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THE EMERGENCE OF NEW TASKS IN CONSTRUCTION PLANNING - CAUSES, CONSEQUENCES, AND IMPROVEMENT ACTIONS

by
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AN ABSTRACT OF THE THESIS OF

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The construction environment is highly uncertain, projects undergo many changes to attain their final completion state and the process includes delays and wastes that must be minimized. Therefore construction planning plays an important role in directing projects and controlling them to increase the efficiency of the system. The success of construction planning depends on many factors. In this study 'new tasks' emergence in construction planning is studied, its causes and consequences are examined to advice ways on improvement. Four case studies are examined in Lebanon and Japan to observe the planning system and behaviors of people when 'new tasks' emerges. An ABC (Antecedent Behavior Consequences) model is developed to explain the emergence of 'new tasks'. Additionally, the different antecedents, behaviors, and consequences are listed to show the possible situations that can be faced on site. Finally, improvement actions and suggestions are recommended based on the planning behaviors that were observed to improve the construction planning system.

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CHAPTER I

INTRODUCTION

A. Introduction

The objective of the planning system on a conventional project is to finish the project on time, on budget, and according to the project requirements, commonly called the triple constraints (Dvir and Shenhar 2007). Planning is defined as a decision making process undertaken to design and bring about a desired future using effective ways (Laufer and Tucker 1987). It is the determination of what has to be performed, how it has to be performed, in which sequence and when, what resources are needed, and their cost within the organization before the execution (Laufer and Cohenca 1990).

Construction planning assists the manager in controlling and directing the project and involves coordination and communication between the project parties. The main objectives of the planning system are first to direct the actions to the correct path before they start, then to regulate them while they are in progress, and at last to keep records of the actions and report them while forecasting for the future. The major advantages of proper planning are: reducing or eliminating uncertainties on the project, while improving the efficiency of the processes, and having a better grasp of its objectives. Construction planning offers a base for work monitoring and control (Kerzner 2006).

However, there are unforeseen changes that often happen in construction planning. What is executed on site can differ from what is planned. There are tasks that have to be executed but are not included in the plan, or that are included in the schedule but with a wrong timing. These tasks appear at the week of their execution on site and are called 'New Tasks'. The reasons for of their emergence vary; yet they tend to affect the project's progress. And there is a need to find ways to make the construction industry more efficient especially in Lebanon where construction delays have negative consequences on the economy (Mezher and Tawil 1998). Therefore, the goal of this proposed research study is to (1) define the reasons for the emergence of 'New Tasks' in construction as observed on several case study projects, (2) describe the differences between the planning systems to find the planning behaviors that contribute to the emergence of 'new tasks', and (3) develop model that explains the emergence of 'new tasks' will be developed.

B. Problem Statement and Significance

Hamzeh (2009) highlighted the issues related to production planning practices by performing a case study. Some of these concerns were the lack of integrated and standardized process, slow removal of constraints, push in construction schedules, lack of collaboration in planning, poor organizational learning and performance of scheduling software, and poor linkage between weekly work plans and the master schedule which weakens the ability to develop foresight (Hamzeh 2009). The link between the weekly work plan and the master schedule containing all the project milestones is in the lookahead planning phase, this phase consists of breaking down activities, doing operations design and removing constraints. When the lookahead planning lacks collaboration and develops a poor linkage, problems can grow. The study shows that some tasks in the weekly work plan are completed but were not anticipated. Therefore the planning system is sometimes weak in anticipating tasks. The study suggests that the improvement of task anticipation is performed by properly breaking down activities into operations. This breakdown is achieved through studying multiple scenarios and using simulation, because any deficiency in the breakdown can cause the appearance of new tasks (Hamzeh 2009). A case study analysis of the weekly work planning report of an AEC (Architecture, Engineering, and Construction) company, showed that at the beginning of the execution week, new tasks emerged that were not broken down or evaluated during the lookahead planning stage. The number of new tasks coming up was large and it even exceeded the number of tasks anticipated (Hamzeh and Aridi 2013).

This study explores the phenomenon of “new task emergence’ in weekly planning by studying it on multiple case study projects. The study shows how the emergence of new tasks affects the construction planning process and the progress of work on site. Planners are interested in knowing the “Why” and “How” of every planning problem that occurs in a project in order to learn from past failures. Hence, it is necessary to collect the data required to identify the causes behind the emergence of new tasks. Also by studying the planning behaviors or construction actions that lead to new tasks, one can suggest the improvement actions that should be taken. Consequently the whole planning process can be improved for a better project outcome.

C. Research Questions

The questions that are answered in this research study are the following:

- What are the reasons behind the emergence of new tasks?
- How can these reasons be interpreted in terms of planning behaviors?

- What is the process behind the emergence of ‘new tasks’?

D. Scope of Work and Limitations

The goal of the study is to find the main causes behind the emergence of ‘new tasks’ during the week of execution on a construction project and the planning behaviors behind that. The causes of new tasks are analyzed and recommendations for improvement are developed. Below are the specific objectives of the research study:

- Describe the actual planning system of the projects. This includes the planning behaviors, the practices used and the problems faced on the construction sites.

- Study how new tasks appear at the week of execution on a construction project. What are the main causes for the emergence of ‘New Tasks’? How can we divide these causes and their sources?

- Explore improvement actions to the planning system. How can the planning process be improved? What are the planning behaviors that should be implemented to improve the planning system?

It is worth mentioning that the results of case study research are not necessarily generalizable for the whole industry, and only specific behaviors are compared, not the overall projects. The study focuses on the reasons behind the emergence of ‘New Tasks’ and the planning behaviors involved. Although the time period spent on the projects in Japan was shorter, the information and records taken were enough to understand the planning behaviors. The model developed contains the range of causes, behaviors, and the possible types of consequences, but it does not relate specific consequences, behaviors and causes with a cause/effect relationship.

CHAPTER II

LITERATURE REVIEW

A. Construction Planning

The main construction activities are planning, executing, coordinating and controlling (Laufer and Tucker 1987). A project plan is important in determining the project success. The plan contains detailed directions for the project team to perform in the proper defined timing and with the proper resources. The project manager is responsible for interpreting the plan on site and passing it to the team, while making sure that everything is performed with the complete satisfaction of major stakeholders (Zwikael 2009). The elements of the project plan are: overview, objectives, general approach, contractual aspects, schedules, resources, personnel, risk-management plan, and evaluation methods (Meredith and Mantel 2006). There are stages for the process of establishing a project plan. They include defining the project objectives, identifying the activities with the relationships of precedence, estimating activity durations and project completion time, comparing project schedule objectives, and determining the resources required (Russell and Taylor 2003). The major components of the planning phase are: objective, program, schedule, budget, forecast, organization, policy, procedure and standard (Kerzner 2006).

B. Failure in planning and its causes

One major deficiency in construction planning is the focus on sticking to the schedule while forgetting the importance of methods and action planning (Laufer and

Tucker 1987). Many reasons lead to failure of construction projects. The major reasons include the lack of integration between the design and construction team, the use of innovative materials, the deficiencies in the procurement systems, the general contracting market conditions, and the unique features of each new building project (Brown et al. 2001). Additionally many mistakes happen in construction due to the nature of the work setting, and the nature of the work itself which is performed by workers. Building construction projects is based on a "negotiated order" which also facilitates mistakes at work (Riemer 1976).

To understand the effectiveness of construction planning, the relationship between construction planning efforts and construction planning effectiveness has been examined by Faniran et al. (1994). The results of their study indicated that shifting the focus of construction planning away from "control" and more on planning itself, could improve its effectiveness. Cost variance, time variance, and labor man-hour variance decrease with the increase of planning time and emphasis on construction methods. The increase in planning time for information analysis lead to an increase in the quality of workmanship associated with a reduction in labor man-hour variance. These results shed the light on the importance of construction planning and how it affects time, cost, and quality. The three critical success factors that affect construction planning were also identified, the first one was spending enough planning time before starting to work on-site. The other two were reducing the focus on developing schedules to monitor and control the project, and increasing the development of operational plans for the implementation of the project (Faniran et al. 1998).

However, many variables have an impact on *the efforts invested in planning.* Findings show that the most influential factors are percentage completion of design, past construction experience, and objective rigidity. Additionally planning efforts must increase when going from simple/certain situations to complex/uncertain situations (Cohenca et al. 1989). Another study confirms a negative correlation between planning time and schedule variance, and between control time and schedule variance. Schedule variance is defined as being the difference between the total actual construction time and the total planned construction time. It also defines the most important factors affecting *construction planning outcome* as being the percentage completion of design, past construction experience, labor supply, weather predictability, and attitudes towards planning (Laufer and Cohenca 1990). These factors are important since they affect the whole planning process and thus the construction success or failure. In this matter, the experience of contractors plays a big role in the identification of tasks to be executed and how to avoid past problems from reoccurring like problems related to supply, coordination, and other technical issues (Tatum et al. 1986). As for labor supply, it does not only affect planning but also construction since it is a parameter for the calculation of productivity and cost estimating. It affects the flow of work on site and can hinder the workflow and cause wastes of two types: workers waiting on work or work waiting on workers (Liker 2004). Weather too is responsible for waste and causes delays in construction due to non-productive days, idle equipment and material, and other financial expenses (Laufer and Cohenca 1990). In previous research ten factors were identified to be responsible for the tasks start time and duration variation which are (1) turnaround time from engineers when there is a question with a drawing; (2) completion of previous work; (3) obtaining required permits; (4) the quality of documents (errors in design and/or drawings); (5) rework; (6) socializing; (7)

people arriving late and/or leaving early; (8) weather Impacts; (9) lack of crew skills/experience; and (10) needing guidance/instruction from supervisor (Wambeke et al. 2011a). Delay can have bad effects on the project like litigation, arbitration, disputes, and cost overrun (Sambasivan and Soon 2007).

To avoid failure in planning, it is necessary first to understand which factors affect the construction project success. A study on this subject concluded a conceptual framework for the factors affecting project success, where the factors were divided into five groups: (1) Project management actions (Communication system, control mechanism, feedback capabilities, planning effort, etc.), (2) project related factors (type, nature, size of the project, etc.), (3) external environment (economy, society, politics, etc.), (4) project procedures (procurement and tendering methods) and (5) human related factors (Chan et al. 2004). Project management actions are basically affected by the planning system used which defines all actions that should be taken and at which time, it is also related to the planning methods and organization structure.

Therefore, the system chosen to be implemented on a project is an essential component to define the success or failure of this project. In this matter, a production planning and control system called the Last Planner System (LPS) was invented and successfully applied in firms and construction companies. LPS is based on the concepts of Lean Production invented by the Toyota Production System, which presents principles and techniques to enhance manufacturing. These Lean Principles extended to other industries like construction (Ballard 2000).

C. Lean Construction

Lean thinking is a philosophy of business management applied to production, it is a system to organize and manage processes like product development, operations, design, production, supply chain interactions, and customer relationships (Hamzeh 2009). Lean philosophy is based on increasing value and minimizing waste in the production process (Hamzeh 2009). Lean construction is concerned with applying Lean Philosophy in the construction industry following the basic lean principles that led to the success of the Toyota Production System.

The summary of the Lean Principles is as follows (Sacks et al., 2010):

- Reduce Variability
- Reduce Cycle Times
- Reduce Batch Sizes
- Increase Flexibility
- Select an Appropriate Production Control Approach
- Standardize
- Institute Continuous Improvement
- Use Visual Management
- Design the Production System for Flow and Value
- Ensure Comprehensive Requirements Capture
- Focus on Concept Selection
- Ensure Requirements Flow Down
- Verify and Validate
- Go and See Yourself

- Decide by Consensus Consider All options
- Cultivate and Extended Network of Partners

These principles are universal, they apply to different kinds of productions like physical production, information and design and even to construction. Lean construction developed work structuring which consists of aligning product design with process design. It helped in structuring the supply chain, allocating resources, and designing pieces to attain reliable workflow. Lean construction focuses on the quality of the product and on increasing value in the eye of the customer. Furthermore, the emergence of the Transformation-Flow-Value (TFV) theory changed the perception of construction from being only a transformation of inputs to outputs to the focus on flow and value in the process. Flow and value help in reducing waste and variability and increasing customer satisfaction. Other concepts of the lean production system are the focus on continuous flow, pull, standardization, and continuous improvement (Koskela 1992, Hamzeh 2009).

D. The Last Planner System (LPS)

LPS is a production planning and control system used to reduce variations in construction work flow, develop foresight, and reduce uncertainties in construction operations (Hamzeh et al., 2012). LPS forms a great environment that embodies the principles and values of Lean thinking. LPS directs planners away from after-the-fact detection of variances and helps them improve predictability, and reliability in planning and workflow (Ballard 2000). What is meant by predictability is the capability of properly defining which tasks can be completed on site, and predicting variations related to uncertainties while allocating a proper buffer for them. As for plan reliability it is measured by the Percent Plan Complete (PPC), which is the number of tasks completed over the number of tasks that were planned to be completed; it reflects how reliable a plan is (Koskela 1999). Workflow however can be understood as: (1) material flow through the supply chain, (2) task flow on a project, (3) location flow of work through locations, and (4) assembly flow that describes the flow of work from a construction phase to another (Koskela 1999). Interest is in smoothening the workflow to attain an optimized continuity in work through locations and without disruptions of the work sequence (Kenley 2004).

LPS is a planning cycle that includes: (1) the master schedule containing milestones of the entire project, (2) the phase schedule developed from collaborative planning, (3) the look-ahead plan, and (4) the weekly work plan. In the master schedule, dates for major milestones of the entire project are specified and critical path method (CPM) is used to determine the project duration (Ballard et al. 2007).

The phase scheduling consists of a schedule broken down from the master schedule and containing more details about the project components. At this stage reverse phase scheduling is prepared along with first run studies to get more accurate durations and task relationships to modify the CPM logic. So far it is called the front end planning, the production planning begins with the lookahead plan. The lookahead plan is a further magnification of the phase schedule, it contains all activities to be completed in the coming six weeks. Responsibilities are identified at this point and “making ready” is completed by analyzing and removing constraints. Finally, the weekly work plan drives the process; it requires reliability by making only quality assignments and reliable promises. The tasks at this stage are shielded from upstream uncertainty. Then assignments are reviewed for completeness, and reliability is measured through PPC to identify any reason for failure and promote learning (Ballard et al. 2007).

The importance of the lookahead plan lies in the fact that it requires collaboration and it links front end planning to production planning. When lookahead planning is not properly implemented, weekly work plans are not properly linked to the long term plans. This makes the system more reactive and loses its ability to develop foresight (Hamzeh et al. 2012). Therefore, it is necessary, at the lookahead stage, to properly break down activities from the master schedule to anticipate all tasks that should be done, to make them ready so that they can be done. This process goes beyond just interpretations and requires operations design to identify and start removing constraints (Ballard 1997, Hamzeh 2009, Ballard 2000).

E. Conceptual Model of Lookahead Planning

The first step in the planning process is to prepare a master schedule of milestones, the convention used in this study is that phases are represented by “boulders”, phases are divided into processes expressed by “rocks” and then processes are broken down into operations represented by “pebbles”. In the phase schedule, where collaborative planning is performed, Boulders are divided into Rocks, this “explosion” details the master schedule activities and the project phases are identified. Additionally, reverse phase scheduling is performed to help uncover constraints (Ballard et al. 2007).

