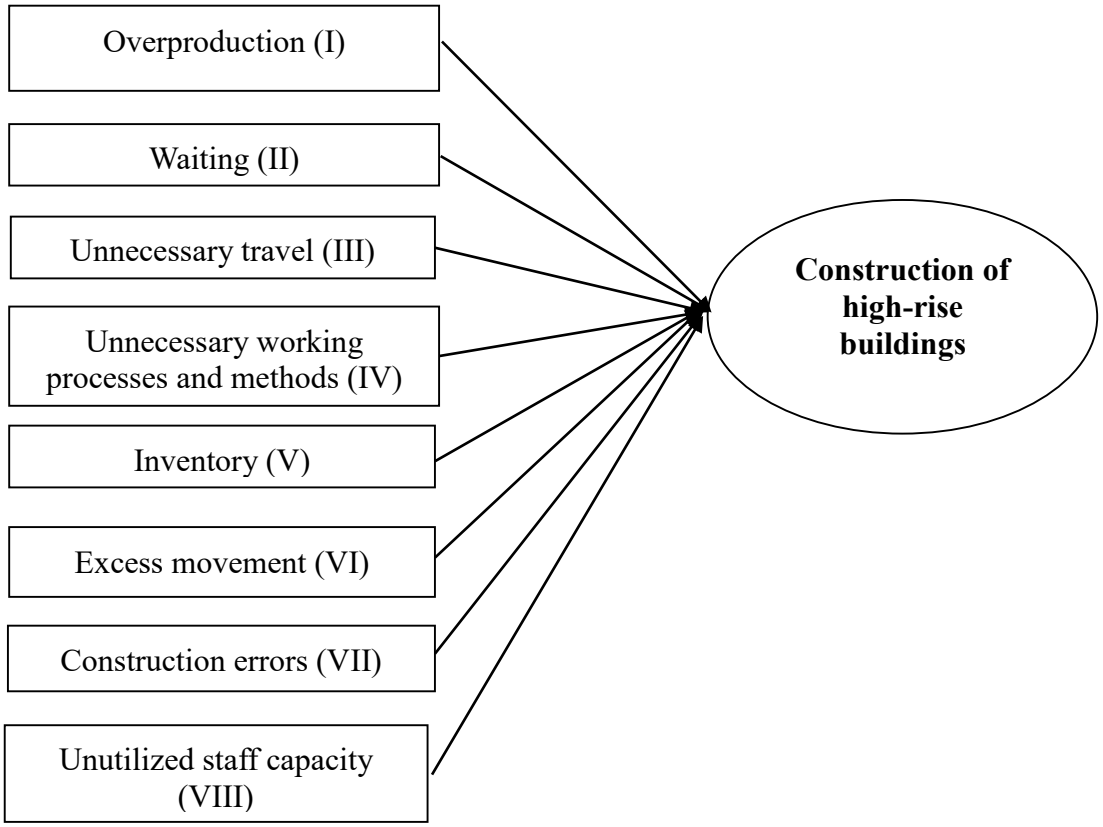

Figure 3.2: Groups of wasteful factors in high-rise building construction

3.2. Preliminary quantitative research

Surveys are basically accepted and official quantitative research is conducted.

3.3. Formal quantitative research

The official quantitative research method is carried out on the basis of survey data on the project implementation process and results of high-rise building investment projects that have been and are being constructed in Hanoi. The subjects surveyed were individuals operating in the construction field in Hanoi city (Investors, Construction Contractors, Design Consultants, etc.). The survey questionnaire will be sent to the surveyed subjects via email and direct interviews with a number of survey samples selected in accordance with the research purposes of the thesis.

3.4. Results of analysis of waste factors in construction

The survey process was conducted for 3 months, with 200 ballots issued and 185 ballots collected, of which the number of valid ballots with complete response information: 150 ballots.

Exploratory factor analysis - EFA

Table 3.18: KMO & Barlett's test results

KMO and Barlett testing		
A measure of the adequacy of sampling		0.808
Bartlett's Test	Approx. Chi-Square	2435,215
	DF	435
	Sig	0.000

From the KMO & Barlett's test table, it can be seen: KMO coefficient = 0.808 > 0.5; It is appropriate to use factor analysis for this study. Barlett's test with significance level sig = 0.00 < 0.5 shows that the observed variables are correlated in the population and using EFA factor analysis is appropriate.

3.4.3. Explanation on wasteful factors in construction

As a result of EFA exploratory factor analysis , the author conducts grouping as follows:

Group X1 includes 5 wasteful elements due to "Construction errors". These causes create a large amount of solid waste at the construction site, taking up a lot of space to store and time and cost to transport to other places. To limit these problems, contractors need to pay attention to the principle of "Doing it right the first time" and pay special attention to labor safety - environmental sanitation - fire prevention.

Group X2 includes two initial elements related to workflow. In the construction industry in Vietnam, unnecessary processes and workflows exist in current operations as an inherent characteristic. Therefore, many efforts to reduce them have been made in practice to “streamline” implementation processes. It is easy to happen when there are errors or unclear information in design drawings and specifications.

Group X3 is the group about travel time factors on the construction site. Lean manufacturing suggests that work flows are continuous. One of the most used methods to prevent these interruptions is to work shifts (or hours). Furthermore, dividing work reasonably is a good way to reduce stress for workers, thereby improving production efficiency.

X4 Team Waiting for others to complete their work is a non-contributory waste of time as recognized by JIT production. However, the progress of delivering those equipment and materials to the construction site is often delayed due to being affected by many unforeseen causes during the construction process such as price slippage, design changes caused by the investor, or related parties. Ineffective communication between parties, traffic problems, and lack of raw materials.

Group X5 includes elements of "Inventory". According to the JIT production

philosophy, Inventory is a general way to indicate problems with materials, machinery, and equipment at the construction site but not in use. Experts in the construction industry believe that this activity is mandatory to perform work. Therefore, they did not see it as waste that needed to be reduced or eliminated from the perspective of JIT production.

Group X6 includes three initial elements mainly related to the contractor's resource allocation during the construction phase. According to the philosophy of JIT manufacturing in construction, over-allocation of resources is considered wasteful because it leads to inventory, spoilage, and chaos on the construction site. This is an unavoidable phenomenon because in reality there is no perfect construction method.

Group X7 includes elements of the employee's working capacity that are not used properly. These are recently added elements of JIT manufacturing. In the Vietnamese construction industry, the lack of human resources for suitable positions causes people to take on additional roles that are not their strengths. Or management levels do not take full advantage of the creativity of each of their subordinates, wasting the organization's human resources.

