

An ABC Approach to Modeling the Emergence of 'New Tasks' in Weekly Construction Planning

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Abstract

Question: How can we understand the emergence of 'New' tasks in weekly work plans and what are the reasons for their emergence?

Purpose: The purpose of this paper is to present a method to observe the causes, planning behaviors, and consequences associated with the emergence of 'New' tasks in weekly work planning. This method was developed by examining four case studies in two different countries and using an Antecedent, Behavior, Consequences (ABC) approach.

Research Method: Case study analysis, on-site observations, and process modeling.

Findings: An ABC model is developed to explain the "emergence of 'New' Tasks phenomenon" and suggest improvements to the planning process.

Limitations: The developed ABC model needs to be tested on more projects.

Implications: By identifying the planning behaviors associated with the emergence of 'New' tasks, dividing behaviors into families, and tracking the possible consequences, last planners become more aware of the nature of these tasks. This can help last planners in employing a more responsive planning approach to address the emerging 'New' tasks through an agile constraint removal process to make tasks ready for timely execution.

Value for authors: This paper introduces the concept of 'New' tasks in weekly construction planning and develops an ABC model to describe the causes of their emergence.

Keywords: Construction planning, Planning behaviors, ABC model, weekly construction planning, 'New' tasks, Last Planner System[®].

Paper type: Full Paper

Introduction

Planning is understood as the determination of what has to be performed, how, in which sequence, when, what resources are needed, and their cost within the organization before execution (Laufer and Cohenca, 1990). Planning is expected to reduce uncertainties in a project and improve the efficiency of the processes while having a better understanding of project objectives. Planning lays the ground for project execution and control and is a key determinant for project success (Cooper & Kleinschmidt, 1995; Fortune & White, (Kerzner, 2008; Zwikael,

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Shimizu, & Globerson, 2005). Moreover, it is an effective decision making process to design and bring about desired future outcomes (Laufer and Tucker, 1987). The objectives of a planning system are to direct actions to the desired path before they start, regulate them while they are in progress, keep records of these actions, and use such records to forecast the future (Kerzner, 2008). Accordingly, sound planning enables a project to be completed as scheduled, within the set budget, and according to the project requirements (Dvir and Shenhar, 2007).

Traditional planning, however, focuses on developing detailed schedules, managing the critical path, and maximizing the productivity within each activity to optimize cost and time. (Howell et al., 2011). Optimizing the parts often results in suboptimal project outcomes, and focusing on critical tasks may undermine flow on construction projects. In contrast, the LPS[®] defers detailed planning until a closer time to the point of action, includes those responsible for designing the production system, plans how to do it, and aims at maximizing project performance. While traditional push methods supply materials to site as per the master schedule leading to an increase in the inventory, the LPS[®] aims at having predictable and rapid workflow through pulling short-cycle items and pushing long-lead items to assure that the inventory is ready when needed. Therefore, shifting to a new operating system based on the theory, principles, and practices of the Last Planner System[®] will reduce waste, enhance learning and innovation, and bring more value to clients (Howell, 2011).

The dynamic and interactive nature of construction projects makes them highly uncertain and, as a result, prone to unexpected events (Desai and Abdelhamid, 2012). Embracing these uncertainties and challenging them is important for enhancing workflow reliability through better communication (Abdelhamid et al., 2009). Uncertainties and variations often impact construction planning; what is executed on site may differ from what is planned. Some tasks, not included in the weekly schedule or are included in it but are allocated within the wrong time frame, have to be executed within a given week. These tasks appear at the week of their execution on site and are called 'New Tasks'. Although they might impact a project's progress, the reasons behind their emergence are not known. Exploring planning behaviors and the situations where 'new tasks' emerge can provide more understanding of the planning process and pave the way for improving the planning system.

This study aims at: (1) identifying the reasons behind the emergence of 'new tasks' in construction planning as observed on several case study projects, (2) describing the planning behaviors responsible for their emergence, and (3) developing a model that explains the emergence process. The model contains the range of causes, behaviors, and possible types of consequences without cause-effect implications.

The study is divided into four main parts: literature review about planning, research methodology, description and findings of case studies, and analysis of the results.