In order to shift to the lookahead planning phase, a greater detail is needed, Rocks are broken down into Pebbles, to determine activity’s inputs and outputs (Ballard et al. 2007; Hamzeh et al. 2009). At this stage, 6 weeks ahead of execution a plan to make tasks ready is prepared to be performed progressively from the beginning of the look ahead planning phase to the weekly work plan and execution week. To make a task ready, all the constraints that it has should be removed. There are two types of constraints, the gross constraints and the specific constraints. Gross constrained, as their name indicate, impact the phase or process, they are evaluated 6 weeks up to 4 weeks ahead of execution and a plan for their removal is devised. As an example is the production of prefabricated items or establishing agreements with testing agency (Hamzeh, 2009).

Processes are then broken down into operations, from week 5 to week 4 in Figure 1, this activity breakdown consists of decomposing tasks into elements moving from processes to operations (Hamzeh, 2009). Consequently, operations design is performed which consists of defining the operations, the best sequence of work, balancing load and capacity, and analyzing tasks for soundness (Hamzeh et al., 2008). Operations design is applied through first run studies that should have been designed by week 3, they are virtual physical prototype scopes. A first run study is a tryout of the operation by actually performing it to study and improve it while learning from errors, which at this stage don't affect the actual construction work. It is mainly important for new, critical, or repetitive tasks. It helps understanding the sequence of the work, identifying the skills and resources needed and the best method to perform the task (Hamzeh, 2009).

Furthermore, at week 2, screening is applied on tasks to determine their status relative to their constraints and locate them on the schedule (Ballard et al., 2007). These tasks are either advanced into the lookahead schedule, and called Ready (R) in the figure, or they are retarded to the master schedule for upcoming weeks because they cannot be made ready (CNMR). Tasks that are not ready and can be made ready (CMR) prior to the activity's scheduled start, are also advanced to the schedule depending on the probability of removing their constraints (Hamzeh, 2009; Ballard et al., 2007). To determine CMR tasks, the planner has to check the lead times needed to get deliverables from suppliers, confirming lead times is the first step in the make-ready process. Pulling is the second step, it tells which tasks to make ready according to site demand, and requests suppliers for delivering material or input as needed on site. The third step is expediting, that is getting the attention of the suppliers to remove constraints (Hamzeh, 2009; Ballard et al., 2007).

At week 1, well defined and constraint-free tasks which are ready are indicated by RR, and they enter the weekly work plan phase. As for those with constraints but can be made ready CMR, they are made constraint-free through collaborative planning and coordination between parties concerned. At this point, 'new tasks' can emerge into the weekly work plan, they are due to previous errors in the break down or unanticipated work. The provisional weekly work plan is prepared by evaluating tasks against quality criteria which are definition, soundness, sequence, size, and learning (Hamzeh, 2009). Quality assignments consist of choosing what work will be performed from what can be performed in the execution week. Shielding is where quality assignments only are put on the weekly work plan as this will protect the successor tasks from uncertainties in predecessor tasks upstream, this will improve plan reliability (Hamzeh, 2009). Moreover, previously called Ready tasks are evaluated and divided into Ready-ready tasks sent for execution and not quite Ready tasks which will not be executed. Likewise, tasks that were previously classified as can be made ready (CMR), are divided after evaluation, into not ready tasks but will be made ready in the execution week, they are indicated by NR, and not ready tasks that will not be made ready in the execution week, indicated by 1 – NR. As for New tasks they are also evaluated and classified as can be made ready, indicated by N, and cannot be made ready, indicated by 1 – N, for the execution week. At week 0 or execution, RR tasks are assumed to be completed with no failure in execution, and 1-RR, 1-R, and 1-N are not completed and moved to the upcoming weeks.

By the end of each week, an evaluation of reliable promising is performed by measuring the PPC and identifying the reasons for variance. Reliable promising is the process of making commitments and executing them (Hamzeh, 2009). To measure the performance of the lookahead planning phase, task anticipation and task making ready are assessed.

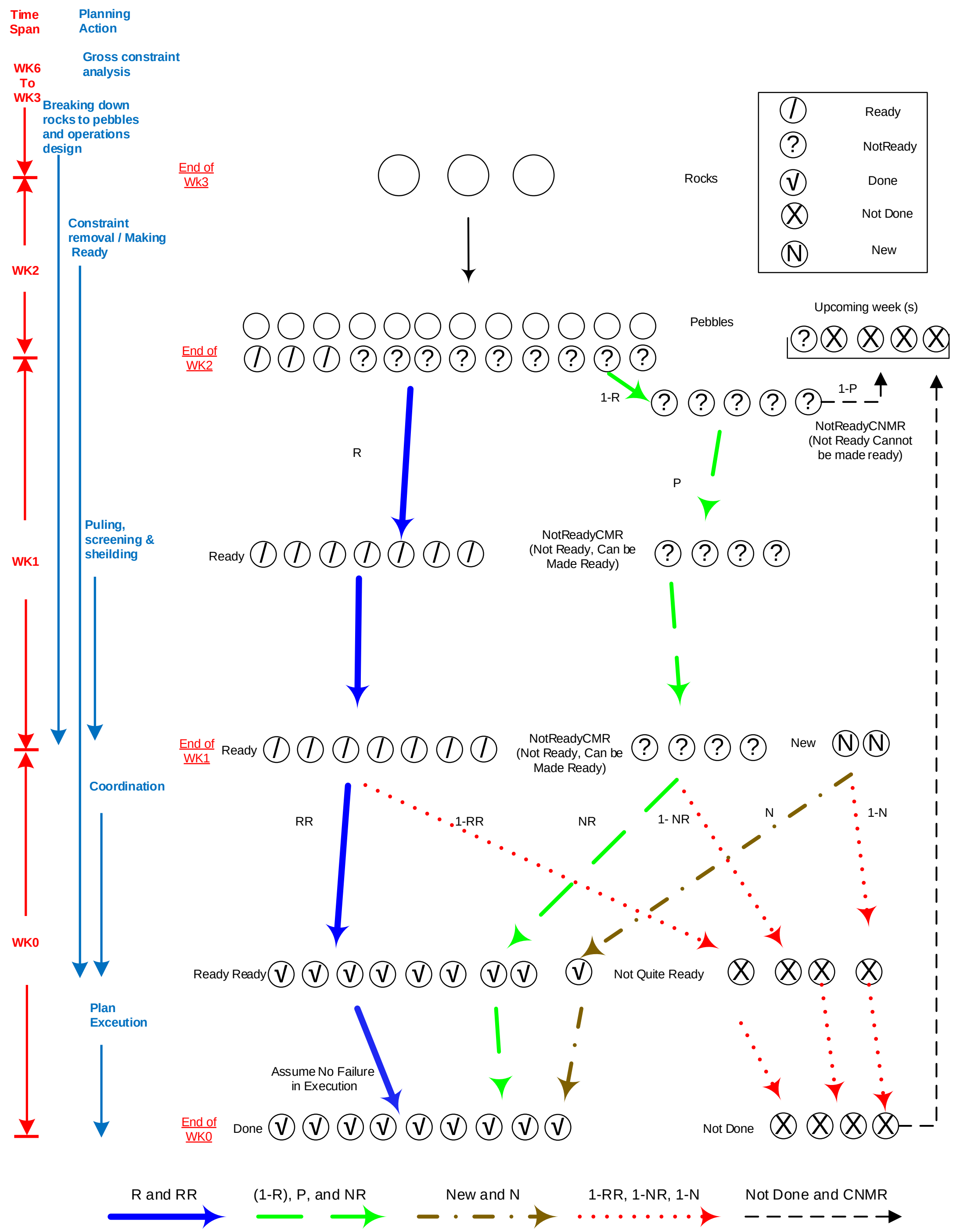

Figure 1: Possible Paths of Planning (Hamzeh et al., 2015)

F. Tasks Made Ready and Tasks Anticipated

TA measure tasks anticipation and TMR measure making ready by constraints removal. TMR and TA define the success of the lookahead planning process. TMR measures the ability to successfully identify and remove constraints. The process of removing constraints for an activity to be executed is called the making ready process. To remove those constraints we have to identify them first, therefore Koskela (1999) has identified six preconditions for ready work: Construction design and management, components and materials availability, workers availability, equipment and machinery availability, sufficient space availability, predecessors' completion. Three other conditions were later added, which are: appropriate climate conditions, safe working conditions in relation to national "Health and Safety at Work Act" have to be present, and known working conditions (Lindhard and Wandhal, 2012). This can give us a picture of how complicated the making ready process is, without forgetting that the soundness of activities also can be variable over time (Lindhard and Wandhal, 2011). The complexity of projects is increasing and causing a high interdependency among tasks along with workflow uncertainties (Bertelsen, 2003).

Researchers studied the last planner system implementation and the monitoring of the make ready process by assessing the ratio of constraint-free tasks over those with constraints which is the Percent Constraint Removal (PCR). These studies proved the importance of the making ready process since it helps increasing information transparency thus solving constraints. The results show a positive correlation between PCR and PPC, and between PCR and the predictability of the resulting workflow. It is thus important to improve the making-ready process since it improves workflow predictability and reliability (Jang and Kim, 2007; Jang and Kim, 2008).

As for TA, it measures the successful anticipation of tasks to be performed two or three weeks ahead. By breaking down the activities into tasks and by doing operations design, planners can anticipate work to be performed. The impact of the changes in TA on the project duration was studied by Hamzeh et al (2014) by simulating the lookahead planning process. The study concluded that improving the planning abilities in anticipating tasks before execution positively affects the reduction in the overall project duration. However the measure of task anticipation (TA) is impacted by the number of ready tasks two weeks ahead of execution, and the number of 'new tasks' that emerge at the week of execution (Hamzeh, et al. 2014). Therefore, explaining 'new tasks' is important to understand planning. What can be the reasons for the emergence of new tasks? How can these reasons be interpreted in terms of planning behaviors? And what is the process behind the emergence of 'new tasks'?

This research aims at understanding the reasons for the emergence of New Tasks, analyzing their consequences on the progress of work, and discussing how their emergence can be avoided by proper planning.

CHAPTER III

METHODOLOGY

A. Research Method

The research method used focuses on the qualitative aspect of planning; it encompasses data collection from different case studies of construction projects. The data are analyzed to help answer the main research questions posed in this study. The major steps are the following:

1. Conduct case study analysis of actual construction projects in Lebanon and Japan and describe how different they are.

The review investigates the planning system on each of the construction projects. Furthermore, the focus is on weekly work planning and reliable promising, along with the challenges faced by the personnel due to the project environment.

2. Describe the emergence of new tasks.

This step consists of following the case studies to analyze the planning behaviors on the construction site and defining the new tasks that appear at the week of execution to map the reasons for their appearance. Each case addresses the subject of new tasks, their reasons and consequences in the light of the planning system used. The projects chosen have a baseline schedule and a planning team responsible for planning, assessing, and updating the schedule. Having a planner that follows up with the construction work is necessary, to be able to study the strategies used.

3. Analyze and report the planning behaviors.

The data and information collected from the case studies and interviews are combined and reported. The information related to planning are analyzed to find the planning behaviors that are performed in each project, and draw conclusions on the light of the results.

4. Suggest improvements for the planning system.

After analyzing the results of the case study, the deficiencies in the planning system are pointed out to advise methods for improvement. The basic goal of the study is to understand the failures in the planning process and suggest improvements to avoid future failures, case studies are helpful in highlighting these deficiencies.

B. Research Methodology

Research into human behaviors helps in analyzing ‘New Tasks’ in construction planning. An ABC model, or Antecedent, Behavior and Consequence approach, was developed in rational-emotive therapy and was also used to study behavior-based safety (Ellis et al. 1995; Dorgan 2013). The Antecedent (A) is a stimulus that triggers a Behavior (B) and leads to Consequences (C). To examine an incident, the antecedent that triggered the behavior is examined, and to get a clear picture of why the behavior occurred, the consequences are also studied. Below is an explanation of the ABC model:

Antecedent →	Behaviour ↔	Consequence
A stimulus or event that occurs before a behaviour in time. This stimulus or event may result in the behaviour. Work examples include goals, policies, training, job aids, guides.	Anything that we can see an individual do, or say.	A stimulus or event that occurs after a behaviour in time. This consequence could increase or decrease behaviour in the future, depending on its reinforcing or punishing properties. Work examples include feedback, recognition, task completion, goal achievement, rewards.

Figure 2: ABC model (Dorgan 2013)

In this study an ABC model for the emergence of New Tasks is developed to define the causes, consequences and actions related to them. To be able to answer these questions, case studies helped in closely observing the phenomenon.

Case study copes with a situation where many variables of interest matter other than specified data points, like people's behavior or attitude, therefore case studies were used in this research (Yin 2003). Additionally, case studies help investigating a phenomenon in a real-life context while relying on multiple sources of evidence. Planners are interested in knowing the "How? And Why?" of 'new tasks' emergence and this can be done without intervening in the process of their appearance. By interviewing concerned people like the project manager, the planner, the site engineer, and the foremen, and by directly observing the facts, the deficiencies in the planning system are described.

Case studies are conducted to provide evidence for the conclusions and to compare results and validate them. The use of multiple case studies strengthens the research findings since the conclusions made are coming from different projects rather than only one.

The goals of the case studies are to examine and evaluate: (1) the planning process in the corresponding project, (2) the lookahead planning, (3) the link between lookahead and weekly work planning including task anticipation and breakdown, (4) the execution of tasks including the comparison between what was planned and what was completed including New Tasks.

Moreover, the case studies were chosen according to the needs of the research. The last planner system is not used in Lebanon but the leading companies in this field apply the basic planning strategies, and have their own planning system. As for the Japanese companies, each has its own planning system too, but it is closer to LPS since the culture is more affected by the Lean philosophy.

After observing the companies' planning system, the stages of planning which are: "SHOULD", "CAN", "WILL", and "DID" are recognized. In general, planners do at least the first stage: "SHOULD" which is interpreted in the baseline schedule on which all the planning in the project is based. As for the three other stages, the way they are interpreted depends on every project. In some cases "CAN" and "WILL" are interpreted using verbal communication, written lists or excel sheets, and "DID" using daily reports or inspections after work completion. In the study, the researcher is interested in the phase between "WILL" and "DID" in which 'new tasks' emerge. The assessment of work progress might not be detailed, for instance PPC is seldom used on Lebanese projects. In this case, the researcher retrieved the necessary information to come up with results and calculate the metrics needed. In the cases of Japan, the information given were used to come up with the results which compensated for the short time spent on each project. The steps that are followed in the project case studies are described below:

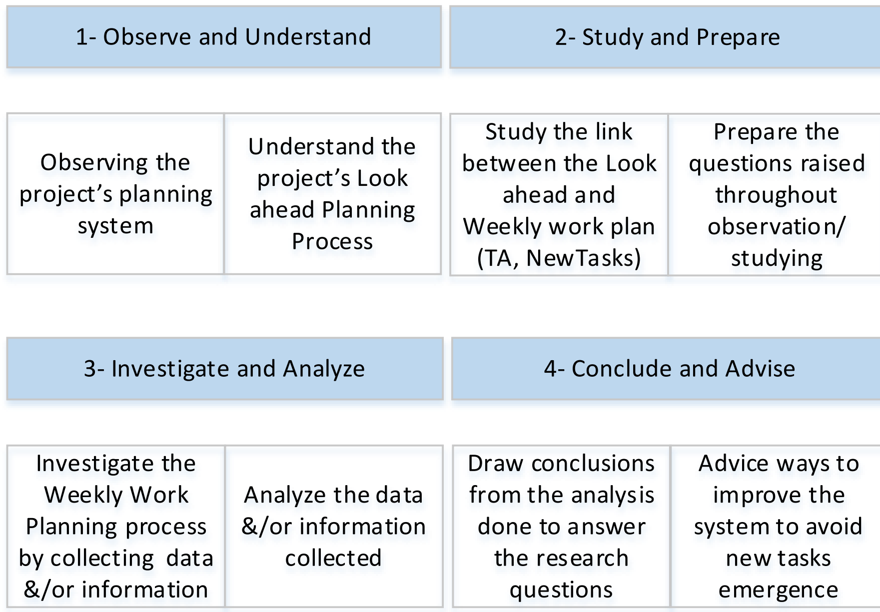

Figure 3: Case Study Research Design

To evaluate the weekly planning performance of the case study in Lebanon, the last planner form is used with some changes to include the New Tasks section and meet the needs of this research study (Ballard et al. 2007). In the beginning of each week this form is filled with the tasks to be done, and at the end of the week the form is updated to see which tasks were done. As for 'new tasks' to be performed, some of them are added during the week and also updated at the end of the week and other are added at the beginning of the week. PPC is calculated for every week along the study and the number of new tasks is specified. As for the case studies in Japan, the studies were based on documents and records as well as interviews and observations. Recording the data for a long period was not necessarily due to the availability of documents that can reflect the work progress.