The X8 group involves two initial factors related to on-site communication and transportation time. Both fall into the category of wasted time contributions under the classification of lean manufacturing. At the same time, supplies and equipment were provided so that work could begin. To prevent this problem, managers should have a plan to distribute appropriate materials to each worker team according to that team's priority.

Conclusion of chapter 3

The construction industry has created great achievements, and is one of the most important sectors in the economic structure. But along with that, it also needs to be responsible for creating inefficiencies and waste in the process of managing construction progress . The survey shows that a lot of time spent on construction is wasted on ineffective activities; that is, anything that does not contribute to the overall work or add value to the project. Chapter 3 built the research model of the thesis, identifying wasteful factors in construction.

CHAPTER 4: SOLUTIONS TO APPLY INSTANT MANAGEMENT THEORY IN HIGH-RISE CONSTRUCTION

4.1. Orientation for applying solutions to actual construction of high-rise buildings in Vietnam

Development orientation of the construction industry

The construction investment sector is growing, especially the demand for construction area for residential, rental, office, commercial and service purposes is increasing in both quantity and quality.

Based on proposed solutions

The economic development orientation of the State in general as well as the development of the construction industry in particular. The types of waste in the construction of high-rise buildings, as well as the remaining limitations in the construction of high-rise buildings in Vietnam, have been pointed out in Chapter 1. Especially the results of the survey of waste factors. construction costs in Chapter 3

Requirements to be achieved for proposed solutions

The solutions proposed must ensure consistency, practicality and feasibility.

4.2. The solution applies the theory of immediate management of high-rise building construction

Solutions to control construction errors

In addition to ensuring that the construction is in accordance with the design and drawings as well as fully implementing the terms of the contract, operating the internal Kanban system is one of the most effective tools for controlling construction errors. Kanban will play the role of information for parties, managing construction progress and managing labor safety; according to the following operating cycles:

Step 1: Based on the “six-week implementation schedule” (according to the Last Planner system), the weekly plan is established by all project members.

Step 2: Based on the weekly plan, all supply and consumption Kanbans are printed for each day.

Step 3: Safety instructions and occupational accident references are added in Kanban.

Step 4: Kanban is classified by date and by site engineer in charge.

Step 5: Every day, site engineers will take out Kanbans from their mailboxes to begin construction.

Step 6: The site engineer notes labor safety information for workers and deploys work for them.

Step 7: Site engineers fill in all information about the actual work process on the consumption Kanban.

Step 8: The site engineer separates the 2 Kanbans, retains the supplied Kanbans for comparison when necessary, and returns the consumed Kanbans to the mailbox.

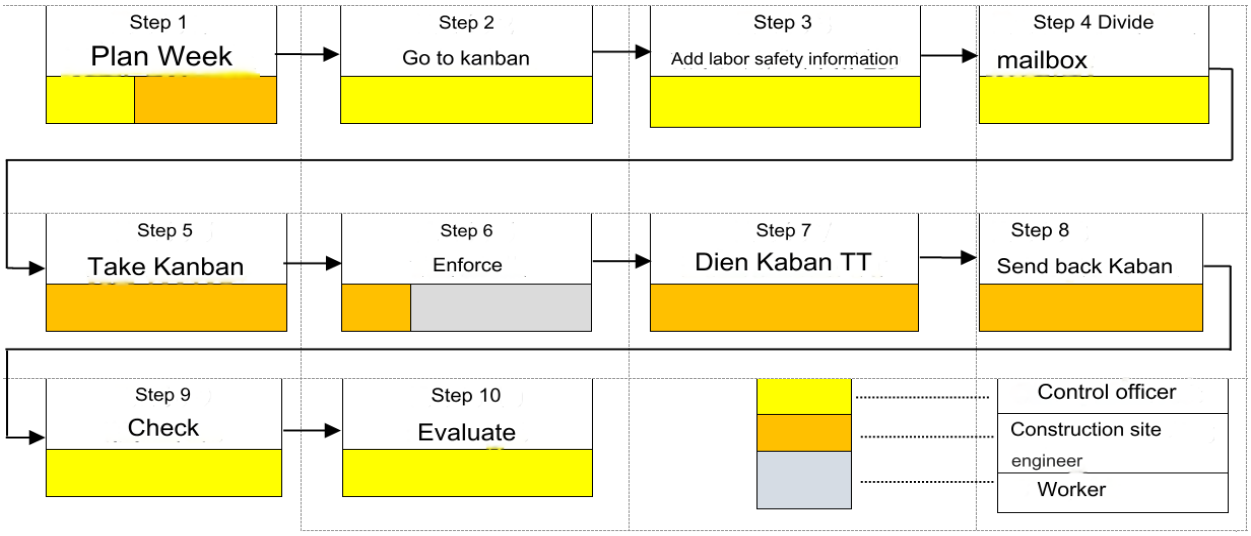

Figure 4.1: Steps to operate the Kanban system in high-rise building construction

Step 9: The control officer gathers these consumption Kanbans to check the construction process and make cost approvals by volume.

Step 10: The control officer evaluates the plan completion rate (PPC), causes of delay, and occupational accidents, if any.

Workflow improvements

Applying JIT to improve work processes at construction sites includes 4 stages: (1) Planning; (2) Implementation' (3) Inspection and supervision; (4) Corrective action.

In particular, the work process at the construction site will apply the 5s rule, visual control and operation of the Kanban system. It clearly states the content, sequence, timing and results for all operations performed by workers. This helps eliminate differences in how workers perform work.