Literature Review

Project Planning

Project planning is important for determining project success as it provides detailed directions for the project team to execute works within a certain defined time and using allocated resources. It is crucial to properly execute a plan on site while making sure that all work is performed to the satisfaction of major stakeholders (Zwikael, 2009). The elements of a project plan include: overview, objectives, general approach, contractual aspects, schedule, resources, personnel, risk-management plan, and evaluation methods (Meredith and Mantel, 2006). Establishing a project plan involves defining the project objectives, identifying project

activities and precedence, estimating activity durations and project completion time, comparing project schedule objectives, and determining the required resources (Russell and Taylor, 2003).

Deficiencies in Construction Planning

One major deficiency in construction planning is solely abiding by the schedule while neglecting the involved methods and action planning (Laufer and Tucker, 1987). The lack of integration between the design and construction team, limited use of innovative materials, deficiencies in the procurement systems, general contracting market conditions, and unique features of each new building project are among the leading causes of failure of construction projects (Brown et al., 2001). Additionally, many mistakes happen during construction due to the nature of the work setting and of the work to be performed (Riemer, 1976). The success of construction planning is majorly affected by spending enough planning time before starting to work on site, 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., 1997).

On the other hand, project success depends on the integration of communication systems, control mechanisms, feedback capabilities, and planning efforts involved in project management (Chan et al., 2004). Project management actions are defined by the employed planning system that specifies the actions that should be taken, their time of execution, the planning methods adopted, and the organizational structure.

The Last Planner System[®] reveals the ability of the production system to perform as planned and opportunities for improvement based on the lean principles. In fact, when using this new operating system, companies can experience more success and reduced risks while increasing collaboration and communication (Howell, 2011). The choice of the system to be implemented on a project can control the project's success or failure. In this regard, the Last Planner System[®] (LPS) was developed based on the concepts of Lean Production as a production planning and control system. Lean Production was established by the Toyota Production System and presents principles and techniques to enhance the manufacturing process. These Lean Principles were then extended and tailored to other industries, namely construction (Ballard, 2000).

Weekly work planning

LPS[®] is a production planning and control system developed to reduce variations in construction work flow, develop foresight, and reduce uncertainties in construction operations (Hamzeh et al., 2015b). LPS[®] diverts planners away from after-the-fact detection of variances and helps them improve predictability as well as reliability in planning and workflow (Ballard, 2000). Production planning is the plan of production using resource allocation of activities, employees, materials, and capacity (Fargher and Smith, 1996). Production planning aims at removing constraints to render workflow more reliable and reduce unexpected events that lead to incidents (Ghosh, 2012). Predictability is the ability of properly defining which tasks can be completed on site. Plan reliability is measured by the Percent Plan Complete (PPC), which is the number of tasks completed over the number of tasks planned to be completed; it reflects how reliable a plan is (Koskela, 1999). LPS[®] is a planning cycle that includes: (1) the master schedule containing milestones of the entire project, (2) the phase schedule developed through collaborative planning and consisting of a more detailed schedule regarding project components, (3) the lookahead plan, and (4) the weekly work plan where reliable promising is made (Ballard, 2000).

This study focuses on the weekly work plan that drives the production process. Although the Last Planner System[®] is not applied in the cases studied, it was used by the author/researchers in the background. Reliable planning, at the weekly work planning level, is achieved by making only quality assignments and reliable promises. This reliability is measured by Percent Planned Complete (PPC) to identify reasons for plan failure and promote learning. When lookahead planning is not properly implemented, weekly work plans are not properly linked to the master or phase schedule. This results in a reactive system that loses its ability to develop foresight. The improvement of task anticipation is performed by properly breaking down activities into operations. Therefore, it is necessary, at the lookahead stage, to properly break down activities from the master schedule to anticipate and make ready all tasks that should be done (Ballard, 2000).

Previous research efforts have shown through simulation that 'new tasks' impact the project through tasks made ready (TMR), tasks anticipated (TA), and project duration (Hamzeh et al., 2015a, Hamzeh et al., 2015b). Results from a case study of an AEC (Architecture, Engineering, and Construction) company showed that, during the execution week, new tasks emerged that were not broken down or evaluated during the lookahead planning stage. The number of new tasks emerging was large, thus adding an extra burden on the planning efforts (Hamzeh and Aridi, 2013). However, not much is known about the emergence of new tasks. Moreover, the stimuli, behaviors, and consequences of their emergence are not clear. This study seeks to evaluate the emergence of 'new tasks' on real life projects and fill the gap regarding the theory behind it.