Project: Prepared by: Carel Rouhana Date Prepared:

PPC = .../... = ... % ... new

	Responsible Party	Activity Description	Period to Perform the Work						PPC Analysis		
		Defined - Sound - Proper Sequence - Right Size - Able to Learn	M	T	W	TH	F	S			
			DD	DD	DD	DD	DD	DD	Y	N	Reasons For Variance
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
New		**New Task description**	M	T	W	TH	F	S	Y	N	Reason for Emergence
1											
2											
3											
4											
5											
6											
7											

Figure 4: Weekly Performance Evaluation Form (Modified from Ballard et al. 2007)

CHAPTER IV

CASE STUDY -1- ACHRAFIEH, LEBANON

A. Project Description

The first case study is a residential project located in Achrafieh, Beirut, Lebanon. The project consists of three residential towers, each tower has two blocks, each with a core having three elevators and a service elevator. Landscaping, commercial shops, and activity areas surround the towers. This case study will focus on the south tower only, having two blocks C and D with two apartments in each block. There are 27 floors in this tower and two below-grade floors containing storage rooms and parking spaces. The overall site area of the project is 12,000 m^2 and each tower has a floor area of 1,000 $m^{2.}$

The Directorate General of Urban Planning permit was given on October 2010; the excavation permit was given on March 2011, and the project started on October 2011. The project was expected to finish on October 2014 but the first claim for time extension was approved by the consultants and the revised completion date was January 2015. The second and third claims requesting time extension are currently being studied by the consultants and they cover the construction events that occurred till July 2014.

B. Case Study Selection

The project was chosen for many reasons, one of them is that it is being executed by a leading mid-size contractor in Lebanon. The contracting company has nearly half a century of experience in the construction services for the public and private sectors. It has 150 engineers and 350 staff excluding labors on projects; and has an annual turnover of 100 million dollars. The company has delivered more than 100 projects in Lebanon of various types like residential, commercial & institutional buildings, road works, bridges, energy, communication & port facilities, offices, warehouse and parking projects, hotels and touristic, and mixed-use projects. It has now 10 projects in progress.

This project was specifically chosen because of its large scale since not all small scale projects have a predetermined planning system in Lebanon. There is a planner on this project who updates the baseline schedule and uses primavera P6 for scheduling, which is important for this study. The project was chosen because it is in the finishing phase, this phase requires more planning efforts compared to the structural phase where a smaller number of teams are involved in work execution. There are 20 engineers and employees and 350 daily labors on the project under study, excluding the subcontractors' labors. Out of the 350 labors, 55 labors are on the south tower. For the tower considered, and in the time span of the study, there were 17 subcontractors working simultaneously, this facilitates the study of the planning system and helps highlight the planning behaviors.

C. Project Delivery System and Contract Type

The project has a contract value of 68,122,940 dollars. It is a lump sum contract and the project delivery system is Design Bid Build where the design company is different from the contractor. The owner is responsible to pay for variation orders that he/she requests. Liquidated damages are to be paid by the contractor for each day of delay according to the consented schedule or the revised schedule that is approved by the consultants. Liquidated damages are considered to be 10% of the total contract value, to get the daily penalty, the total of $ 6,812,294 is divided over 180 days, which is a period of 6 months.

As for the contracts binding the subcontractors with the contractor, they are either re-measured or lump sum contracts based on the FIDIC (International Federation of Consulting Engineers) contract. In the re-measured contract the subcontractor is paid according to the work he performs and the material used. In the lump sum contract, the subcontractor is paid the total sum if he/she performs the work according to the agreement. But 10% of his money is retained and paid when the work is completed. Hence, if the subcontractor fails to meet the requirements, the main contractor has the right to keep 10% of the money. However, this is not being applied with all the subcontractors. The foremen claimed that some work is not performed as agreed specially with the production rate, but the responsible people are ignoring this due to nepotism and favoritism. Yet a plastering subcontractor was fired because of poor performance. Furthermore, some of his payments were retained because his work was incomplete.

D. Project Planning

The project planning is based on the baseline schedule prepared using Primavera P6 software. The planning engineer updates the baseline schedule on P6 every month according to the work progress. Every two weeks the planner visits the site to assess the work completed while estimating percentages of completion of the work in progress. This update is entered in an Excel sheet, and divided according to the following locations: kitchens, rooms, toilets, and balconies. Then, the update is sent to the assistant project manager (PM) responsible for the project, the latter checks the critical activities to make them ready. To meet the deadlines for the critical activities, the assistant PM changes the sequence of work. For example, when a subcontractor is delaying him, he starts to work on the rest of the activities and shields them from their delaying predecessor. However, this method is risky because many mistakes can happen when changing the work sequence, this will be discussed in the analysis of data. According to the assistant PM, the primavera schedule is unchangeable; it can only be changed if the owner representatives approve the changes. Therefore, any change in the work sequence is implemented on site without changing the schedule. What helps the assistant PM in changing the work sequence is the fact that some tasks' durations in the schedule are greater than their actual duration. This is done on purpose so that the contractor uses these buffers in case of delays.

The main concern of the planner and the project manager is the duration of the project. If the update affects the total project duration and shows that an extension of time is needed, a request for extension should be prepared and sent to the consultants with reasons for delays. But some planning actions like allocating resources are performed by the assistant PM who delegates tasks to engineers.

Hence, the main goal of the planner on this project is not to plan future work, rather to assess the progress of work while making sure that no extensions of time are needed. This is the first planning problem that one can notice from the very first day at the construction site and from the first interview with the project manager.

Moreover, after the interview with the planner, another issue appears, it is that the updated schedule does not match the actual construction work. The update contain only what the contractor wants the consultant to know about the construction progress, it is not the exact reality of work. So basing this study on the primavera schedule is not accurate, going to site and measuring the actual progress of work is the only option to get accurate information.

This project is following an old planning process. First a baseline is prepared, then the project is monitored by the consultant and contractor to meet the baseline and do the monthly update. Project planning is thus based on four main steps: organizing, planning, monitoring, and updating.

In the course of work, changes occur and are identified as either client modifications, consultant changes, “Force Majeure”, or construction delays. These delaying events are analyzed and the team assesses their impacts to include the event in the baseline program. The CPM is used to find the actual path and get the extension of time needed and money compensation. There are two cases, in one case the delay is due to the consultant so the owner is responsible for compensating, in the second case it is due to the contractor so the latter is responsible for compensation.

Lookahead planning is prepared every 15 days, it starts with an “update” combined with a filter of the baseline for the upcoming 2-weeks prepared by the planner. The latter sends this update to the assistant project manager, who studies the critical activities to make them ready, and in his turn, informs the site engineers about them so that they prioritize them.

E. Results

The case study spans over a period of nine weeks, data was collected for eight weeks because the sixth week of the study was a vacation for Fitr. The holy month of Ramadan started in the second week of the study till the sixth week, this affected the data collected and will be explained in the analysis. The weekly work plan was prepared by the researcher and the site engineer responsible for the south tower, with the help of two foremen that are responsible to follow up with the labors on site. The idea of weekly work planning was explained to the site engineer but the purpose of reliable promising and weekly planning was new and hardly understood by the team. The Last Planner mentality and the importance of anticipating tasks and measuring PPC were not significant to the team until the 7th week of the study, after which the team was more interested in preparing weekly work plans to get significant PPC results. The team was not used to reliable promising and to the exact definition of tasks, they are used to "shooting from the hip" numbers and quantities that are impossible to achieve. The weekly work plan was filled and the reasons for variance of tasks along with the reasons for emergence of 'new tasks' were recorded and summarized below. The causes were divided in three categories: causes from the realm of planning, construction, and uncertainties.

Table 1 is a summary of the evaluations performed over nine weeks on the case study in Lebanon for the tasks that were included in the WWP but that were not completed and their total is 142 tasks. The reason for the variance or non-completion of each task was noted. The causes with the highest number of tasks non-completed were "Improper estimation of time" and "Lack of Labors". The poor planning and allocation of resources causes shortage in labors, additionally in the period of Ramadan many labors take their vacation and no replacement is provided. This is highlighted by the increase in the shortage of labors in week 7 and 8 that coincide with the Fitr Holiday. Furthermore no one notes the labors' production rates and tasks durations to improve the estimation of time. As seen in the table, most of the tasks were not completed due to problems from the real of planning, the reasons were indicated by the researcher and engineer. Note that many reasons can cause the non-completion of a task, therefore the sum of the total for each reason does not show the total number of tasks.

Table 1: Reasons for Variance in Weekly Work Plans (142 tasks)

	Reasons for Variance	week 1	week 2	week 3	week 4	week 5	week 7	week 8	week 9	Total
Planning (203)	Lack of communication	5	0	0	0	0	0	0	0	5
	Improper estimation of time	8	7	4	1	2	0	1	0	26
	Reasons for Variance	week 1	week 2	week 3	week 4	week 5	week 7	week 8	week 9	Total
	Lack of Experience	8	0	0	0	0	0	0	0	8
	Lack of Coordination	5	0	1	0	0	0	0	1	7
	Improper sizing of tasks	8	5	0	0	1	0	0	0	14
	Improper sequencing of tasks	5	0	0	0	0	0	0	0	5
	Improper Definition of tasks	8	0	0	0	1	0	0	0	9
	Improper Deadlines (Missing information)	6	0	0	0	0	0	0	0	6
	Lack of Material /equipment	1	2	7	0	2	0	0	0	12
	Lack of Labors	0	4	7	5	11	0	17	20	78
	Lack of training	0	0	0	0	2	0	0	0	2
	Lack of Prioritizing Tasks	0	4	5	2	0	0	1	3	17
	New Project type or Complexity	0	0	0	0	2	0	0	0	2
	Absenteeism	0	0	0	0	1	0	1	0	4
	lack of funding	3	0	0	0	0	0	0	0	8
Construction (20)	Natural human Errors	0	0	1	0	0	0	0	0	1
	Lack of Supervision and Guidance	5	0	1	0	0	1	0	0	7
	Previous work not completed	0	4	0	0	3	0	4	0	11
	Construction Errors	0	0	1	0	0	0	0	0	1
Uncertainties (2)	Client changes	0	0	0	1	1	0	0	0	2

Table 2 below is a summary of the reasons for the emergence of 'new tasks' over nine weeks on the project of case study -1- and the total number of tasks was 75. 'New tasks' emerged mostly due to causes from the realm of planning and uncertainties. There is a poor communication between the project's teams and a poor anticipation system which causes the appearance of unexpected tasks like the arrival of drawings, changes in design, and other causes as shown in Table 2.

Table 2: Reasons for Emergence of 'New Tasks' in the WWP (75 tasks)

Reasons for Emergence	week 1	week 2	week 3	week 4	week 5	week 7	week 8	week 9	total
Lack of communication	2	0	0	1	0	0	0	0	3
Wrong estimation of time	0	0	0	1	0	0	0	0	1
Lack of Experience	0	0	1	0	0	0	0	0	1
Lack of Coordination	2	0	0	2	0	0	0	0	4
Improper sequencing of tasks	0	1	0	1	0	0	0	0	2
Clashes not Detected Earlier	0	0	1	1	5	0	0	0	7
Lack of Labors	0	0	4	1	0	0	0	0	5
Lack of Prioritizing tasks	0	6	4	3	1	0	0	0	14
Natural human Errors	2	0	0	0	0	0	0	0	2
Out of sequence work	0	0	1	0	0	0	0	0	1
Previous work completed unexpectedly	1	0	0	0	0	1	3	4	9
Construction Errors	2	0	1	0	0	0	0	0	3
Unexpected arrival of held information	0	0	0	4	0	2	7	1	14
added workers	0	0	0	0	0	2	0	2	4
material arrived	0	0	0	0	0	0	4	0	4
Getting clearance	0	0	0	0	0	0	0	1	1
Poor task anticipation	0	0	1	0	2	10	1	1	15

The Graph below summarizes the data retrieved from the first case study. The blue line is the PPC for every week on site. The average PPC for the nine weeks period is 51.7%. At week 3 the PPC was low (41.6%), the engineer over committed himself and was not able to complete the tasks on the weekly work plan. These tasks were partially completed and added again on the WWP of week 4, this explains the high result in PPC that was obtained in week 4 (62.5%). When other tasks were added on the WWP of week 5, the same happened again, these tasks were not completely made ready, constraints removal took another week and these tasks were completed in week 7 (No work was performed in Week 6 because it was a vacation week). Therefore PPC shows how reliable promising is applied on site, it teaches planner and engineer how to implement commitment planning. The red line is the total number of tasks which also had an effect on PPC. In week 4, with the lowest total number of tasks, the project scored the highest PPC. When commitment planning is properly implemented and there is no over commitment, PPC can increase. In this week, the engineer did not add all the tasks that he desire to achieve but only the tasks that were ready to be completed, this is why the PPC was high. The green line represent the number of 'new tasks' that emerged every week.

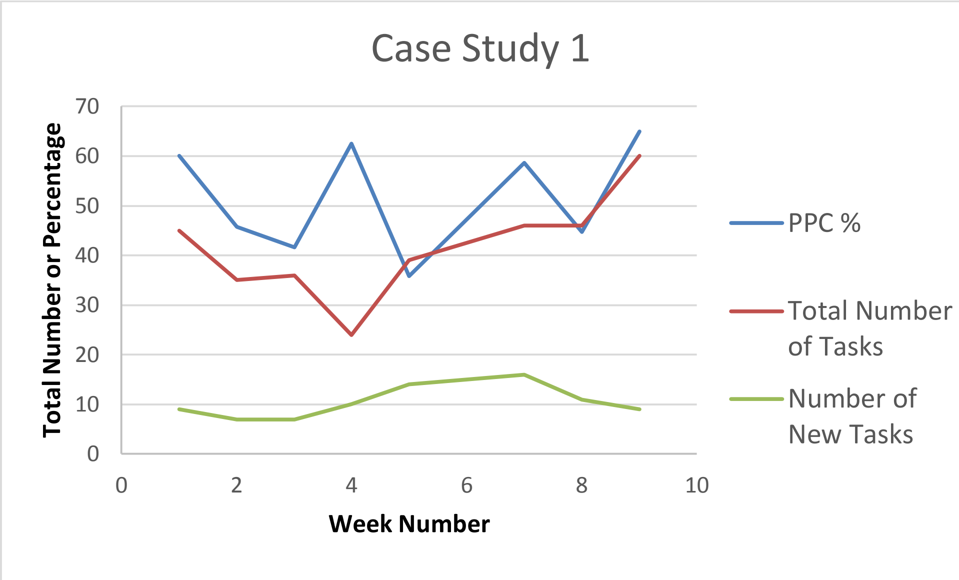

Figure 5: Graphical Summary of Case Study 1 Data

F. Data Analysis

1. Weekly Work Plans Variance

Many factors were identified to be reasons for the variance in weekly work plans, below are some examples about each case.