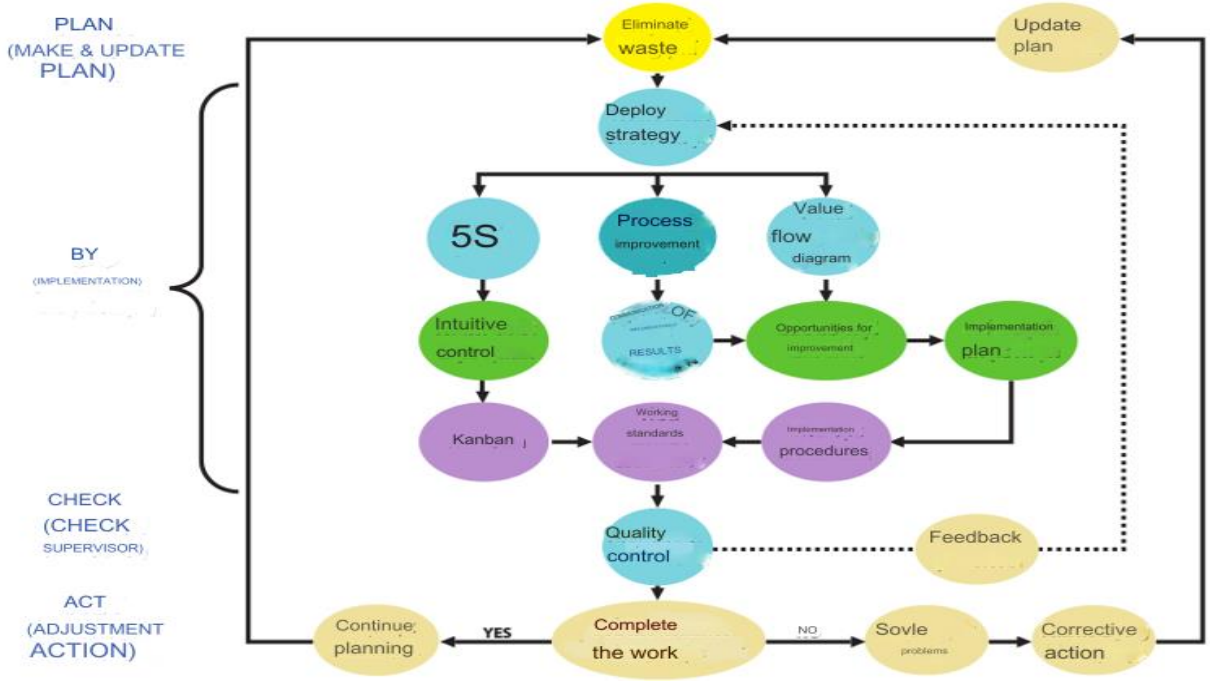

Figure 4.2. Applying JIT in improving work processes (Source: Researcher's proposal)

Solution to eliminate inventory waste

Force to choose LPS (Last Planner System) tool in coordination with BIM implementation in construction.

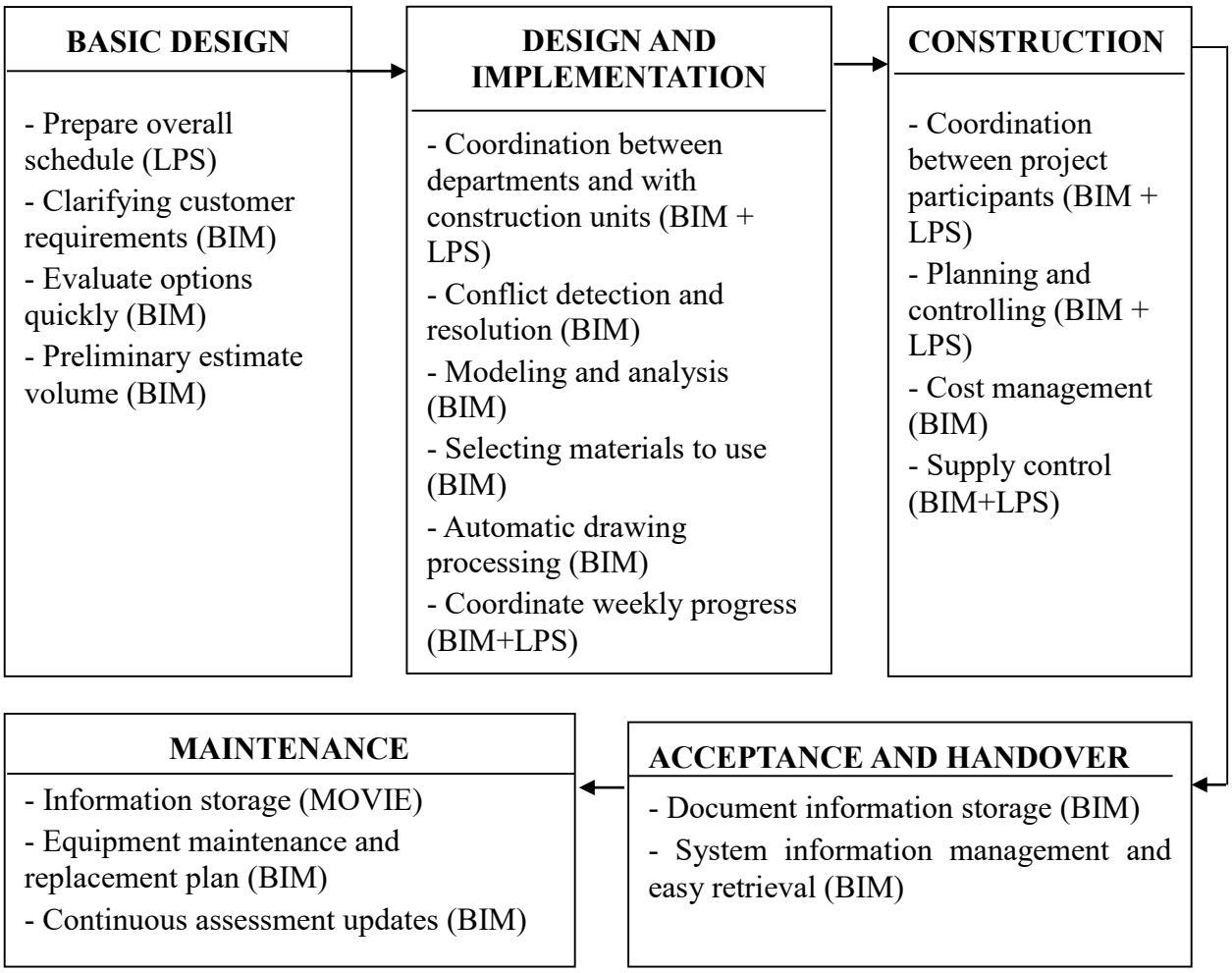

Figure 4.3: Sequence of coordinated application of Lean Construction and BIM in the construction product life cycle

Solution to reduce travel time

For moving materials, use a pull system in supplying materials.