This paper explores the phenomenon of the emergence of "new tasks" in weekly work planning by studying multiple case study projects. The purpose of this research is to explore and understand the main causes behind the emergence of 'new tasks' during the week of execution on a construction project, analyze them, and identify the associated planning behaviors. By studying the planning behaviors or construction actions that lead to the emergence of new tasks, suggestions can be provided to improve actions that should be taken. Consequently, the whole planning process can be improved for a better project outcome. To explain this relationship, an Antecedents, Behaviors, and Consequences (ABC) model is developed.

This research bridges the missing gap of knowledge regarding the emergence of 'new tasks' by developing an ABC model to describe their emergence and the main causes, identifying the associated planning behaviors, dividing behaviors into families, and tracking the possible consequences.

Research Methodology

An ABC model describing the emergence of 'new tasks' is developed. The ABC model approach was originally 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 a Consequence (C). To examine an incident, the antecedent that triggered the behavior is examined, associated behaviors are investigated, and the corresponding consequences are studied. In order to understand the causes of what is happening in the planning system, define the actions taken and the outcomes, develop an empirical model, and closely observe the emergence of 'new tasks' phenomenon, the planning system was studied on four case study projects: one in Lebanon and three in Japan. Case study research is an appropriate method to investigate a situation where many variables of interest matter besides specified data points such as people's behavior or attitude (Yin, 2003). Additionally, case studies help investigate 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 occurrence. By directly observing the facts and by interviewing concerned specialists such as project managers, planners, site engineers, and foremen, the deficiencies in the planning system are better understood and described. Case study research is conducted to provide evidence for proposed models or frameworks, to compare results, and to validate patterns. The use of multiple case studies strengthens the research findings by the convergence of results and conclusions from different projects, as well as by employing various methods of data triangulation such as interviews, observations, daily records, project schedules, photos, etc.

Results of case study research are not necessarily generalizable for the whole industry where only specific behaviors are compared within a number of selected projects. Although the time period spent on the projects in Japan was shorter than the period spent in Lebanon, the information and records collected were sufficient to understand and interpret the planning behaviors. The model developed contains a range of causes, behaviors, and possible types of consequences, but without cause-effect implications.

The research method employed in this study includes: 1) conducting case study analysis on construction projects and comparing the results, 2) describing the emergence of new tasks in an ABC model, 3) reporting and analyzing the associated planning behaviors, and 4) suggesting improvements to the planning system.

Case Studies

Table 1 presents the location, type of project, delivery system, planning software used, baseline-schedule update frequency, progress-report frequency, number of time extensions, reasons for extension, and progress status for each of the four case studies.

To evaluate the weekly planning performance on case study 1, the weekly planned tasks were monitored against the completed tasks on a weekly basis by meeting individually with site engineers and crew foremen. PPC was calculated at the end of each week, reasons for variations were identified, and the emergence of 'new tasks' was tracked. Some of the 'new tasks' were added at the beginning of the week and others during the week of execution. In comparison to case study 1, cases 2, 3, and 4 involved studying 8 months of documents and records. These records included daily reports, task hazard planning reports, safety reports, daily schedules, weekly schedules, master schedules, etc. Moreover, the first author conducted semi-structured interviews with three practitioners on each site. The availability of documents that reflect the work progress was very advantageous and substituted for the need to personally collect data. The in-house software used in the last three case-studies applies the critical path method for scheduling. These projects employed time scale diagrams to track the project progress and plan future work.

As per the authors' observations on case-study 1, the main reasons for the emergence of 'New tasks' was routed in the lack of coordination within the contractor's team, between the contractor and subcontractors, and between the contractor and the engineer. For example, an early release of information such as approval of a high priority shop drawing by the engineer prompts the contractor to add new tasks to the weekly work plan and execute the released work during the current week. Figure 1 summarizes the weekly work planning data collected on case study 1. The solid line is the weekly PPC of construction tasks. The average PPC for the studied period is 51.7%. At week 3, the PPC becomes lower (41.6%) because one of the team's engineer over committed and was not able to complete the tasks on the weekly work plan. These tasks were partially completed and added again to the Weekly Work Plan (WWP) of week 4 which explains the high PPC for that week (62.5%). When other tasks were added to the WWP of week 5, the same issue was observed as these tasks were not completely made ready due to several

constraints. Removing these constraints required another week and these tasks were completed in week 7.

Results show poor performance on reliable planning (low PPC) and urges planners and engineers to implement commitment planning. The dashed line is the total number of tasks which shows an effect on PPC. For example, week 4 has the lowest total number of tasks and the highest PPC. When commitment planning and constraint analysis are properly implemented and there is no over commitment, PPC can increase. Results also show that a sizable number of 'new tasks' emerge every week which are presented by the dotted line in Figure 1.