- Lack of Communication: For example, labors were working on putting the putty on the walls of floor 13; instead of continuing to floor 14, they worked on floor 18. This type of miscommunication between the foremen and the subcontractor's labors happens very often. The foreman has to specify what work he wants to be finished every week so that the labors stick to the sequence defined. Additionally, there were times when the subcontractor was not aware of all his responsibilities.

- Improper estimation of time: This factor has the second highest number of tasks that are not completed. The fact that the site engineer and foremen are not used to do weekly work planning caused many mistakes in the estimation of durations. They are often not aware of the production rates of the labors or they calculate it as if they have a continuous flow, which is not the case. Because even if the labors need three days to perform a task, the planner has to make sure that these tasks are unconstraint and that the work can be performed over three continuous days.

- Lack of Experience: This factor appeared in week 1 of the case study. It is also related to the anticipation of tasks, since the lack of experience in planning and in managing site works affects the work progress.

- Lack of Coordination: The lack of coordination between the downstream members and the upstream members was a reason for the non-completion of many tasks. For example the tiling subcontractor was not aware that he is responsible for tiling apartments C1002 and C0402, although these tasks were mentioned in the weekly work plan. Another event involved the mechanical subcontractor who noticed that there was a mistake in the electrical conduits but did not tell the electrical labors since it is not his responsibility. This lack of coordination is due to the project delivery system which encourages people to work individually seeking only their own benefit.

- Improper Sizing of Tasks: In the weekly work plan, some tasks were only partially completed because they were big compared to the capacity of labors. For example installing wood door frames for three whole floors is a big task (week2).

- Improper Sequencing of Tasks: The sequence of tasks that is used on site is different from the sequence that the planner and site engineer are following in their plans. For example in the plan, the aluminum sub frames should be installed before starting the plastering works. However, the sub frames were not ready to be installed on time, so the plastering works started and this was not changed in the baseline schedule. The problem that the construction company faced, was that after installing the sub frames a lot of mistakes in plastering were discovered and all the plastering of the walls containing windows and doors was reworked, because plastering should be done after installing sub frames not before. Such a variation in the work sequence causes major problems on site, especially when the site engineer who is taking decisions does not have enough experience.

- Improper Definition of Tasks: Tasks are not well defined because the site engineer is not totally aware of how the subcontractors are working and what parts they are starting to work on and how they are dividing their tasks.

- Improper Deadlines: When wrong deadlines are put the prediction of completion time and duration is wrong and the production rate calculation is estimated without having actual data from the site.

- Lack of Material/Equipment: Every task requires certain material and equipment. When these resources are not available, the task is postponed for later. For example the tile polishing subcontractor has only one machine for polishing, it is not enough to perform the work required. This lack in equipment affected the progress of work and its sequence. Closets have to be installed after tile polishing, but since the latter was delayed, some closets were installed without the tiles being polished under them. This caused rework since the consultant did not accept it. Another example is marble tiling which is a task that was postponed many times because of the shortage in marble tiles.

- Lack of Labors: This is the major problem found in the planning system of this case study, 78 tasks were not performed due to shortage in labors. The balance between load and capacity is not performed since there is a shortage in labors for almost all the period under study. Therefore, there is no continuous flow of work on site, there are locations where no work is being performed and the time gap between the team and the other is big. The resources are not leveled in a way that minimizes waste in the system and the subcontractors do not provide every day the same number of labors on site.

- Natural human Errors: This type of errors occurs on site when labors are not meticulous or are not well trained or supervised to do the job appropriately.

- Lack of supervision and guidance: When labors on site work according to the sequence that they find better, it means they are not well guided or supervised. Such events happened on site and led to a change in the sequence of work and priorities. It can be at the same time due to miscommunication between the foremen and labors.

- Lack of training: Some tasks were postponed to the upcoming week because of the lack of trained labors. For example for a certain apartment, a special type of tiles was chosen and not any labor can do its tiling. It needs a professional and meticulous worker, therefore the task was postponed.

- Lack of prioritizing tasks: This factor was included in the “construction” category, since the priorities and sequence in which work is performed on site is different from the baseline. Therefore the priorities are set by the site engineer or assistant project manager on site and are not well communicated to the labors and foremen, this causes variances in the weekly work plan. In week 2 workers were supposed to work on skirting but the priority was for tiling kitchens and toilets so they were shifted.

- Previous work not completed: There are tasks that cannot be done unless their predecessor is finished. For example surface preparation is a necessary predecessor for putting putty on walls. In other cases the sequence and relationship between the tasks can be changed.

- Uncertainties: Many factors cause uncertainties on site, like weather, political, social, and economic environment, and other changes. These factors affected the project under study, it was the first time the site engineer manages this type of projects with this complexity, and since it was the month of Ramadan, there was a lot of absenteeism. In addition, when labors take the permission to miss a working day, the plan is not checked and there are not always a replacement to keep the work flowing. Absenteeism is not well organized, also human resources are not provided as needed. Furthermore, some changes occur to the drawings because of the apartments with client modifications. Their drawings are not always ready and even if they are, sometimes the work stops before completion due to additional changes.
- Lack of funds: The problem of funding affected the project progress, many tasks on the WWP of week 1 were not performed because tiling labors protested for not receiving their salaries. This wasted time and delayed the tiling work which is a task on the critical path of the schedule.
-

2. 'New Tasks' in Weekly Work Plans:

- Lack of Communication: As an example, 'new tasks' were completed instead of other tasks on the WWP, because the door frames subcontractor was working in locations different from those mentioned in the weekly work plan. This kind of miscommunication changes the sequence of work on site. However in this case, the installation of door frames is not directly preceded by a task, this buffer shielded the predecessor from delays.

- Clashes not detected earlier: For example, mechanical ducts were supposed to be installed in the lift location in week 5, but the space left for them was less than 37cm, workers were unable to install them. This is a clash that created a 'new task' which is breaking the lintel to create a clear space of 37cm so that ducts could be installed. This new task caused delay in the work since the workers started working on it instead of performing the predetermined tasks for the week. Additionally, another clash was detected in the electrical shaft. When electrical subcontractor' labors arrived they found that an opening in the wall had to be left for the electrical network, this added a new task to the weekly work plan and caused a delay in the electrical work.

- Lack of prioritizing Tasks: What is observed on site is not only a change in priorities for tasks, but also it is sometimes a lack of labors that obliges managers to shift them to a 'new task' that has a higher priority. But these tasks with higher priority should be initially on the WWP, so the problem of properly selecting the tasks has to be solved.

- Out of sequence work: In Week 3 for example block work was completed in the electrical shaft area before receiving the MEP (Mechanical, Electrical, and Plumbing) plans. When the plans arrived, workers had to do an opening in the masonry wall for the ducts to enter.

- Previous work completed unexpectedly: When a task finishes earlier than expected, tasks on the workable backlog are performed. In this case there is no written workable backlog, but the subcontractor knows what to perform next, therefore 'new tasks' were completed.

- Construction/human error: In this case study, not all labors are skilled neither perfectionist, hence when consultants inspect the work completed, many errors appear.

These errors cause rework and wastes the time of labors who were supposed to shift to the WWP tasks, unfortunately they have to do new corrective actions first.

- Unexpected arrival of held information: the lack of follow up with the design status or maybe the lack of coordination between the planner who follows up with the design status and the site engineer who is guiding the foremen, is a key factor in the emergence of ‘new tasks’ that are due to plans that arrive suddenly. If the site engineer had known that the drawings are about to finish, he would have included these tasks in the WWP, however they were performed as ‘new tasks’. And in a project where there is a fixed number of labors, when ‘new tasks’ are completed, it means other tasks on the WWP were not completed.

- Addition of workers: After the holiday of week 6, labors were added on site. This step caused the emergence of ‘new tasks’ since the addition of labors was unexpected. This step had a positive impact because the newly added tasks were ready to be performed but the only problem was that no labors were available to perform them, adding labors made it possible for all the tasks to be completed.

- Material arrival: The case of material arriving on site without preparing the WWP accordingly is similar to the case of the design plans.

- Getting clearance: ‘New tasks’ can emerge when a certain clearance for a task is given and workers can start to work on it. This happened when the work was stopped in the apartments with client modification and then workers were allowed to start working in it again after the tasks were made ready.

- Poor task anticipation: Since the exercise of weekly work planning is new for this project, it was not easy for the site engineer and foremen to remember all the tasks that they are supervising. When the leader has not a clear view of the construction work in progress, he/she cannot have full control over the project.

The following table is an example from the case study presented using the ABC model that was introduced in chapter III.

Table 3: ABC for ‘New Tasks’ Example from Case Study 1

A	B	C
Mechanical **drawings were not ready** so lintels were poured. A **clash was detected** later between the mechanical duct and lintel	**Making ready** for duct installation by breaking the lintels so that the duct can fit	Breaking the lintels was performed in the same week so the **New Task was completed. But it affected the work negatively** since the same labors were supposed to perform other tasks on the WWP that had to be postponed.

CHAPTER V

CASE STUDY -2- SHIBAURA, MINATO-KU, TOKYO, JAPAN

A. Project Description

This case study consists of a residential project located in Shibaura, Tokyo, Japan. The project consists of a residential tower built on a site area of 10,590.01 m^2 with a floor area of 4,259.84 m^2. The building is made of reinforced concrete and it is seismic isolated. There are 34 floors and a penthouse, and 883 doors with apartments ranging from 60 to 120 m^2 with shops and a childcare center. The building surrounds its tower parking that fits 360 cars.

The project started in July 2013 and is expected to finish in January 2016. It has currently no delays and the delivery time has never been extended.

B. Case Study Selection

The construction company that is executing this project is one of the biggest six construction companies in Japan. It was selected because of its valuable experience in the construction domain. The project was selected because it is a residential building project that has a scale close to the previous case study selected in Lebanon. There are 500 to 550 labors on this project daily, all of them are skilled and hold the Japanese nationality.

The company has delivered projects in Japan, Europe, the Middle East, Africa, china, Malaysia, Singapore, Indonesia, North America and other Asian countries. The projects types are residential, offices, medical and welfare, logistics, commercial, production and research, urban and community development, transportation and telecommunications, resources and energy, environment and waste, and disaster-prevention and conservation.

This project was chosen because of its large scale and its good planning and management system since no delays are required and no injuries are faced on site. Such projects can help in learning how to successfully complete projects. The project is in the finishing phase in some floors and in the structure phase in other floors, this shows how the work is flowing to minimize waste.

C. Project Delivery System and Contract Type

The project has a contract value of almost 300 million dollars. It is cost plus contract, the client needs to detail every cost and know everything about the pricing of the project. This is usually the case in the Japanese construction industry so that the owner pays the exact value for the variation orders that he/she makes. The delivery system is Design Build, the contractor is responsible for the design too. Liquidated damages form a very big penalty for the construction company, and it is a strict system that pushes contractors away from delays since the price is very high.

As for the relation between the contractor and subcontractor, it is based on trust and coordination. The contracts that relate them are strict but these parties solve their problems away from the legal terms and rely on gentlemanly negotiations. The subcontractor is responsible for providing a certain number of labors on site whatsoever, from fear of breaking this trust relationship between him/her and the contractor. This kind of approach is typical in the Japanese construction sector, because the culture is based on trust and team work for the benefit of the project. Therefore, every party is responsible for providing the labors material and all that is necessary to completing the job. This is why the contractor is not responsible for the absenteeism of any labor from the subcontractor's team. Every contractor and subcontractor has a stand by team of labors who interfere in case of emergencies or delays.

D. Project Planning

The planning software that is used for the master schedule on this project is an in-house built software specifically developed by the company, for weekly work planning excel is used. The project is divided into four areas of almost 1000 m^2 so that the same labors can switch locations while working on the same tasks. The cycle time for the structural work of each floor is 7 days. Finishing works start immediately after the 7^{th} day and have a cycle time of also 7 days. The master schedule is updated every week and all the data related to the production rate and manpower are reported also. These data are recorded by the site supervisor daily with the daily report including all the tasks that were performed on site and who performed them in a detailed way. The data and feedback are sent to the company's Product engineering section and planning division to be documented and used for later projects and for continuous improvement (or 'Kaizen' in Japanese). Any mistake or delay is immediately solved in the same week by adding labors from the stand-by group or working overtime, no delays are postponed to the week after so that the cycle time does not get affected. The work sequence is not changed, every day has a predetermined schedule. A daily meeting for the specialist contractor's foremen and project manager's staff, is held at 3 Pm every day to review the progress and plan the next day's tasks. The workplace is standardized since labors perform the same tasks every week on different floors, which helps in the minimization of errors and uncertainties. For the 14 days of the cycle time of structural and finishing works, in every floor and every area, a team is working. For the day after, the same team works on the floor after. This predetermined schedule minimizes the occurrence of mistakes related to uncertainties, because all the floors are similar and the work is repeated for each floor by the same team of workers.

E. Results

For this case study, no official data were allowed to be taken due to the company's strict privacy rules, therefore the information needed were gathered verbally and noted down during the site visit. The amount of time spent on site was limited to half a day, according to the company's rules. This limited the amount of information and material that can be gathered, furthermore the language and cultural barriers affected the communication between site engineers and the researcher.

Despite these limitations, important information were collected. The weekly work plans are prepared by the supervisors on site, but since the work is based on a repetitive cycle, these plans do not change radically from week to another, but comments are added for the supervisor to remember some details about the work. This organized system results in a construction project that has zero delays. Behind this company's successful project there is an institute of technology with a department specialized in the research and development of planning. This continuous development of planning strategies improves the system and is highlighted by the results on this project. As for the causes of appearance of 'new tasks' on site for the period of three weeks prior to the visit, they were due to weather conditions since it was typhoon season. Two typhoon hit Tokyo in October, the first on October the 6^{th} 2014 and the second on October the 13^{th} 2014. These events added 'new tasks' to the weekly work plans but these tasks were expected and added before the beginning of the week, as soon as weather agencies forecasted the typhoon. However, to be able to accomplish them and prevent delays to occur on site, the team worked overtime and stand up labors worked and made ready all necessary resources required. Safety measures were taken to protect the material and equipment from falling or getting damaged by the typhoon. By taking these measures and working overtime, these 'new tasks' did not cause the project to be delayed.

The table below is an example of an incident that happened on this project, it is represented as an ABC model where the antecedent was expected therefore the tasks added were included in the weekly work plan.

Table 4: ABC for 'New Tasks' Example from Case Study 2

A	B	C
Weather condition **change**: Typhoon	**Contingency planning** has helped by the interference of stand by labors and by working overtime to keep the project on time.	The tasks related to the weather change were **expected and included in the weekly work plan**, which made no negative effect on the project progress.

CHAPTER VI

CASE STUDY -3- FUJIMI, SAITAMA, JAPAN

A. Project Description

The project is a shopping mall in Saitama, Japan, north of Tokyo. The project consists of a shopping mall containing 300 stores, the site area is 152,000 m^2 and the size of the floor area is 185,000 m^2, it has a width of 350 meters. The building is made of a steel structure of 5 floors where the roof is a parking. And independent parking building is also next to the shopping mall, but another contractor is responsible for building it. The total number of parking spots is 4,600. The project started in October, 2013 and is expected to finish in February, 2015. The progress rate is 55.1%, it should be 53.4% but three tasks are delayed.

B. Case study selection

The construction company that is executing this project is a well-known Japanese company. The project was selected because it is a big scale project that contains more complexities in the construction process. There are currently 1,200 employees working on this project with 50 engineers on site every day.