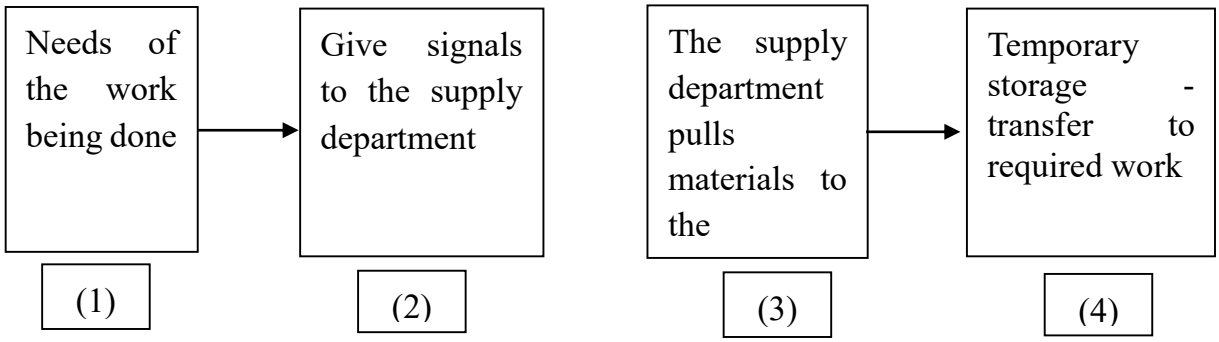

Figure 4.6: Applying the "pull" system in supplying materials on construction sites

4.3. Experimentally apply the theory of immediate management

Experimentally apply the theory of instant management in the construction of formwork,

columns of high-rise buildings

❖ *project introduction*

Project "A" was built in Hanoi City on a land area of 3,948 square meters. The project has a scale of 31 floors, specifically:

❖ *Methods of implementation*

Conduct direct and actual observation and set up cameras to record the erection of column formwork on the 5th floor, observing two main groups of activities including: On-site logistics and Work flow.

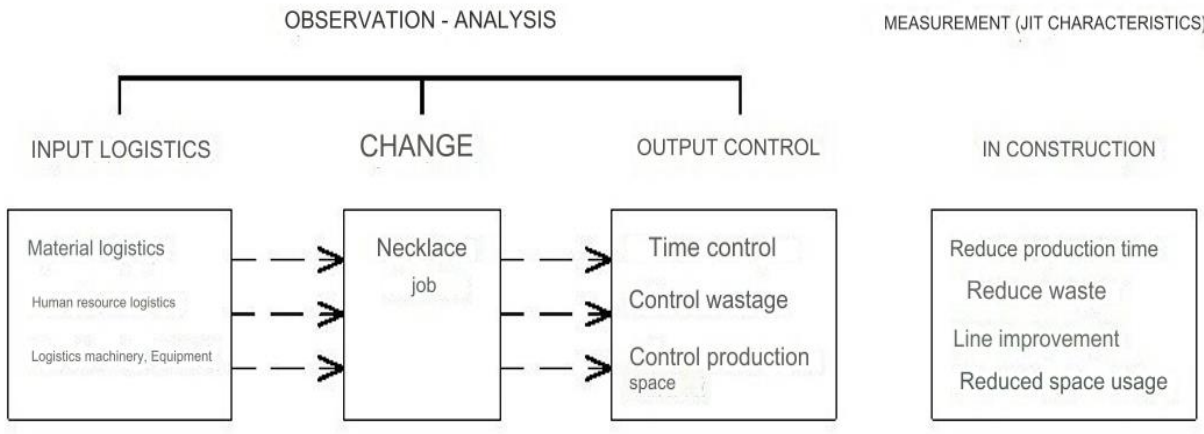

Figure 4.8: Description of the experimental process on the construction site

➢ ***Install column formwork according to the traditional method of observing on the construction site.***

(1) Current construction site

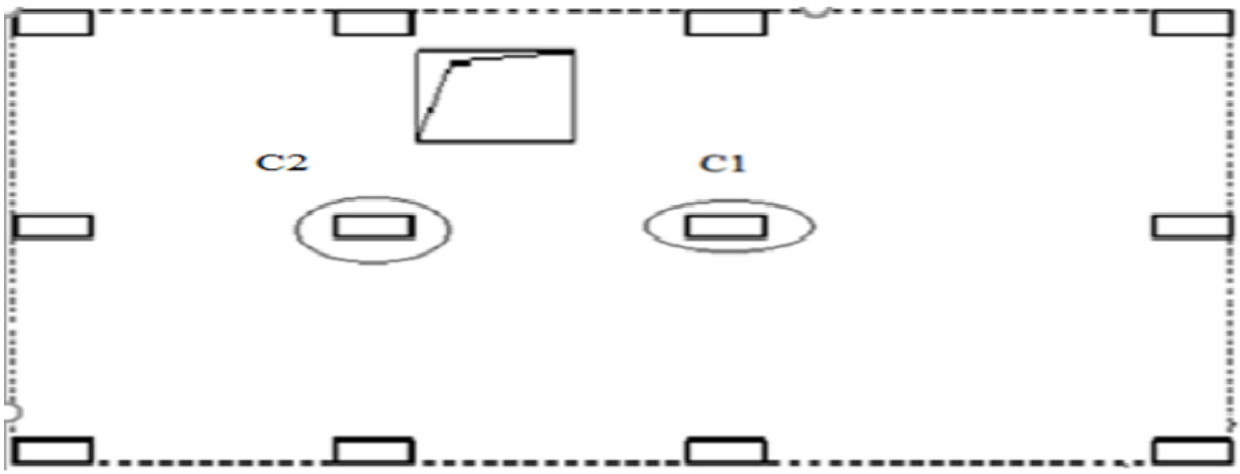

Figure 4.9: Current status of construction and erection of column formwork

(2) Construction process (method).

The erection of column formwork is constructed sequentially (column C1 to column C2 completed) and is carried out manually, due to lack of mechanical support as well as rudimentary formwork technology solutions. leading to increased workload and operations of workers.

(3) Material distribution and gathering ground

Materials: At the time of observation, materials (formwork) were gathered on the floor, but the formwork was not assembled into sets and was not arranged neatly but was thrown around, the quantity was unknown. clear

Machinery: Has been gathered on the 5th floor, however, the machines are still not neatly arranged, leaving them very messy.