Table 1: Description of case-study projects

Case Study	1	2	3	4
Location	Lebanon	Japan	Japan	Japan
Type of project	Residential	Residential	Shopping Mall	Mixed
Delivery system	Design-Bid-Build	Design-Build	Design-Build	Design-Build
Planning software used	Primavera 6	in-house*	in-house*	in-house*
Baseline updates frequency	Monthly	Weekly	Bi-weekly	Monthly
Frequency of progress reports	Bi-weekly	Daily, weekly, bi-weekly	Daily, weekly, bi-weekly	Daily, bi-weekly
Number of time extensions	3	0	0	1
Reason for extension	Contractor's delay and owner's changes	-	-	Soil conditions
Project progress	Behind the plan. The average PPC is 51.7%	Close to plan	Slight delay, the project actual overall progress is 53.4% (The planned progress was 55.1% at that time)	Slight delayed, the project actual overall progress is 20.8% (The planned progress was 21% at that time)

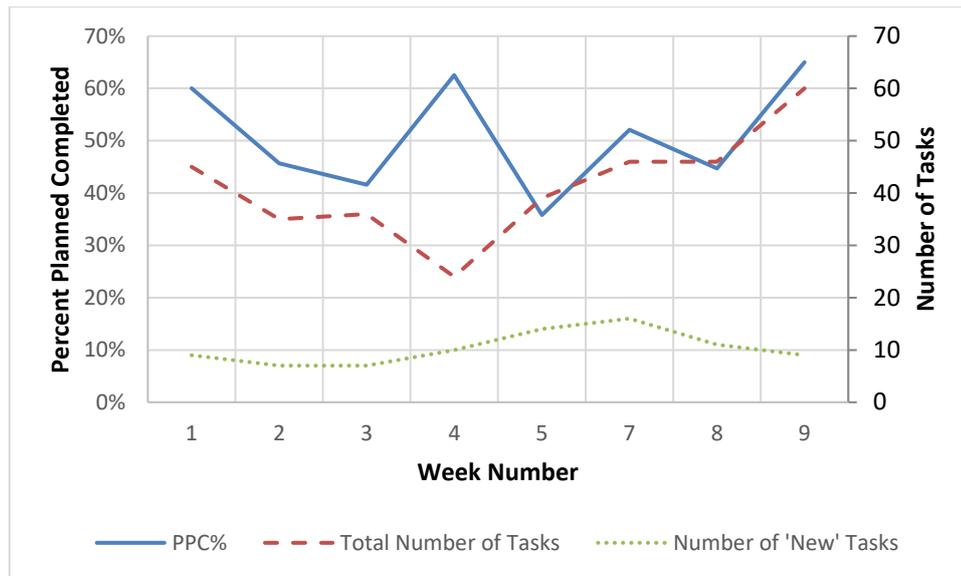


Figure 1: Weekly work planning data and number of 'new tasks' on case study 1

On case study 2, planning-related data collected on site and feedback from workers, foremen, and engineers are sent to the company's product engineering section and planning division to be documented and used on later projects. On site, the work sequence is rarely changed; every day has a predetermined schedule. The workplace is standardized as labors perform repetitive tasks every week on different floors which helps minimize errors. The reasons behind the appearance of 'new tasks' on site were mainly due to changes related to weather. However, to complete the 'new tasks' and delays, the team works overtime, and stand by units intervene to remove constraints (provide any prerequisites needed) and make all tasks ready for execution.

On case study 3, the project team closely follows the established daily schedule. The schedule shows the work completed along with other data such as labor productivity, materials' status (automated with bar codes), and safety risk assessments. However, some 'new tasks' still emerge on the weekly work plan due to the inherent uncertainties and external events. The most common resort to these tasks is labor overtime and over manning.

On case study 4, the project experienced some delays at the beginning due to the presence of contaminated soil. However, the builder compensated for the lost time without having to pay liquidated damages. The construction planning team adjusted the schedule by changing work sequences, adding labor, and implementing alternative production techniques to minimize floor cycle time. Every week the planning engineers break down the tasks, add those to the weekly work plan, and record the progress of work. 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*: Sort, *Seiton*: Straighten, *Seiso*: Shine, *Seiketsu*: Standardize, and *Shitsuke*: Sustain.