The company has delivered projects in countries other than Japan too, like Turkey, Mexico, Malaysia, Singapore, Indonesia, U.S.A., Canada, southern and Central America and other countries. The projects type are offices, medical and welfare, dams, airports, bridges, production and distribution facilities, educational and research facilities, water and sewer systems, tunnels and roads, and other public works. This project has a system that focuses on planning, scheduling, quality control, and safety. It is in the finishing phase, all the structural work is completed.

C. Project Delivery System and Contract Type

The project's contract value is almost 183,835,475 US Dollar without the parking building which has a cost of almost 20 million US dollar. The contract is cost plus and the client has the right to check the detailed bill of quantities, the delivery system is Design Build. The liquidated damages are too high which leads contractors away from causing any construction delay.

The contract type is based on trust because Japanese people have a sense of social responsibility, they focus on building long-term business relationship between each other. Lawyers are not part of the contract negotiations, and arbitration or litigation is rarely considered, since problems are solved through negotiation and gentlemanly agreements. The subcontractor and main contractor work together on a regular basis to complete the project successfully, and some subcontractors only work for one contractor, this builds trustful relationships.

D. Project Planning

The project was designed in a period of 6 months only and its construction period is of 16 months. The labors working on this project start their day by exercising for 15 minutes to warm up for work and avoid injuries. A safety briefing is also held every morning for the 1200 labors in the same location, the site is well organized and labors respect the rules, this attitude is embedded in the Japanese culture. The working days are from Monday to Saturday without holidays, and from 8:00 Am to 5:00 Pm, however they often work overtime, for one or two extra hours. When the typhoon hit Saitama, some employees and labors had to work overnight to protect the site material and make sure that no damages occur. The delay on this site is 1.7% from the total progress rate, which is caused from the delay of only three tasks two are related to gypsum board installation and the third is waterproofing. The total progress planned should have been 55.1% for the month of September, 2014, however the actual progress rate is 53.4%. The software used for planning is an in-house built software developed by the company, other Software used are: Autocad, ArchiCad, VectorWorks, and Excel. On the weekly lists of this project, almost all the tasks are done. There is also a daily list of tasks to be performed and the work completed is also noted along with other data related to the labors productivity, materials status (automated with bar codes) and safety risk assessment. The data are reported to the company's head office every two weeks.

F. Results

The site visit consisted of meeting the design, construction, and marketing supervisors and then checking the construction site which was in the finishing phase. Documents related to the planning progress were given, along with the details related to site meetings. The meetings held on site are as follows: General meeting (1/month), Overall Arrangement (1/Month), Design (3/month), Construction (3/month), Architecture (3/month), Equipment (3/month), Manufacturing (1/month), Supervising (1/month), Inspecting (1/week), Cinema (1 / 2weeks), Food Court (1/month). All these meetings help in collaboratively planning the construction work and building a strong social network between the employees.

However, few tasks do emerge on the weekly work plan due to uncertainties and external events. For example the typhoon that left the labors working overnight. Such a problem could have been solved differently by adding labors for example. The change in the weather condition affected the project progress as the example shows in

Table 5. The possible antecedents, behaviors, and consequences will be explained in chapter X.

Table 5: ABC Example for ‘New Tasks’ from Case Study 3

A	B	C
Weather condition **change**: Typhoon	Working overtime and overnight to protect the material	Project is slightly delayed

CHAPTER VII

CASE STUDY -4- CHOJAMACHI, YOKOHAMA, KANAGAWA, JAPAN

A. Project Description

The project is a building with residential apartments in the upper 5 floors and the 5 other floors are a bank in Kanagawa prefecture south of Tokyo. There is 1.5 meters that divides the building in the middle, and it contains utilities like pipes. The building is made of reinforced concrete and it is designed to be seismic resistant with its 40 meter piles. The excavated 7 meters are surrounded by concrete and soil mix walls to support the surrounding soil, the foundation work need one year to be completed, because the building is below sea level and very close to the sea.

There is an underground car parking which make the total number of floors is 12. The site area is 710.24 m^2, the building area is 505.28 m^2, and the total floor area is 5,304.56 m^2.

The project started in December, 2013 and was expected to finish in August, 2016. However, the soil excavated contained chemicals which caused a problem in finding a place to throw it. Therefore the project was delayed two months and a half to find a place for the soil and the new end date is November, 2016.

B. Case Study Selection

The construction company executing this project is a well-known Japanese company. The project was selected because it is a medium scale project relative to the others but it has complicated foundations, and the project's team has faced some challenges in construction planning. There are currently 12 labors on site because they are in the foundation phase, later the maximum number of employees will be 70.

The company has delivered projects in Japan and also in China, Mexico, Vietnam, and Indonesia, U.S.A., Australia and other countries. The projects types are in housing, business and life support like home centers, sports clubs, hotels, and resorts. The company's philosophy focuses on satisfying customers and having a sincere relationship with them. The company's team collaborates and coordinated with business partners to create appropriate mutual relationships.

C. Project Delivery System and Contract Type

The project's contract value is around 15 million US Dollars. The contract is cost plus which is the most common form of contracts in Japan. The delivery system is Design Build.

The contract type is similar to the previous case studies because it is inspired from the Japanese culture based on mutual trust and integrity. They don't focus only on following the law but conforming to the highest ethical standards and caring for the health and safety of the personnel. With this philosophy in mind, construction projects are better managed and litigations avoided.

D. Project Planning

The project started with a challenging problem, the soil excavated contained Phosphate and Fluor, which are chemicals that cannot be thrown in any random place. The team worked hard to solve this issue and it took them months to find a place to dispose these materials. Therefore the project end date had to be delayed. The construction company and owners communicated and collaborated to find a solution for this problem. The construction company was not blamed for this issue and did not have to pay any liquidated damages. However, the construction planning team adjusted the schedule by changing some work sequences, adding labors, and implementing new techniques to minimize the cycle time of some tasks. The work was successful and the cycle time of each floor was reduced from 15 days to 12 days. Therefore, the total project duration was only delayed by two months and a half.

The planning software used on this project is developed by the company and the schedule is updated every month. Every week the planning engineers breakdown the tasks and add ‘new tasks’ to the weekly work plan.

There are four supervisors who work on planning the construction work. Three of them work on site and the fourth one in the office. After the working hours, these engineers work two to three extra hours to report the data and progress of work which include the productivity of labors, material status, safety warnings and risk assessment. They meet every day at 6:00 Pm to plan the following day, a sample of the daily report is included in Appendix X. An assessment of the construction work is performed every two weeks, it included merging the daily report in one file and reviewing the data to improve the performance if needed. Every month, planners meet in the head office to update the master schedule if needed and perform collaborative planning.

The project has a zero accident rate and the site is organized according to the Japanese 5S methodology summarized by the following 5 words: Seiri or Sort, Seiton or Straighten, Seiso or Shine, Seiketsu or Standardize, and Shitsuke or Sustain. A big poster where these five words are written is mounted to the fence of the construction site, to remind labors how important it is to organize their workplace.

E. Results

The site visit to this project was brief since the project is in the foundation phase, few tasks are in progress. However, the site visit was followed by a visit to the site office located in a nearby building. The team was welcoming and explained about the project planning while showing us their schedule before and after the soil problem. The team showed a sample daily report and we were allowed to take it along with a general time-scale network showing the progress of work.

The communication was difficult since none of the project's engineers speaks English. However, the information given in the office meeting was very useful. For instance, one of the 'new tasks' that were added in October, 2014 is the drainage and pumping of water from the excavated area. This was caused by the heavy rains that were brought by the Typhoon. This task caused a delay of 5 days in the schedule. This delay was fixed by adding labors and working hours for the period of two weeks, hence currently the project is only 0.2% delayed, the planned progress should have been 21% in October, 29th, 2014, but it is currently 20.8%. The example in Table 6 shows the effect of the change in the weather and the 'new tasks' that emerged due to this antecedent. The ABC model was introduced in chapter III and will be developed in chapter X.

Table 6: ABC Example for 'New Tasks' from Case Study 4

A	B	C
Weather condition **change**: Typhoon	Work stopped to pump the water out because the project is in the building foundation phase	A **delay** of 5 days resulted and the project recovered from this delay by working overtime for 2 weeks

CHAPTER VIII

TYPOLOGY OF PLANNING BEHAVIORS

A. Families of planning behaviors

The planning behaviors were grouped into families that contribute to the successful completion of the project. These behaviors are commonly used on projects following the Last Planner System. However, the grouping was concluded from personal observation of on-site actions and research on the LPS and general planning approaches. The families are divided as follows:

1. Social networks and communication:

The importance of communication in projects was highlighted through different incidents on the case studies performed. This was validated in research on this subject, for instance, improving communication and coordination between the project's teams is an important construction planning role (Laufer et al. 1994). Open discussions and active participation result in decisions and inputs that are key factors in the successful development and monitoring of construction planning (Subbiah 2012; Laufer and Tucker 1988). A better project performance can be accomplished when the project's members are more knowledgeable about each other's needs and constraints (Chinowsky et al. 2008). The participation of the foremen, superintendents and other stakeholders in the planning process is a trait of LPS (Fauchier and Alves 2013). This multi-leveled collaborative planning results in better productivity of crews in the field (Wambeke *et al.* 2011b). Huddle meetings allow team members to share their views and discuss the work progress, as well as solving problems (Aziz and Hafez 2013). A study showed that the majority of workers found value in such meetings that provided feedback on the construction work (Salem *et al*. 2006). Another study underlines the importance of meetings as primary planning mode by interviewing construction members and conducting a workshop for senior executives of nine large construction companies and researchers from five universities. The findings of this study indicated that a major part of planning was completed during construction and through meetings (Cohenca *et al*. 1994). However, to be able to succeed in the information sharing and openness of individuals in the team, commitment and trust should be built between them. The quality and amount of information shared depends on the level of commitment of the individual to the project and also affects the person's reaction to other shared information (Phelps 2012). When individuals feel their belonging to the team, a strong commitment to the team's outcome, or shift in values, is observed as Phelps (2012) called it and developed it in the following cycle (figure 6).

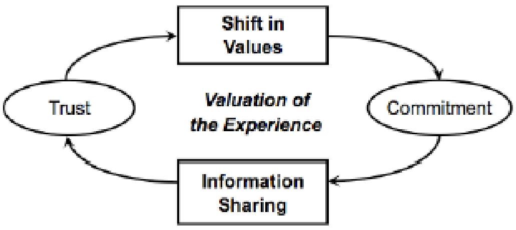

Figure 6: Trust and Commitment Cycle (Phelps 2012)

The following table includes the planning behaviors that belong to this family:

Table 7: Social Networks and Communication Planning Behaviors

Family	Behavior
Social networks and communication	Transparency/ open communication
	Trust/ reliable promising
	Collaboration
	Huddle meetings: daily huddle, subcontractors and internal organization meetings.
	Identifying customer's view on value

2. Construction as a production system:

Lean construction implementation focuses on treating construction as a production system based on flow, transformation and value (Koskela 2000). The transformation is about managing tasks to deliver them as expected (Fauchier et al. 2013). The improvement of value adding activities and flow can reduce waste in the construction process (Koskela 1992 and 1993). Additionally other concepts were highlighted, for example in order to reduce waste in production, inventories of work in progress had to be reduced by applying Just in Time (JIT) production and small batches, kanban and pulling, that is, producing what is initiated by demand rather than what is forecasted (Koskela 1992). The quality of what is produced is also a key factor in production. For instance, the Japanese have evolved from only inspecting products to total quality control (TQC) in all the departments, from workers to management, covering all operations in the company (Shingo 1988). Quality has received wide attention in the Japanese construction companies, which was obvious in site visits of case studies 2, 3, and 4. Quality management provides considerable benefits and is driven by standardization of work processes, which was observed in case study 2; as well as establishing teams for finding solutions to problems, and the development of a measurement system to support and monitor process improvement (Koskela 1992; Shimizu 1979 and 1984). Furthermore, the recognition of uncertainties and the need to continuously adjust planning by measuring PPC and tracking the reasons for non-completion helps in avoiding the reoccurrence of problems in construction. The definition of clear production goals is used by the Toyota Production System and seen in the plant visit in Nagoya, Japan, where the production target of that day was 228 cars for the first shift and the status of production at that time was 95% of production achievement. Applying this concept in construction, through weekly work, can help in the earlier completion of projects or reduction of delays. Setting the goals leads to better results and "what gets measured, gets done" (Dorgan 2013; Fauchier et al. 2013). Other behaviors mentioned in Table 8 were explained in Chapter II.

Table 8: Construction as a Production System Planning Behaviors

Family	Behavior
Constructi-on as a production system	Using small batches and one piece flow
	Total Quality Control
	Focus on project control
	Focus on construction methods
	Recognizing uncertainties and the need to continuously adjust planning
	Defining clear production goals
	Value stream mapping the process to eliminate non-value adding activities
	Identifying waste
	Promoting flow and predictable handoffs between workstations and trades
	Perform long term and short term planning
	Allocate buffers (contingency planning)
	Collaboratively agreeing production tasks for the next day or week
	Pulling: Use JIT or kanban system or bar coding materials to reduce inventories. Use flexible resources like multi-skilled labors, flexible information systems and equipment.
	Standardizing
	Operations design: Balancing load and capacity, performing first run studies.
	Quality criteria: definition, soundness, size, sequence, and learning
	Using concurrent engineering: executing various tasks by multidisciplinary teams.
	Setting correct milestones
	Break down the tasks
	Perform reverse phase scheduling
	Identify responsibilities
	Prepare weekly work assignments
	Prepare a workable backlog

3. Making Ready:

Making tasks ready is an important phase since for every task to be completed many constraints has to be removed, like the completion of prerequisites, and the allocation of resources. In the first case study performed, many tasks on the weekly work plan were not completed because of their constraints or prerequisites and therefore they were postponed to the week after. This phenomenon was common in the 9-week period on this project and some tasks on the critical path were postponed many times which caused project delays.

The making ready process starts with screening and analyzing constraints, and the lead time of the supplier responsible for the constraint should be confirmed. Then a request for delivery of the input needed for the readiness of the task is sent to the supplier (Ballard et al. 2007). The use of the pull system dictates which tasks to make ready first, by removing their constraints and ensuring the availability of their prerequisites (Hamzeh 2009). Additionally, expediting is performed to get selective attention from the supplier to remove constraints (Ballard et al. 2007). In his dissertation, Hamzeh (2009) states that the make-ready actions are assigned to team members and are done for tasks produced by the lookahead planning process; as for the newly added tasks to the weekly work plan, their make-ready process should be further investigated. Which is a subject that has to be further studied as a suite for this current study covering the reasons for having these ‘new tasks’. The reasons are mainly due to the deficiencies in the application of the planning behaviors explained in this chapter, an analysis is provided in the coming chapters.

Table 9: Making Ready Planning Behaviors

Family	Behavior
Making Ready	Screening
	Analyzing and removing constraints
	Confirming lead times
	Pulling
	Expediting
	Provide equipment
	Provide material
	Follow up with design status
	Provide a list of actions needed to make assignments ready when scheduled
	Arrange for prework (scaffolding) and shared resources
	Allocating resources
	Agile response to unexpected tasks

4. Safety Management and Risk Analysis:

The introduction of a safety and health plan to construction projects can generate activities that might hinder the work progress. Therefore, these safety activities should be included in the construction plan of the projects (Aziz and Hafez 2013). Daily feedback from crew and subcontractors on safety is provided so that safety practices can be included in the short term plan (Picchi 2001). Similar to what was observed in case studies 2, 3, and 4. Moreover, the use of the 5S principles to organize the workplace can help in avoiding injuries (Sort items by what is needed and what is not, Straighten by organizing and labeling everything; Shine: clean the workplace and the items, Standardize the procedures of cleaning, straightening, and sorting, and Sustain by maintaining a stabilized workplace).