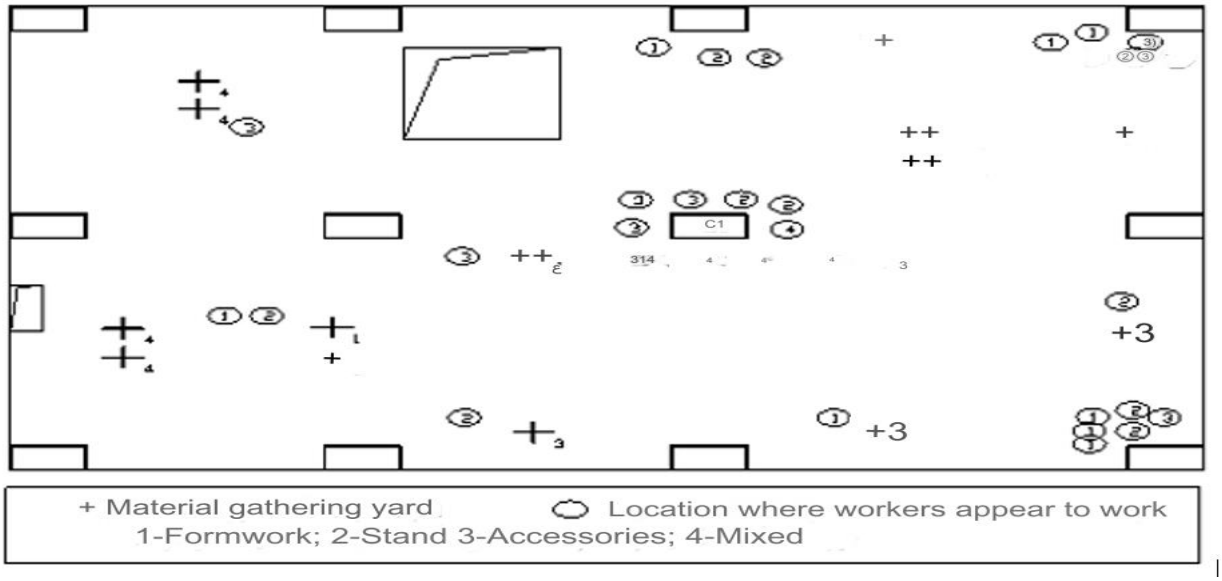

Figure 4.10: Current material distribution and gathering site

However, it can be seen that the distribution and arrangement of materials, machinery and labor on the construction site is haphazard, without clear calculation and organization, basically following the working habits of the workers. core.

(4) Ground distribution of movement of workers during work

Workers: To install column C1, a team of 7 workers is being arranged on the construction site and there is no clear assignment of responsibilities to each person.

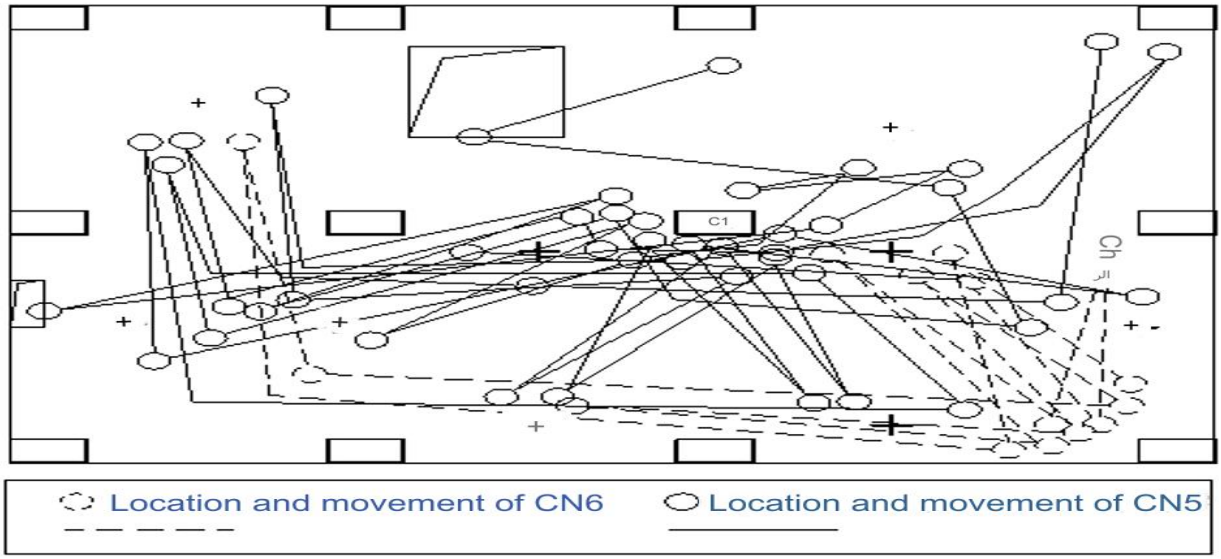

Figure 4.11: Location distribution and current labor movement routes

Table 4.2: Total construction time for erecting formwork for column C1 and column C2 before applying JIT

Unit: Minute

Status	work content	Total completion time	Work time		
			Useful labor	Labor required	Useless labor
first	Install formwork for column C1	**341.0**	167.0	111.0	63.0
2	Install formwork for column C2	**333.0**	166.0	108.5	58.5
	Total	**674.0**	**333.0**	**219.5**	**121.5**

- ***Applying instantaneous management theory to column formwork installation***

Through the installation of columns C1 and C2 according to the traditional method, travel time, waiting time, etc. will be resolved when applying JIT specifically:

Formwork will be shipped 2 days in advance, but will be pre-assembled according to the size of the column and neatly arranged at the base of the construction column and the worker team will be shortened to 5 people. (formwork has been pre-assembled according to size) and parallel construction of 2 columns C1 and C2 is carried out. Specifically:

(1) Construction process (method).

Use the conveyor belt construction method (combination of two sequential and parallel construction methods). Here, columns C1 and C2 will be constructed in parallel to avoid waiting.

(2) Material distribution and gathering ground

Materials are divided and arranged according to each type on the premises. The amount of materials is carefully calculated for each workload. The distribution of materials matches the flow of work, does not hinder the movement of workers, limits the distance of workers, creating simplification in each line.

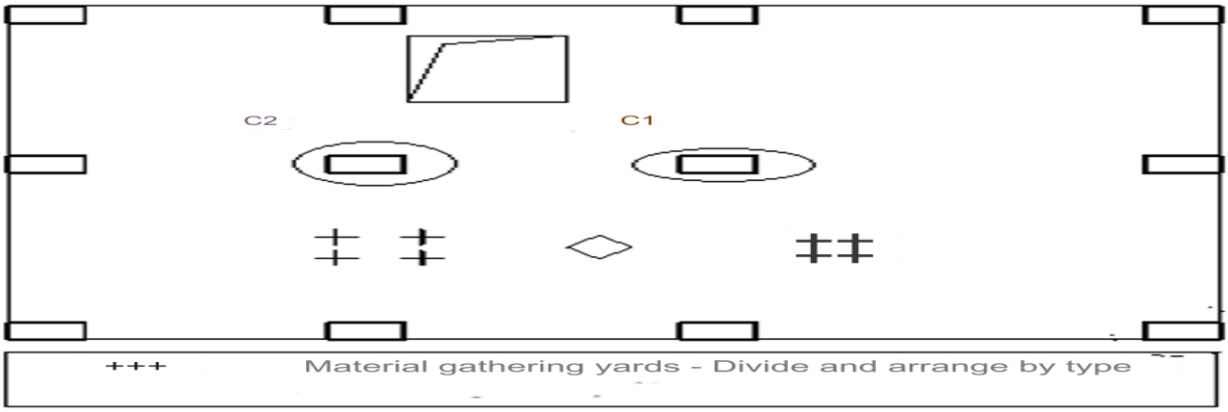

Figure 4.13. Space for distributing and gathering materials according to JIT

In that circle: the (+) signs have different numbers corresponding to different groups of materials classified and gathered in prescribed locations.