The integration of risk management in the construction industry is a basic step in planning to avoid failures (Wehbe and Hamzeh 2013). For instance, improper planning and methodology are major causes of project failures where 78% of projects in the MENA region are delayed due to poor planning (Skaik, 2010). There are multiple risk management tools that represent effective means to avoid planning failures if implemented correctly (Wehbe and Hamzeh 2013). By integrating safety risk analysis in production planning and control in the various construction planning levels, many of the risks and hazards related to construction work can be eliminated including the emergence of dangerous misses, accidents, and injuries on the construction site (Aslesen et al. 2013).

Table 10: Safety management and Risk Analysis Planning Behaviors

Family	Behavior
Safety management and risk analysis	Provide a list of safety warnings for each action to be performed
	Plan conditions and work environment: safety and health plan for activities
	Safety meetings and briefings for labors
	Task hazard analysis
	Use 5S principles to organize the workplace

5. Learning, understanding, and continuously improving:

The philosophy of continuous improvement, understanding, and learning was developed by the Toyota production system that is succeeding because of the people who are working, communicating, resolving issues, and growing together. When employees are fully involved, they can help in the growth of the company (Liker 2004). As noticed in the Japanese construction sites, when labors express their excitement to start their job in the morning by exercising all together; they show their commitment to working as a team. The Japanese construction and manufacturing systems following the Lean philosophy developed by Toyota have the purpose of continuous improvement (*Kaizen*) imbedded in their organization’s culture. Kaizen strategy has been called the single most important concept in Japanese management and the key to Japanese competitive success. It the sum of small improvement that makes a dramatic change in performance (Evans and Dean Jr 2003). To improve the system, one has to understand

and analyze the root causes of all issues in order to solve problems and come up with long term improvement actions (Dombrowski and Mielke 2014). Learning from past failures can help projects in recovering from delays and avoid future problems (Fauchier and Alves 2013). When the culture of continuous improvement is imbedded in a company, it can achieve improvements in quality, safety, and efficiency which can be reflected in the company's projects (CCI 2007). Training workers, bringing external experts, and hiring leaders who follow this philosophy can encourage employees to be involved in the improvement process (Aziz and Hafez 2013; Alarcon and Seguel 2002; Dombrowski and Mielke 2013).

Table 11: Learning, Understanding, and Continuously Improving Planning Behaviors

Family	Behavior
Leaning, understanding, and continuously improving	Setting standards
	Thinking systematically, discussing as a team, and deeply analyzing causes to solve complex issues
	Assessing work periodically
	Acting on reasons of plan failure
	Long term goals should not be abandoned for short term goals
	Training workers and bringing external
	Go to the Gemba check the problems and analyses all involved events
	Measuring performance (like PPC and productivity)
	Fast problem detection by minimizing buffers and stocks, using kanban, 5S, one piece flow, and visual management and inspection
	Fast problem solving: taking corrective actions and temporary counter measures to satisfy the customer immediately
	Making comparisons with pervious projects
	Leadership and coaching: Competent people should lead the team and supervise labors to avoid errors and problems.

CHAPTER IX

TRACKING PLANNING BEHAVIORS ON CASE STUDIES

A. Assessment

In order to track planning behaviors on the case studies, first I analyzed each behavior to divide them into families. Second I performed an assessment for each behavior in each family in both countries Lebanon and Japan. The behaviors were categorized based on incidents that occurred on site. The behaviors level of application on the projects studied was therefore indicated as:

- "Very Strong": when the incidents observed show strong commitment to the planning behavior tackled,
- "Strong": when the behavior is strong enough and the team is working to improve it,
- "Neutral": when the behavior is performed in a sufficient way but not as good as possible,
- "Weak": when the behavior is seldom applied, and has a weak implementation plan
- "Very Weak": when the behavior is not applied or has a very weak implementation plan
- In case the information given or the observations were not sufficient to fairly rate a behavior, "No Sufficient Information" (NSI) will be used.
- The case studies in Japan were grouped, due to their systems' similarities.

The following table summarizes the results:

Table 12: Planning Behaviors Level of Application in Studied Projects

Family	Behavior	Case study 1- Lebanon	Case Studies 2, 3 & 4 - Japan
Social networks and communication	Transparency/ open communication	Weak	Very Strong
	Trust/ reliable promising	Very Weak	Very Strong
	Collaboration	Neutral	Very Strong
	Huddle meetings: daily huddle, subcontractors and internal organization meetings	Neutral	Very Strong
	Identifying customer's view on value	NSI	NSI
Construction as a production system	Using small batches and one piece flow	NSI	NSI
	Total Quality Control	Very Weak	Very Strong
	Focus on project control	Very Weak	Very Strong
	Focus on construction methods	Neutral	NSI
	Recognizing uncertainties and the need to continuously adjust planning	Very Strong	NSI
	Defining clear production goals	Very Weak	Very Strong
	Value stream mapping the process to eliminate non-value adding activities	NSI	NSI
	Identifying waste	NSI	NSI
	Promoting flow and predictable handoffs between workstations and trades	Very Weak	Very Strong
	Perform long term and short term planning	Neutral	Strong
	Allocate buffers (contingency planning)	Very Strong	NSI
	Collaboratively agreeing production tasks for the next day or week	Weak	Very Strong
	Pulling: Use JIT or kanban system or bar coding materials to reduce inventories. Use flexible resources like multi-skilled labors, flexible information systems and equipment.	NSI	NSI
	Standardizing	NSI	Very Strong
	Operations design: Balancing load and capacity, performing first run studies.	Weak	Strong
	Quality criteria: definition, soundness, size, sequence, and learning	Very Weak	Very Strong

Construction as a production system	Using concurrent engineering: executing various tasks by multidisciplinary teams.	Strong	Strong
	Setting correct milestones	Strong	Strong
	Break down the tasks	Neutral	Strong
	Perform reverse phase scheduling	Very Weak	NSI
	Identify responsibilities	Weak	Very Strong
	Prepare weekly work assignments	Very Weak	Very Strong
	Prepare a workable backlog	NSI	NSI
Making Ready	Screening	NSI	NSI
	Analyzing and removing constraints	Weak	Very Strong
	Confirming lead times	NSI	NSI
	Pulling	NSI	NSI
	Expediting	Very Strong	NSI
	Provide equipment	Neutral	Very strong
	Provide material	Neutral	Very Strong
	Follow up with design status	Weak	Very Strong
	Provide a list of actions needed to make assignments ready when scheduled	Very Weak	NSI
	Arrange for prework (scaffolding) and shared resources	Strong	Very Strong
	Allocating resources	Weak	Very Strong
	Agile response to unexpected tasks	Very Strong	Very Strong
Safety management and risk analysis:	Provide a list of safety warnings for each action to be performed	Very Weak	Very Strong
	Plan conditions and work environment: safety and health plan for activities	Very Weak	Very Strong
	Safety meetings and briefings for labors	Very Weak	Very Strong
	Task hazard analysis	Very Weak	Very Strong
	Use 5S principles to organize the workplace	Very Weak	Very Strong

Learning, understanding, and continuously improving:	Setting standards	Neutral	Very Strong
	Thinking systematically, discussing as a team, and deeply analyzing causes to solve complex issues	Neutral	Very Strong
	Assessing work periodically	Strong	Very Strong
	Acting on reasons of plan failure	Weak	N/A
	Long term goals should not be abandoned for short term goals	Weak	Strong
	Training workers and bringing external experts	Very Weak	N/A
	Go to the Gemba check the problems and analyses all involved events	NSI	Strong
	Measuring performance (like PPC and productivity)	Neutral	Very Strong
	Fast problem detection by minimizing buffers and stocks, using kanban, 5S, one piece flow, and visual management and inspection	Weak	Strong
	Fast problem solving: taking corrective actions and temporary counter measures to satisfy the customer immediately	Very Strong	Very Strong
	Making comparisons with pervious projects	NSI	NSI
	Leadership and coaching: Competent people should lead the team and supervise labors to avoid errors and problems.	Neutral	Very Strong

B. Analysis

The table is not necessarily generalizable for the whole countries' industry but it shows the strength of the planning behaviors in the project studied. There is a great difference in the application of the planning behaviors between the projects. Below is the explanation of the table:

1. Social Networks and communication

The behaviors in this family are weak in case study -1- in Lebanon, but are very strong in the case studies in Japan. This is affected by the culture and environment, and the approach used in each project. In the Japanese projects visited, the supervisors affirmed the importance of commitment planning, they attribute the success of this approach to the culture of the Japanese society. On the other hand, the engineers and foremen in Lebanon blame the culture for the lack of reliable promises and commitment planning, which weakens the communication between project parties.

2. Construction as a production system

As noticed in general this family is weak in the Lebanese case study, however some behaviors in it are strongly applied like the recognition of uncertainties and the allocation of buffers. But the excessive adjustment of planning and over sizing of buffers can encourage people to deviate from the schedule and rely on buffers instead of meeting the deadline. Additionally, the schedule in case study 1 includes the important project milestones, the baseline is clear but the implementation plan is not strong enough. In the case studies of Japan the behaviors related to this family are strong because it is the Japanese who started with the practice of treating construction as a production system, therefore they are experienced in this.

3. Making Ready

In the Lebanese project the lack of reliable promising constitutes a big obstacle for making ready because the arrival of held information, equipment, or material depend also on the people providing them, not only on the engineer who is following up. Additionally lookahead planning is weak, lists of tasks anticipated and weekly work plans are not prepared to be able to properly perform constraints removal. On the other hand, expediting in the first case study is very strong as well as the agile response to unexpected events since the team is used to work under pressure and to deal with problems that occur unexpectedly. Unlike the case studies in Japan where making ready is strong and the relationship with suppliers providers is based on reliable promising.

4. Safety management and risk analysis

The fact that all labors are skilled in the Japanese projects visited reduces the risk of safety accidents on site particularly when using special equipment. In the case study in Lebanon labors are not all skilled and they come from different countries, they are not all educated about safety, and are not aware of the risks associated with the work they are performing. This is due to lack of safety inductions and warnings which are severe in the Japanese projects.

5. Learning, understanding, and continuously improving

Due to the unexpected events that occur in case study -1- people are used to fast problem solving this is why it is a very strong behavior. However the philosophy of continuous improvement and seeking long term goals is not imbedded in the Lebanese project unlike the projects visited in Japan, this depends on the culture of labors and engineers. This will be further explained in Chapter X.

CHAPTER X

ANALYZING THE EMERGENCE OF NEW TASKS

A. The Antecedent

The ABC model is employed to understand how ‘new tasks’ emerge in construction planning. The cases studies performed helped in identifying the types of antecedents causing the emergence of ‘new tasks’. ‘New tasks’ can come from in scope causes, or out of scope causes. However the out of scope group, which contains causes that are not included in the initial project scope, is beyond this study.

Therefore, the causes of ‘new tasks’ that appeared from in scope work are divided in three categories: within the realm of planning, within the realm of uncertainties, and within the realm of ongoing construction. For example, they can be tasks that are included in the plan but they appeared in a time frame different from the scheduled one. This can be due to planning problems like wrong tasks breakdown from the master schedule, predictability mistakes, lack of experience, or failing to properly implement the necessary planning actions. Other causes are from the construction site, for example when clashes are detected and a ‘new task’ is added to fix the clash. Some problems in the field can be solved properly if the responsible foreman or engineer has enough knowledge about the overall sequence of work, or knows the planning behaviors to fix such problems. However, other problems can be created if the engineer does not have enough experience to lead the project to success, and instead, causes more construction errors.

Some unanticipated events can be due to uncertainties, or events that resulted from changes in the project. For example client modifications, weather conditions, political issues. Client modifications can cause the appearance of ‘new tasks’ like changing all the door frames or breaking a certain partition to change the house's interior. Contractors as well as Architecture and Engineering firm in Lebanon rate the factor of changes by owners as a the most important cause of delays in construction (Mezher and Tawil 1998). However, some planning approaches include alternative operational plans for such events but the information related to the events cannot be totally expected before their appearance. For example, the planner can expect that some client modifications will be requested but he/she cannot know when nor what will these modifications be. Therefore the consequences of these causes depend on the planning behaviors of the team. Below is the table summarizing the causes of 'new tasks.'

Table 13: Causes of 'New Tasks'

Within the realm of Planning	**Within the realm of Ongoing Construction**	**Within the realm of Uncertainties**
Lack of coordination	Construction errors	Client changes
Lack of follow up with design/preparation of drawings	Lack of supervision and Guidance	Design changes
Lack of communication	Natural human errors	Weather and environmental changes
Improper estimation of time	Out of sequence work	Political factor
Lack of training	Late clash detection	Economic factor
Lack of prioritizing tasks	Previous work completed unexpectedly	Social factor
Lack of experience		
Lack of funding		
New project type or complexity		
Improper definition of tasks		
Improper making ready of tasks		
Improper sizing of tasks		
Improper sequencing of tasks		
Absenteeism		
Improper deadlines (missing information)		
Lack of material or labors		

B. The Behavior

The planning behaviors explained in chapter XII Tables 7, 8, 9, 10 and 11, represent the "Behavior" in the ABC model. The behavioral responses affect the performance of an organization (Love et al. 2002). Therefore improving people's behavior is an important factor for the construction planning success. The planning behaviors depend on four factors: the planning approach, the environment or culture, the contract type, the technology used and the personal, inter personal and intrapersonal summation.

1. The Planning Approach:

Different approaches to planning were identified: satisficing, optimizing, responsiveness, and contingency planning (Simon 1957; Ackoff 1970; Faniran et al. 1997). Satisficing planning is a term invented by Herbert A. Simon (1957), it is where the planner seeks to do "well enough" but not "as well as possible". In optimizing planning, the planner seeks to do "well enough" and "as well as possible", while minimizing resources required, maximizing performance, and obtaining the best balance of resources and performance (Ackoff 1970). In responsiveness and contingency planning, emphasis is placed on developing the capability to respond to different situations. In contingency planning, different plans are prepared for all anticipated events. In responsiveness planning, the plan is designed to detect deviations from the expected and to respond effectively.

The knowledge of the future can be divided in three types: certainty, uncertainty, and ignorance, the type of planning used for each on is respectively, commitment, contingency, and responsiveness planning (Ackoff 1970). Any anticipated event is certain, it is not considered an antecedent and a detailed plan to complete the tasks related to it is thus previously developed and a commitment planning approach is used.

However there are aspects of the future of which one cannot be totally certain but can know what are the possibilities, in this case contingency planning is used (Ackoff 1970). In contingency planning, several detailed alternative plans for anticipated project environments are prepared, and alternative construction methods are evaluated (Faniran et al. 1997).

On the other hand there are aspects of the future that one cannot anticipate, in this case responsiveness planning is used (Ackoff 1970). In responsiveness planning, the plan is designed to detect deviations from the expected and to respond effectively (Faniran et al. 1997).

2. The Environment or Culture:

Cultural dimensions are identified and cultural clusters are classified based on societal culture practices to come up with appropriate scores for each one (Javidan et al. 2006). For example, uncertainty avoidance and future orientation have a low score in the Middle East but high scores in Nordic and Germanic Europe (Javidan et al. 2006). Therefore, in the case studies performed in Lebanon and Japan, the culture factor highly affected the planning behaviors of people on site (Haley 1994, Javidan et al. 2006). For instance, Japan has a high score in societal collectivism, it is a culture based on cooperation rather than competition. On the other hand, Middle Easters like Lebanese are highly self-protective and have a low score in the participative and team oriented dimensions (Javidan et al. 2006). The desire to achieve high quality is within the Japanese society, for example if a worker sees a problem and has the necessary knowledge to solve it, he/she will take the responsibility for solving it (Haley 1994).

The change of culture is a long and challenging process that is faced by a resistance to change and technological barriers (Hamzeh 2011).