The location of construction machines is denoted by the symbol ◊

(3) Ground distribution of movement of workers during work

For the application of instantaneous theory in the construction and erection of formwork, a crew of 05 workers is used.

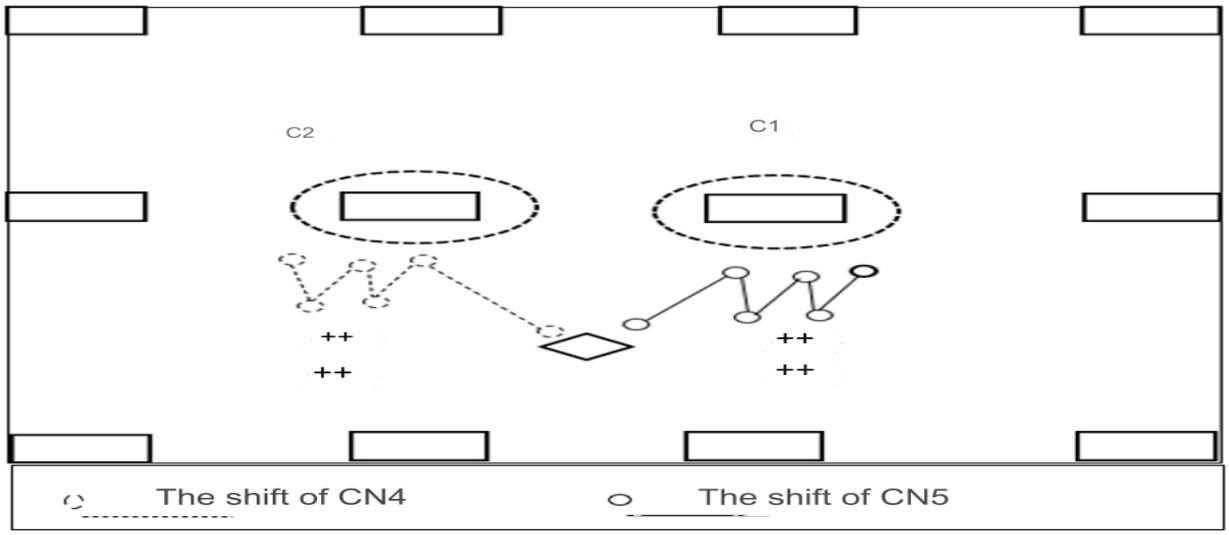

Figure 4.14. Location distribution and labor movement routes according to JIT

It can be seen that when applying JIT, workers are gradually specialized, and waiting is minimized. Workers who have completed work in column C1 will immediately move on to perform work in column C2.

Table 4.4: Total construction time for erecting formwork for column C1 and column C2 after applying JIT

Unit: Minute

Status	**work content**	**Total completion time**	**Work time**		
			Useful labor	Labor required	Useless labor
first	Install formwork for column C1	**176.5**	98.0	63.5	15.0
2	Install formwork for column C2	**123**	65.5	55.5	2.0
	Total	**299.5**	**163.5**	**119**	**17.0**

- ***Compare results***

After experimenting with erecting formwork for two columns C1 and C2, it shows that if JIT is applied in formwork erection, the time to complete the job is greatly reduced, specifically in the following table:

Table 4.5: Measurement results of column formwork erection solution on construction site

Unit: Minute

Status	**work content**	**Lead time before applying JIT**			**Lead time after applying JIT**		
		Useful labor	Labor required	Useless labor	Useful labor	Labor required	Useless labor
first	Install formwork for column C1	167.0	111.0	63.0	98.0	63.5	15.0
2	Install formwork for column C2	166.0	108.5	58.5	65.5	55.5	2.0
Total		**333.0**	**219.5**	**121.5**	**163.5**	**119**	**17.0**
Effective		**674.0**			**299.5**		
		374.5					

From table 4.5, it shows that before applying JIT, the total time (including 3 types of useful, necessary and useless time) of construction of both columns C1 and C2: 674.0 minutes.

After applying JIT, total time (including 3 types of useful, necessary and useless time) of construction of both columns C1 and C2: 299.5 minutes.

Thus, after applying JIT to the construction and erection of formwork for columns C1 and C2, the time was reduced by 374.5 minutes compared to before applying JIT.

Note: The author applied JIT to the formwork erection of the entire floor, but only included in the thesis the erection stage of 2 columns C1 and C2

Experimental application of just-in-time management theory in the process of supplying construction materials at the Company's projects

Project cycle and material needs in construction works: Construction works are formed and implemented according to the Construction Contract between company A and the investor or General Contractor. (called project).

The current situation of applying the material (steel) supply process at company A when JIT has not been applied

Through observation and measurement by the researcher, a steel order from company A is as follows:

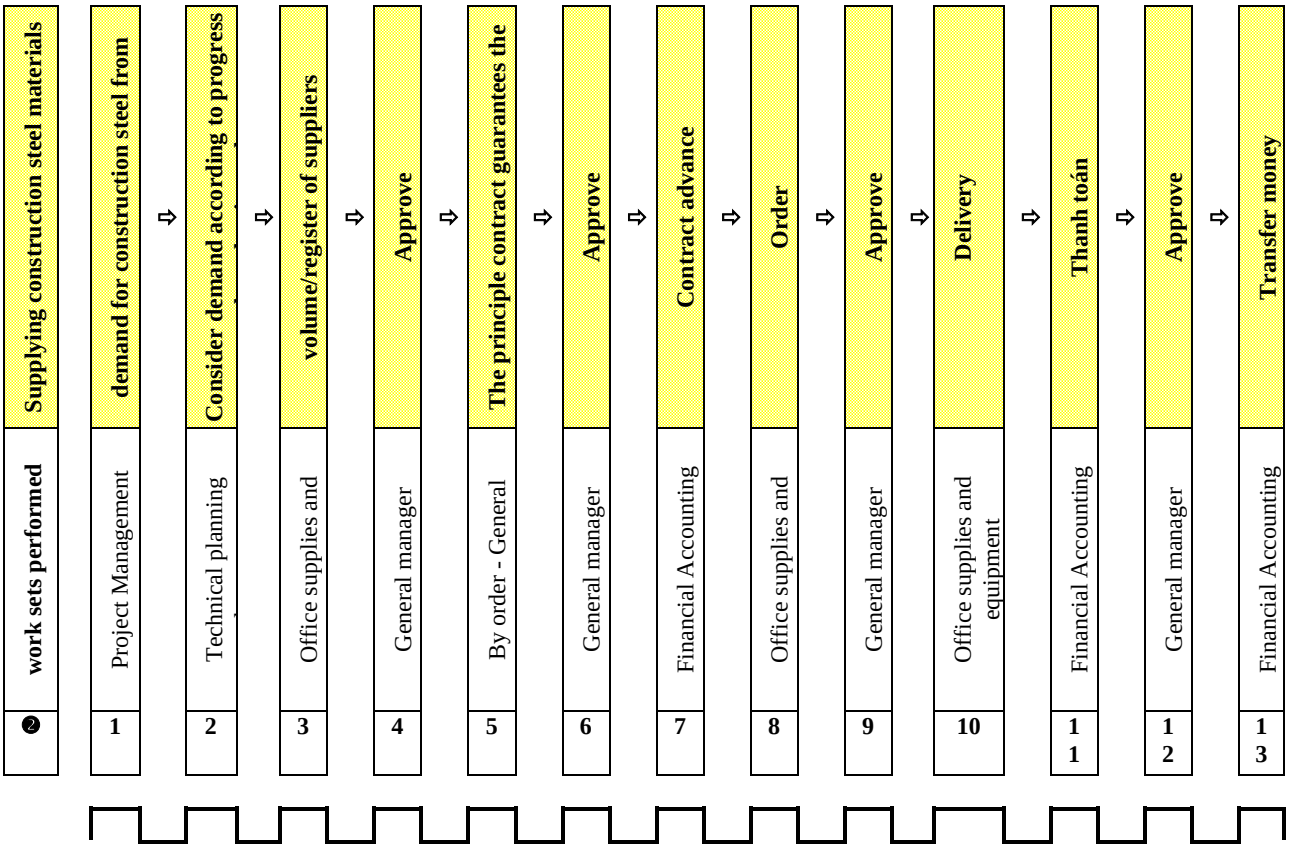

Figure 4.20: Time to complete a steel material order when JIT is not applied

In which: One working day is 8 hours (480 minutes)

P/T: Time needed to process the job = 2,040 minutes

D/T: Waiting time (time stagnant between work steps (BCV) = 1,240 minutes

L/T: Total time to complete the job = 3,280 minutes

- ***Applying JIT in the material supply process at company A (steel)***

To analyze and evaluate the current model, we will use the principles of JIT. However, due to the characteristics of office activities, it is difficult to determine the demand rhythm specifically and accurately. Because in reality, to do this we need to determine the demand rhythm and production rhythm, then build a KANBAN system to balance the demand rhythm, production rhythm and "unlock" the flow. This.

Researcher will in turn use the principles of JIT to evaluate the model:

Step 1: Determine the value of products and services according to customer needs.

Step 2: Establish value flow

In fact, work will only be done when it has enough input resources.

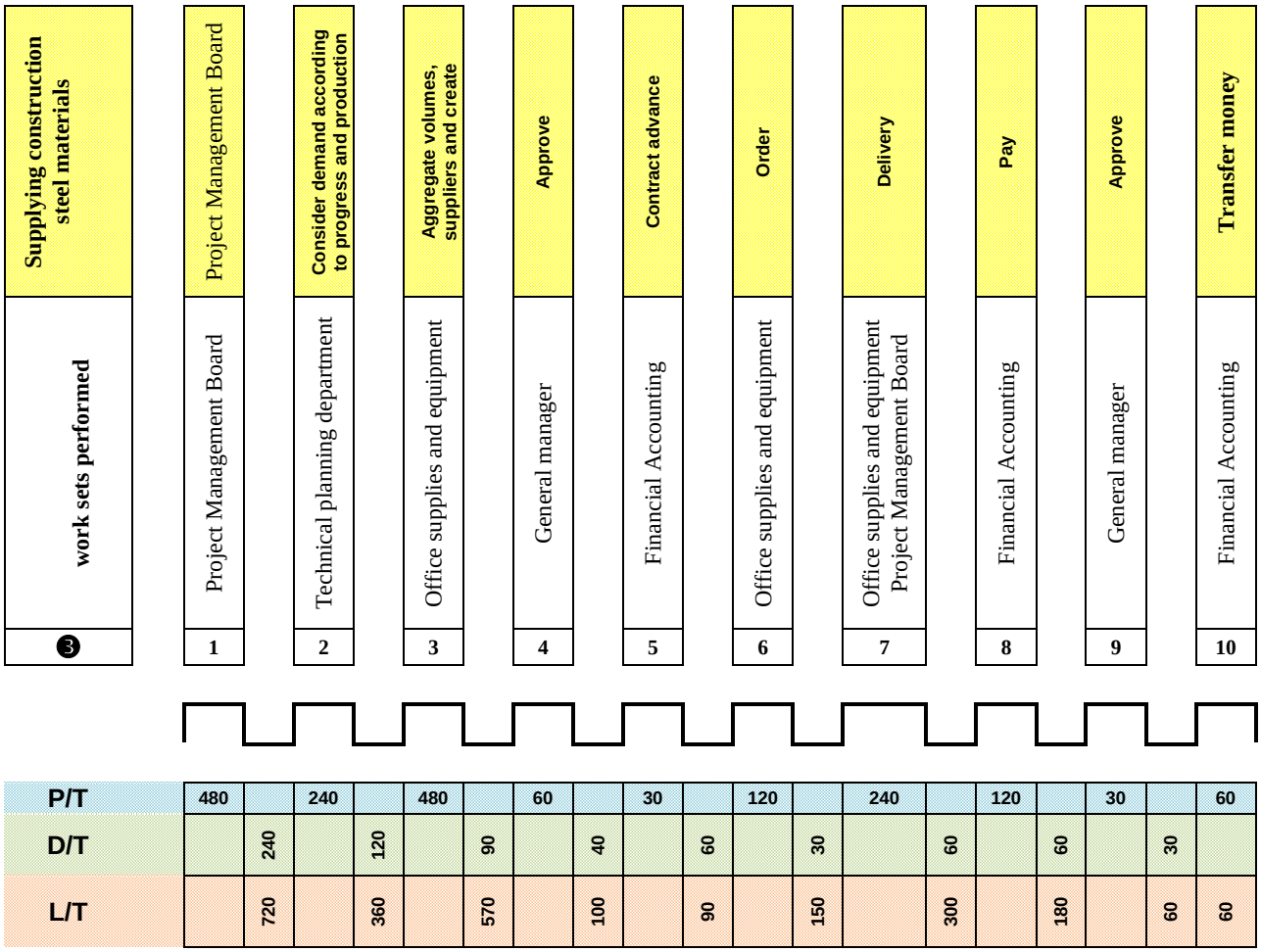

Figure 21: Time to complete steel material orders when applying JIT

In which: One working day is 8 hours (480 minutes)