3. The Contract Type:

Part of the success of projects is the contract type that is used. In the Japanese contracts, parties have a social obligation, they care about keeping a good long term relationship between each other, and therefore arbitration and litigation are considered the last option in (Haley 1994). For example, relational contracts encourage reliable promising between parties without the fear of superiors. As said in Rousseau and Parks' words (1993, p. 9), ''Exchanges over time create relationships involving trust, predictability and often ongoing interactions. Frequent interactions introduce socio-emotional concerns including the need to maintain and stabilize relationships through information exchange and concern for the long-term well-being of other.'' On the other hand, transactional contracts, like the one used in the construction industry in Lebanon, are short-term and performance related. They are focused on compliance with a specific request and has difficulty addressing behaviors that are unanticipated (Chong et al. 2013). Contractors in Lebanon have rated the contractual relationship factor as the most important cause of delays in construction projects (Mezher and Tawil 1998).

4. The Technology

The technology used in the construction work affects the behavior of people on site because it can promote better communication and interaction between team members. An example of technology used in construction is Building Information Modeling (BIM). BIM could play a significant role in improving the construction processes to better serve the scope, quality, and financial requirements of the project.

One of the main benefits of BIM in the construction industry is its ability to generate shop drawings for various complex components in a reduced amount of time (Azhar et al. 2008). As well, one of the benefits provided by BIM on the construction industry is its impact on facility management; BIM integrates the data provided by the manufacturers and construction teams to allow the managers to daily plan the construction operation and better manage changes and their impact (InfoComm BIM Task Force 2009). Additionally, other technologies can be used like the bar coding system that was used in case study -3- and can facilitate material management on site. Therefore, the technology used can facilitate the application of planning behaviors that positively affect the construction progress.

5. The Personal, interpersonal and intrapersonal factor:

This factor is related to the personal summation of every person in the team. People's behaviors are affected by the way they are raised, their past experience, their personality, and their beliefs. Therefore, considering this factor in the work environment is necessary. For example, there are people who have been through situations that created in them the fear of trusting others, this affects their behavior in teams and can hinder the cooperation between team members. The interpersonal relationship between team members and the intrapersonal relationship between different teams is a major factor that affects communication and cooperation in projects.

C. Consequences

Consequences can be one of three options: No emergence of 'new tasks' (indicated by 0), The Emergence of 'new tasks' and then making them ready and executing them (indicated by N), or the emergence of 'new tasks' that could not be made ready in the same week nor executed and thus postponed (indicated by 1 – N).

In this study 0 are the result of successful coping with antecedents without the emergence of 'new tasks'. N results from the fast making ready of 'new tasks' that result from antecedents, using appropriate planning behavior. As for 1 –N, they result from the failure to withstand the effect of antecedents and thus the emergence of 'new tasks' that cannot be made-ready without impacting the progress of work negatively.

For a certain antecedent there can be various consequences depending on the planning behavior. For instance, the use of the contingency approach along with a very strong planning system able to cope with 'new tasks' or even avoid their emergence, can leave the project with no or minimal negative consequences. In this chapter, the positive planning behaviors described have been studied in previous papers to have positive consequences on construction projects. If such behaviors are positively enforced, and are not only applied out of fear or because workers have to do them, i.e. in a relational contract context, they can promote strong, durable, behavioral changes (Dorgan 2013). Furthermore, positive feedback by leaders can act as a positive consequence to increasing behavioral change. The environment helps in changing employees' behavior and their mentality to better implement construction planning actions. Constructive feedback encourages employees to set goals and implement techniques with a positive approach knowing all the positive consequences of their actions (Dorgan 2013).

Table 10 and Figure 7 represent a summary of the findings, the possible antecedents, behaviors, and consequences for 'new tasks' are shown. Consequences can come from different combinations of antecedents and behaviors that are affected by different factors. The ABC model for the emergence of New Tasks shown below

(Figure 7) represents a summary of the process in which the consequences can be the emergence of ‘New Tasks’.

Table 14: Possible ABC for ‘New Tasks’

A	B	C
Antecedents related to the realm of : -Planning, -Construction -Uncertainties Table 13	Planning behaviors related to the families of: -Social networks and communication (Table 7) -Making Ready (Table 8) -Construction as a production system (Table 9) -Safety management and risk analysis (Table 10) -Learning, understanding, and continuously improving (Table 11)	0 N 1-N

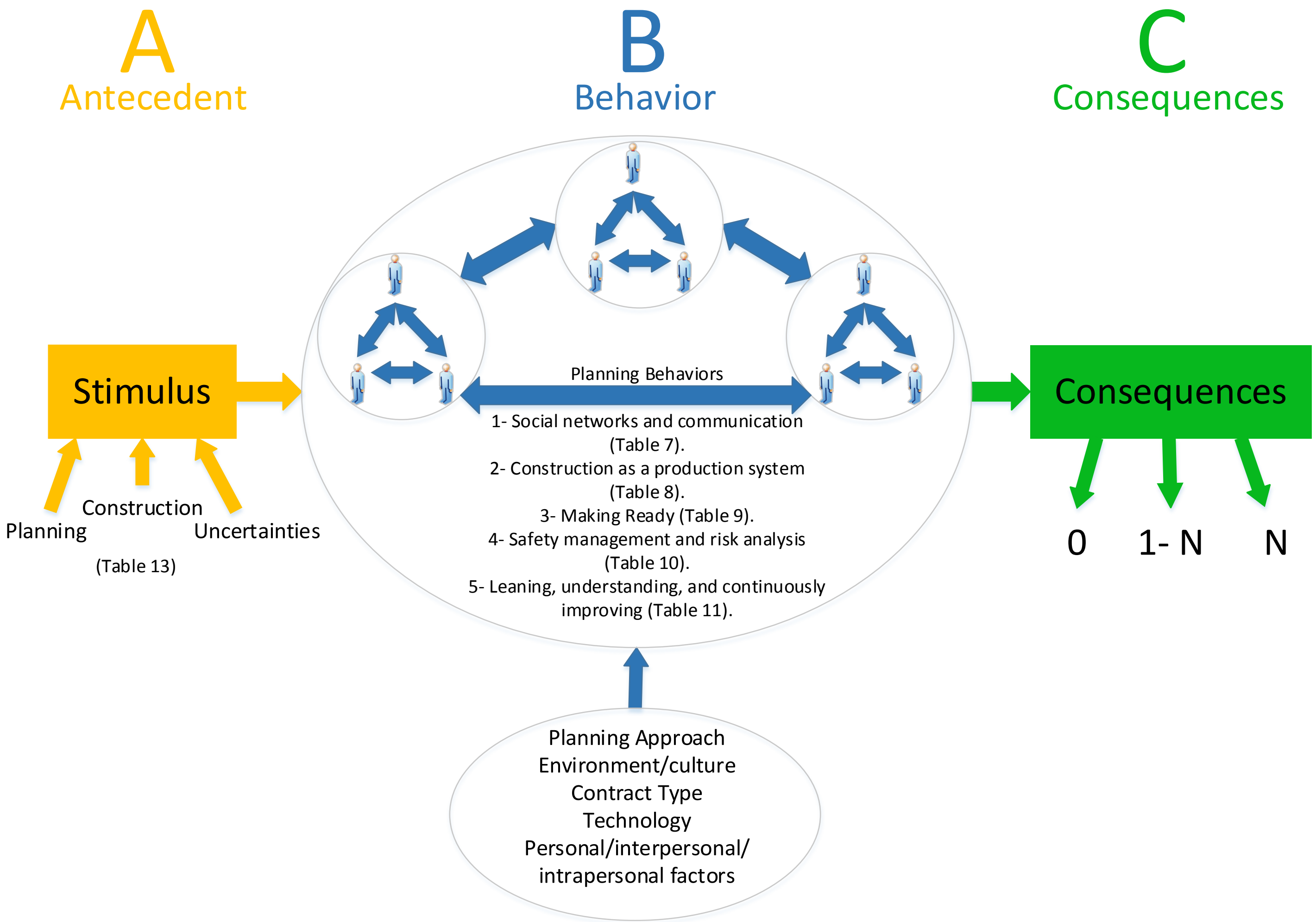

Figure 7: The ABC Model for New Tasks

CHAPTER XI

SUMMARY AND CONCLUSIONS

A. Summary

This study investigated, using case study research design, the emergence of ‘new tasks’ in construction planning, it analyzed their causes, the planning behaviors that they are facing, and their consequences. The research aimed at understanding ‘new tasks’ in the light of an ABC model that can explain the process of their emergence. To develop this model, case studies were performed in Lebanon and Japan. Four projects were visited and the causes for the emergence of ‘new tasks’ as well as the planning behaviors were observed and noted from each site. The results were grouped, the causes of ‘new tasks’ were divided in three: causes from the realm of planning, construction, and uncertainties. This answers the first research question which is “what are the reasons behind the emergence of ‘new tasks’?” As for the planning behaviors, they were divided in five families according to their purposes which are: social networks and communication, making ready, construction as a production system, safety management and risk analysis, and learning understanding and continuously improving. This answers the second research question which is “How can the causes of ‘new tasks’ be interpreted in terms of planning behaviors?”. By observing how in some projects in Japan the emergence of ‘new tasks’ did not affect the progress of work negatively, planners can understand that improving the planning system and behavioral responses help avoiding at times the emergence of ‘new tasks’ and in other times the negative effect of their emergence. This answers the third research question: “How can planners learn from problems that occur in the system?” The consequences of these antecedents (causes) and behaviors were found to be one of the following three: Neutral (0), ‘new tasks’ emergence and their completion in the same week (N), and ‘new tasks’ emergence without their completion in the same week and with negative consequences on the project progress.

B. Lessons learned

1. Case Study 1:

The first case study served to come up with the planning families and causes for the emergence of ‘new tasks’. From the first case study in Lebanon what can be concluded is that most of ‘new tasks’ emerged due to causes from the realm of planning and others due to uncertainties related to changes. Most of the planning behaviors were recognized as being either weak or very weak (Table 12). The contract type does not encourage coordination and trust, on the contrary it encourages time extension due to the common use of claims. The environment and culture surrounding the project of case study -1- affects the social network since it is not common to do reliable promising in Lebanon, and breaking promises is a normal thing, this weakens commitment planning and thus the whole planning process.

2. Case studies 2, 3, 4:

The case studies performed in Japan helped in understanding the philosophy behind the Japanese culture which is based on trust and respect. All the labors are Japanese and the subcontractor and engineers, this common culture makes it easier for people to communicate. Therefore commitment planning does not face difficulties, which minimizes the concern to contingency and responsiveness planning. Most of the planning behaviors in case studies 2, 3, and 4 are recognized as strong and very strong (Table 12), the process is standardized and construction is treated as a production system. The data recorded and the assessments that engineers prepare are major factors that help learning and understanding. In addition to the contract type which is a major factor in providing timely delivery of the project and avoiding litigation and claims.

C. Suggestions for Improvement

The causes for the emergence of 'new tasks' can be one of the three antecedents which are the planning behaviors, uncertainties, or ongoing construction work. When planning actions are not properly implemented to reveal all the events present in the scope before their appearance, an antecedent is created and the team will react to it. The team's planning behavior is affected by four factors: the planning approach, the environment or culture, the contract type, the technology used, and the personal, interpersonal and intrapersonal factors of each individual and teams. Additionally, the planning behaviors determine the consequences of antecedents on the project's progress which can be 0, N, or 1 - N. When work is planned everything is working with a certain preset order that was studied for the best outcome. The introduction of new tasks requires fast analysis and improvisation which is not covered in this study. Consequently following the planning behaviors described in chapter VIII is a key element in avoiding and coping with antecedents to avoid or minimize the impact of 'new tasks' in construction. In order to improve the planning behaviors one has to improve the factors affecting these behaviors, suggestions for improvement of each factors are explained below:

1. The planning approach:

- ‘New tasks’ from the realm of planning:

If ‘new tasks’ are emerging due to weaknesses in planning, the material might be ordered or the resources available but because of a breakdown problem other constraints are still not removed. Unanticipated events in planning will lead to the emergence of ‘new tasks’ but to avoid them, contingency planning can be used. In this approach, the response time to changes in project environment conditions is minimal because of the availability of contingency plans (Faniran et al. 1997). Therefore ‘new tasks’ will be dealt with using the proper planning behaviors and will be completed in the required time. Nonetheless if the planning system is very strong and the team fosters positive planning behaviors, antecedents will have minor effect on the project and fewer ‘new tasks’ will emerge.

- ‘New tasks’ due to uncertainties or ongoing construction problems:

If ‘new tasks’ are due to uncertainties or construction problems, their constraints are not all previously removed. This process of constraints removal which usually starts almost three weeks ahead of execution has to be accomplished in a minimal time to be able to execute the task, i.e. agile make ready. A lot of effort is put to provide the resources needed for the completion of the task, like ordering materials, providing the equipment, and the required skilled labors for the task. All these things have to be prepared at the execution week knowing that in the normal case they need weeks to be prepared. If not all the work was made ready, the planner is left with the choice of completing only what is ready and postponing the other tasks similar to the case of ‘1 – N’. Thus to cope well with ‘new tasks’, responsiveness planning should be used. In responsiveness planning only one general project plan is prepared and it does not include details of individual operations, yet it is designed to be flexible to minimize the response time to changes (Faniran et al. 1997). Therefore it is a strong agile approach that can withstand the emergence of 'new tasks' by performing fast responses and can lead to case N. Considering the two other planning approaches (optimizing and satisficing) is not recommended. The optimizing planning approach focuses on minimizing resources required and maximizing performance. Only one project environment is considered, and extensive data analysis is used to come up with the best plan. The system is strong enough to detect and correct anticipated errors (Faniran et al. 1997). Therefore, this approach is weak in responding to unanticipated 'new tasks'. The same for satisficing planning, which is the weakest approach, it emphasizes on producing project schedule and cost plan. Minimal time is invested in planning and it focuses on adjusting plans to actual performance instead of taking appropriate measures to correct performance variances (Faniran et al. 1997). In order to improve the efficiency and effectiveness of construction planning, planners need to move their approach from satisficing to contingency planning where quality time is invested in planning prior to work execution (Faniran et al. 1997). Using this approach improves the predictability and responsiveness of the system to anticipate tasks and make them ready for timely execution. The planning system has to be standardized and planners has to understand their role in anticipating and making tasks ready, this way the planning steps become imbedded in the system and through practice the planning purposes will be met.

2. The environment/culture:

The culture is the hardest factor to change because it is a long process that needs a lot of efforts. Cultural change is possible through good leadership where leaders trust in people and articulate the direction in which they want the company to go (Evans and Dean Jr 2003). When leaders behave according to a certain philosophy, they represent an example for employees and teach them continuous improvement approaches (Evans and Dean Jr 2003). By improving the culture of the company, learning and continuously improving becomes easier and communication between members and teams become stronger. But this is a long process, the way people think and execute things has to be changed (Hamzeh 2011). Therefore, leaders should be trained and taught how to apply the philosophy and pass it to team members. In this matter quality can be improved because labors will learn about the importance of long term thinking, they will not ignore mistakes at work and be more cooperative for a better project outcome rather than personal goals.

3. The contract type:

The contract type affects the team's behavior, it can encourage or discourage coordination and communication. By changing the contract type, communication and cooperation between teams and subcontractors can improve. The contract type affects how people interact if they share risk and rewards. For instance traditional Design Bid Build contracts foster adversarial relationships, as for new collaborative contracts, they foster people to share risk and reward so that

4. The technology:

Using technologies like Building Information Modeling and implementing the philosophy behind it, promotes communication and coordination between team members, it also helps in detecting clashes and errors. This will reduce delays related to clash detection and will help teams in cooperating and communicating changes faster than the traditional methods. BIM technology and processes are tools that have the potential to revolutionize the industry by altering the way teams perform (Eisenmann and Park 2012). Other technologies also can help managing resources like material bar coding.

5. Personal, interpersonal, and intrapersonal factors:

The personal factors are related to the person's own experience, personality, and way of thinking. The interpersonal factors depend on the relationship between team members of the same group, for example between engineers in the same department. As for the intrapersonal relationships, they connect people from different teams like mechanical engineers and civil engineers that belong to different departments. The three factors explained together impact the relationship between people and the communication and collaboration between them. Through training and proper education and guidance these factors can be improved and communication becomes stronger.

The above suggestions can change the philosophy of people if applied properly, starting by hiring leaders who follow the philosophy of commitment, dedication to work, continuous improvement, and training them to work as per the system while being autonomous. Furthermore the planning approach and the environment should be improved, and collaborative processes should be implemented with new contract types that foster sharing risk and rewards. The system, which is made of people, technologies, and processes, should be more robust in terms of better planning and removing constraints. Having a strong production planning, that is, lookahead and weekly work planning, can reduce the emergence of 'new tasks'. However, there is a limit for the extent of planning, and antecedents from this realm, mentioned in Table 13, might cause the emergence of 'new tasks'. Therefore the system should be prepared to have an agile response to make these ‘new tasks’ ready. Similarly, during construction, some events happen unexpectedly, and other uncertain events occur, which are antecedents from the realm of ongoing construction and uncertainties (refer to Table 13), this causes the emergence of ‘new tasks’ as seen in Graph 7. Hence, the planning system should be capable to cater for the emergence of ‘new tasks’ by training teams to effectively improvise and make ‘new tasks’ ready on time prior to execution. Further research is required on the subject of agile planning and improvisation.

APPENDIX A: SAMPLE FORM DEVELOPED

Project: Case study 1 Prepared by: Carel Rouhana Date Prepared: 23-Aug-14

PPC = 39/60 = 65% 9 new

	Responsible Party	Activity Description Defined - Sound - Proper Sequence - Right Size - Able to Learn	Period to Perform the Work						PPC Analysis		
			M	T	W	TH	F	S			
			18	19	20	21	22	23	Y	N	Reasons For Variance
1		Plastering F8 to F12 Part D Lift's lobby walls							x		
2		Plastering F20 to F26 Part D Lift's lobby walls							x		
3		Stiffeners part C2 saloon Balcony 24 to F26								x	Lack of carpenters - priority for lifts lobby c
4		Stiffeners part C2 saloon Balcony 20 to F23								x	Lack of carpenters - priority for lifts lobby c
5		Stiffeners part C2 saloon Balcony F16 to F19								x	Lack of carpenters - priority for lifts lobby c
6		Stiffeners part C2 saloon Balcony F12 tof 15							x		
7		Block Work Fire Hose Cabinet mock up part D F1							x		
8	sub	lintels lifts lobby C F3 to F6							x		
9		lintels lifts lobby C F7 to F10							x		
10		lintels lifts lobby C F24 25 26							x		
11		blockwork above lintel part- C -F21 to F26							x		
12		blockwork above lintel part- C -F17 to F20							x		
13		blockwork above lintel part- C -F13 to F16							x		
14		blockwork to lintel level part- D - F1 to F12							x		
15		Paint of FC kitchens F18(exc.C1)							x		
16		Paint of FC kitchens F19							x		
17		Paint of FC kitchens F20 part C							x		

Figure 8: Weekly Evaluation Form of Week 9 in Case Study 1

18		Painting on FC chil+masterToilets F18							x		
19		Painting on FCchil+master Toilets F19							x		
20		Painting on FCchil+master Toilets F20							x		
21		Paiting walls F1 salons living and rooms								x	Lack of manpower
22		Paiting walls F2 salons living and rooms								x	Lack of manpower
23		Paiting walls F3 salons living and rooms								x	Lack of manpower
24		Paiting walls F4 salons living and rooms								x	Lack of manpower
25		Paiting walls F5 salons living and rooms								x	Lack of manpower
26		Painting kitchen FC C0802 C0701 C1002 D1001 D0602							x		
27		Painting FC children+master toilets D0602 C1002								x	Lack of manpower
28		handicap toilet walls tiling F22							x		
29		handicap toilet walls tiling F23								x	Lack of manpower
30		Tiling finish guest toilet F16 to 20								x	Lack of manpower
31		tiling maid floor toilet F 19 20							x		
32		skirting terrazo F10							x		
33		skirting terrazo F11								x	Lack of manpower
34		skirting terrazo F12								x	Lack of manpower
35		skirting terrazo F13								x	Lack of manpower
36		Tiling loggia C0401 D0402							x		
37		Tiling loggia F13							x		
38		Tiling loggia F14							x		
39		Tiling loggia F15							x		
40		Tiling loggia F16							x		
41		Tiling loggia F17							x		
42		Tiling loggia F18							x		
43		Tiling loggia F19							x		
44		Tiling loggia F20							x		
45		Tiling loggia C1002 C0402								x	lack of coordination sub does not know

Figure 9: Weekly Evaluation Form of Week 9 in Case Study 1 (Cont'd)

46		skirting marble F10							x		
47		skirting marble F11								x	Lack of manpower
48		skirting marble F12								x	Lack of manpower
49		skirting marble F13								x	Lack of manpower
50		tiling maid walls F21							x		
51		tiling maid walls 22 excl (c2201)								x	Lack of manpower
52		tiling children walls F21							x		
53		tiling children walls 22 excl (c2201)								x	Lack of manpower
54		tiling master walls F21							x		
55		tiling master walls 22 excl (c2201)								x	Lack of manpower
56		tiling guest toilet floor D0102 C0401							x		
57		tiling guest toilet floor C0402 C0301							x		
58		tiling guest toilet floorC0701 D0602							x		
59		FC first Fix C0702							x		
60		tile finish guest toilet F14 to F16							x		
New		**New Task description**	M	T	W	TH	F	S	Y	N	Reason for Emergence
1		lintels lifts lobby C F11 to F12							x		predecessor finished
2		stiffeners (thickening) Part C in lifts lobby F1 to F3							x		predecessor lintels just fiished
3		stiffeners (thickening) Part C in lifts lobby F13 to 18							x		predecessor lintels just finished
4		Putty on FC joints f20 D01 D02							x		without handicap just got cleared
5		putty on walls F21							x		added manpower
6		putty on walls F22							x		added manpower
7		FC fist fix without toilets F21							x		plans just arrived
8		Putty FC children+master toilets D0602 C1002							x		forgot to mention
9		blockwork above lintels level part- D - F1 to F12							x		predecessor Finished

Figure 10: Weekly Evaluation Form of Week 9 in Case Study 1 (Cont'd)

APPENDIX B: FORMS AND DOCUMENTS

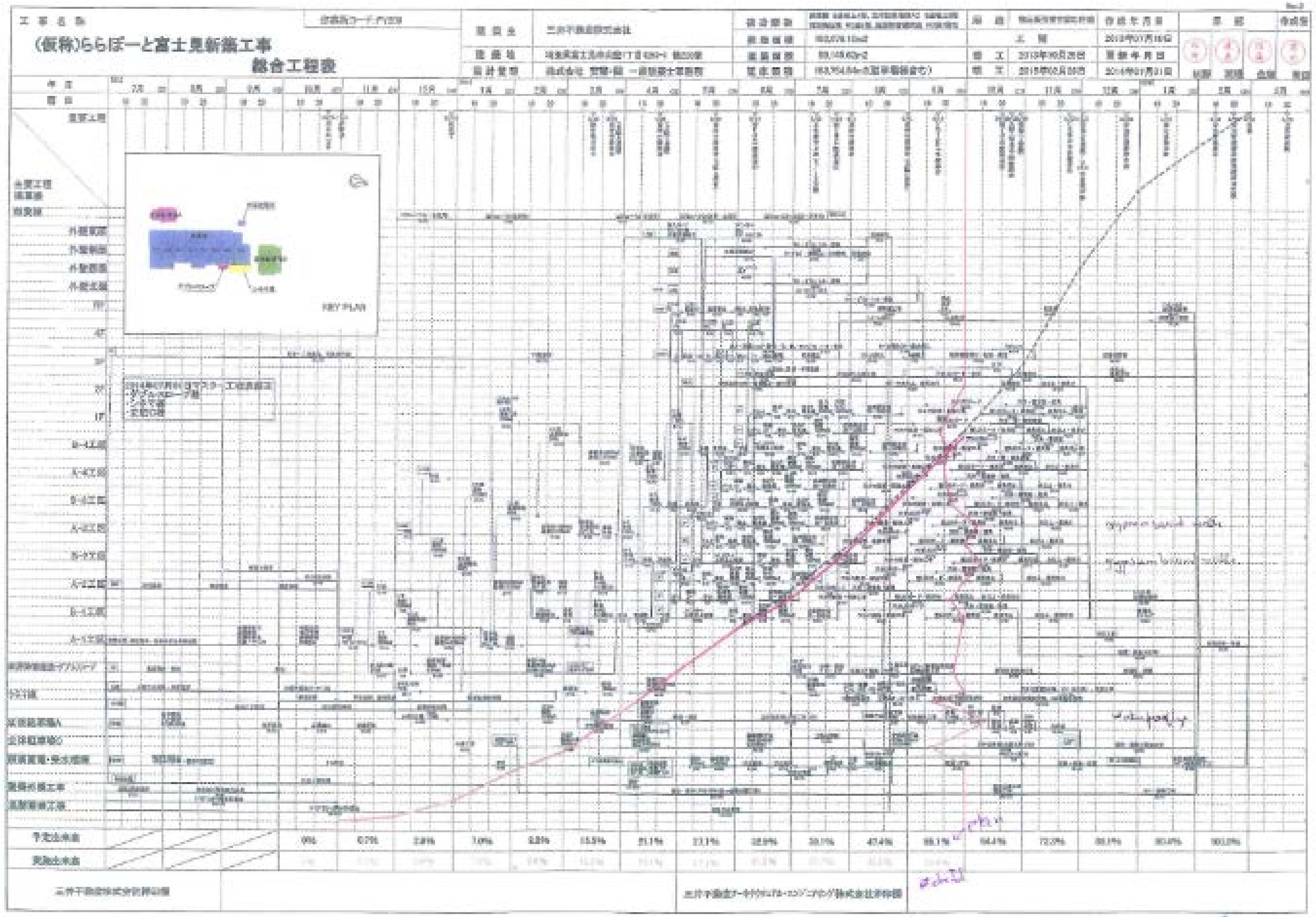

Figure 11: Case Study 3 Project S Curve

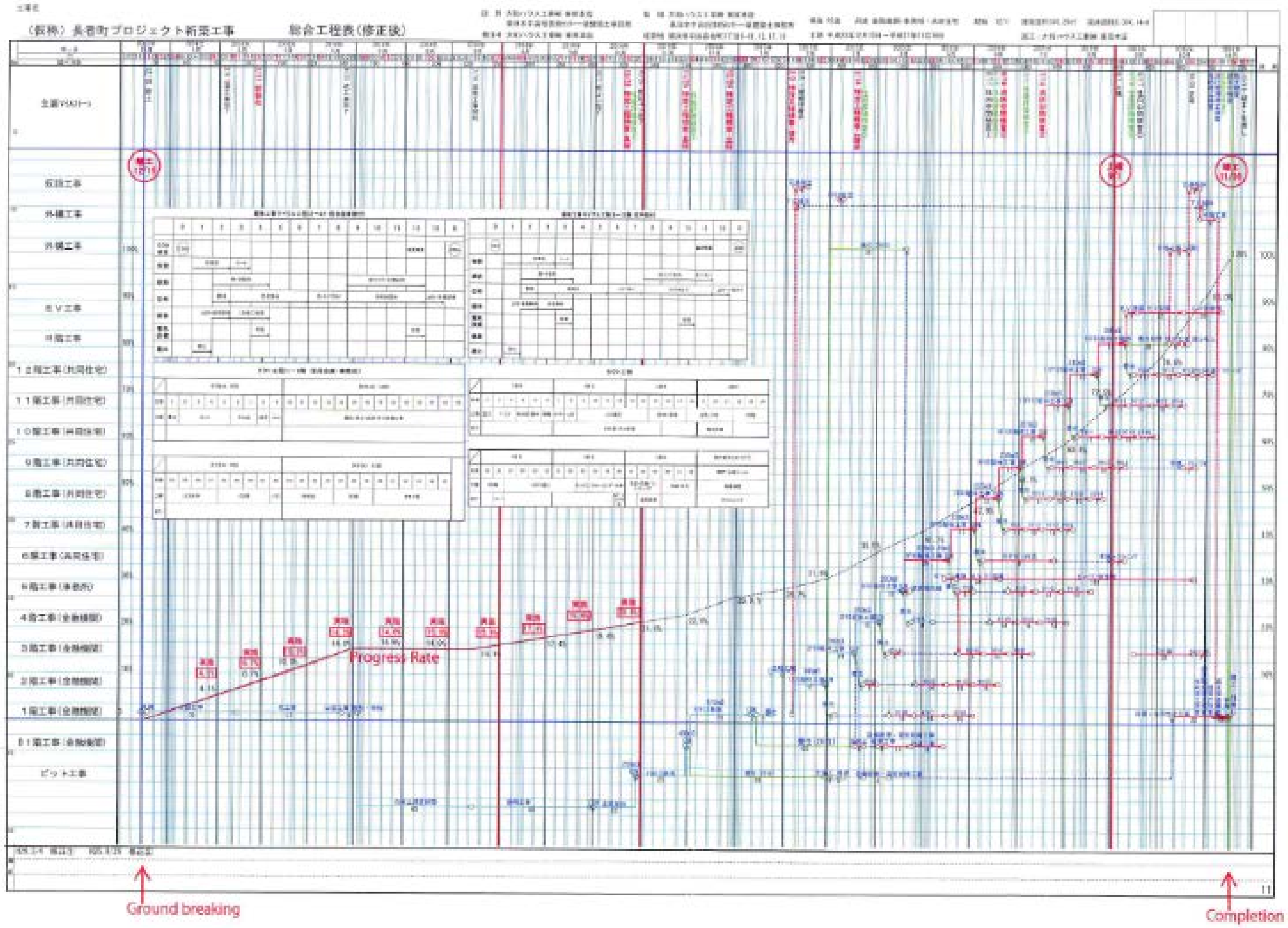

Figure 12: Case Study 4 Project S Curve

Figure 13: Case Study 4 Daily Planning Form

KY・安全作業指示書

(仮称)長者町プロジェクト

1. 作業内容・出面予定・重点安全事項

2. 使用建設工具・機械名

3. 元方事業者担当者安全指示・注意事項

・足場昇降は昇降階段を使用し、外部からよじ登らないこと。

・資材につまずき、転倒を防止のため、足元の確認を行うこと。

・作業指示内容に変更が生じた場合は、元請に必ず連絡し打ち合わせを実施する事。

連絡事項

4. リスクアセスメント危険予知(KY)活動報告

(対象作業名)

1. Every labor writes what was his planned work, what he did, and comments about safety

2. Materials and name of company

3. Comments to third parties or subcontractors + safety warnings

4. Risk assessment and warnings

Figure 14: Task Hazard Analysis and Risk Assessment Form from Case Study 4

APPENDIX C: CASE STUDY PHOTOGRAPHS

Figure 15: Case Study 2 Project Picture

Figure 16: Case Study 3 Project Picture

Figure 17: Case Study 3 Material Coding

Figure 18: Case study 3 Interview Picture

Figure 19: Case Study 4 Project (5S poster)

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