P/T: Time needed to process the job = 1,860 minutes

D/T: Waiting time (time stagnant between work steps (BCV) = 730 minutes

L/T: Total time to complete the job = 2,590 minutes

- ***Evaluate results after applying JIT in the steel supply process***

Comparing and evaluating the effectiveness of JIT application in the steel supply process at company A is shown specifically as follows:

Table 4.7: Table comparing results before and after applying JIT in the steel supply process

Before applying JIT		**After applying JIT**	
Total time of a steel material supply process:	P/T: 2,040 minutes D/T: 1,240 minutes L/T: 3,280 minutes	Total time of a steel material supply process	P/T: 1,860 minutes D/T: 730 minutes L/T: 2,590 minutes
Time shortened due to applying JIT: 3,280- 2,590 = 690 minutes equivalent to nearly 1.44 days			

In terms of financial efficiency: Savings costs (payable salaries) will be calculated as follows:

Cost savings = Average salary/month * shortened time/30 * Number of orders in the year

The current average salary the company pays its employees is 10,000,000 VND/month.

Average steel orders per year are 90 times (300 tons each time)

Cost savings= 10,000,000 x (1.44/30) x 90 = 43,200,000 (VND)

Thus, after improvements, the company will save 43,200,000 VND in salary budget.

Conclusion of chapter 4

In chapter 4, the researcher has proposed directions and proposed solutions to apply immediate management theory in high-rise building construction in Vietnam. It clearly states the requirements as well as the preparations to apply the solution. In addition, the researcher has proposed a number of solutions to apply immediate management theory in high-rise building construction, such as solutions to control construction errors; solutions to improve work processes; Solution to eliminate waste in inventory... Besides, to prove the effectiveness of JIT, the researcher conducted an experimental application of JIT in the construction of column formwork and the supply of reinforcement in a high-rise building project. specifically.

CONCLUSIONS AND RECOMMENDATIONS

In construction, the basic characteristics of JIT, if promoted, will be very important factors, directly affecting the progress and quality of a construction project, contributing to determining product prices and quality. production and business efficiency of construction enterprises.

The results achieved by the thesis:

Within the research scope of the topic, the thesis has basically achieved the set goals and solved the following problems:

1- Systematize and perfect the theoretical basis of immediate management theory and apply immediate management theory in high-rise building construction in Vietnam.

2- Analyze and evaluate the conditions for applying instant management theory in high-rise building construction, as well as challenges when applying instant management theory in current construction.

3- Based on an overview of domestic and foreign research, the thesis proposes a model of wasteful factors in high-rise building construction in Vietnam. includes 0 8 Factors, specifically: Overproduction; Wait; Unnecessary travel; Processes and ways of working are not necessary; Inventory; Excess movement; Wrong, construction error; Staff capacity is not used .

4- Propose solutions to apply immediate management theory in high-rise building construction. These solutions contribute to perfecting the professional construction management and organization system, improving the level of management and construction

organization for managers, investors, consulting contractors and construction contractors. build.

5- Experimenting with immediate management theory in sample situations, specifically: (1) Experimenting with the construction of formwork and columns of high-rise buildings; (2) Experiment in the process of supplying construction materials at projects of a specific company

Limitations of the thesis and future research directions

Limitations of the thesis:

Although the thesis has basically achieved its set goals. However, there are still limitations in the research, which are: The research object only stops at the construction stage of high-rise buildings (apartments), there are no conditions to research other construction projects. as well as throughout the life cycle of construction investment projects. Surveying experts to collect primary data is only done for domestic organizations, there are no conditions to survey subjects (investors; consultants; contractors) abroad to participate. Participate in construction investment projects in Vietnam. High-rise building investment projects were surveyed in Hanoi city but have not had the conditions to be implemented in other provinces and cities domestically and abroad.

Further research directions:

Based on the inheritance of the research results of the thesis, the next research direction of the thesis topic: Will delve into the application of immediate management theory in terms of overall management of the entire initial project life cycle. construction investment. From the project preparation stage, the project implementation stage and the construction completion stage to put the project's works into exploitation and use. However, to conduct research on these issues, researchers require basic time and resources and the cooperation of construction units.

LIST OF SCIENTIFIC WORKS PUBLISHED BY THE AUTHOR RELATED TO THE THESIS TOPIC

*** SCIENTIFIC ARTICLE:**

1/ Nguyen Quang Vinh; Dinh Tuan Hai (2016). Applying the Pulling System in the JIT (Just in Time Management) model to streamline the supply of materials on the construction site. Construction Economics Magazine. No. 03/2016. ISSN 1859 - 4921.

2/ Nguyen Quang Vinh; Dinh Tuan Hai (2019). *Introducing research on just-in-time management in construction* . Architecture & Construction scientific magazine. No. 36 November 2019. ISSN 1859 - 350X.

3/ Nguyen Quang Vinh; Dinh Tuan Hai (2021). *Scientific and practical basis for the theory of immediate management in construction* . Natural Resources and Environment Magazine. No. 8 (358) April 2021. ISSN 1859 - 1477.

4/ Nguyen Quang Vinh (2022). Organize and manage construction site premises using the 5S model to improve productivity and protect the environment. Natural Resources and Environment Magazine. No. 6 (380) March 2021. ISSN 1859 - 1477.

*** SCIENTIFIC SEMINAR:**

1/ Nguyen Quang Vinh; Dinh Tuan Hai (2016). *Application of Just in Time Management (JIT) on Finishing Masonry Works for Highrise Building Projects* . International conference on Sustainable Development in construction technology, University of Civil Engineering.

2/ Nguyen Quang Vinh; Dinh Tuan Hai (2017). *Introduction to research on Just-In-Time Management in Construction* . The 3rd conference on advanced construction technology towards sustainable development - ATCESD 2017.