An ABC model describing the emergence of 'new tasks'

To answer the question "how do 'new tasks' emerge in construction planning?", an ABC model is developed to describe the antecedents, planning behaviors, and consequences involved in the process. Based on data from case study research, Figure 2 presents a summary of the: 1) possible causes or antecedents behind the generation of 'new tasks' in weekly work planning and certain planning behaviors; 2) different patterns of planning behaviors (for an individual and within a team) and the factors influencing those behaviors, and 3) the consequences resulting

from having certain antecedents, behaviors, and influencing factors. These consequences can in turn increase or decrease certain behaviors in the future based on how the planning team makes adjustments based on outcomes or feedback.

Case study research helped identify the types of antecedents causing the emergence of 'new tasks'. Although changes to the scope of work (e.g., change orders) contribute to the emergence of 'new tasks', this study focuses on 'new tasks' that are in scope but emerge at the weekly work plan outside their original chronological plan. Table 2 presents three types of causes or antecedents that are identified in this study: within the realm of planning, within the realm of ongoing construction, or within the realm of uncertainties. The sample space or the universe of the antecedent's pool is not necessarily exhaustive. The authors have developed all the causes from observations on case studies and from searching for other possible causes. These causes were divided into three categories: within the realm of planning, within the realm of ongoing construction, and within the realm of uncertainties.

Causes that belong to 'the realm of planning' relate to the performance of the planning team during the planning period that precedes on-site construction. These planning problems include: wrong tasks breakdown from the master schedule, errors in forecasting, lack of experience, or any failure to properly implement the necessary planning actions. Causes attributed to 'the realm of ongoing construction' relate to work-in-progress reasons that require the team to counteract certain challenges that appear during construction but were not planned for. For example, a certain clash that is detected late and not resolved prior to commencing construction (e.g., when using clash detection using Building Information Modeling (BIM)) requires that a 'new task' is added to the weekly work plan to address that clash. Also the development of a common understanding relies on the quality of the information, documentation, and the ability to relate and share cognitive elements. When explicit instructions and clear information are given to workers, they are less likely to execute wrong assignments. (Lahouti & Abdelhamid, 2012; Pasquire, 2012; Pasquire & Court, 2013). Hence, the correction of wrong assignments requires adding 'new tasks' to the weekly work plan. The third category includes causes that belong to 'the realm of uncertainties' such as unanticipated events that can occur on a project due to uncertainties or randomness. These uncertainties can impact any of the task prerequisites (previous task, material, labor, equipment, information, tools, and space) or the execution environment (weather, safety, litigation, access to site, etc.). For example weather conditions, or political issues can impact the progress of work and impose the addition of 'new tasks' to weekly work plans. Since information related to such events cannot be totally expected before they occur, alternative plans are needed to maintain the progress of the work.

The planning behaviors of a construction team member and the team as a whole in relation to a certain antecedent can lead to a wide range of consequences. Planning behaviors were identified from the case studies and from a literature search for any reported planning behaviors; behaviors of a similar nature were grouped into a separate family. The planning behaviors, though not necessarily exhaustive, are divided into five families as shown in Table 3: social networks and communication, construction as a production system, making ready, safety management and risk analysis, as well as learning, understanding, and continuously improving. Since the behavioral responses of team members affect the performance of an organization (Love et al., 2002), improving people's behavior is an important factor for successful construction planning. Training employees and creating the right working environment is an essential step in facing project uncertainties (Jayaraman et al., 2008) Furthermore, how workers feel, react to disruptions, improvise, and take decisions when faced with unexpected task disruptions may help or hinder efforts to improve workflow (Menches and Chin 2013). Not all workers react to disruptions in the same way (Menches et al., 2014). Workers often resolve the majority of obstacles they encounter while performing activities on site without outside help (Moore, 2013).

Results from the four case studies reveal that planning behaviors are influenced by several factors. These are divided into five categories: the planning approach, the environment or culture, the contract type, the technology used, and the personal, inter-personal and intra-personal summation. The influence of these factors will be discussed in a following section.

Table 2: Causes behind the emergence of 'new tasks'

Within the realm of Planning	Within the realm of Ongoing Construction	Within the realm of Uncertainties
Lack of coordination	Construction errors	Unavailability of prerequisites
Lack of follow up with design/preparation of drawings	Lack of supervision and Guidance	Weather and environmental factors
Lack of communication	Natural human errors	Political factors
Improper estimation of time	Out of sequence work	Economic factors
Lack of training	Late clash detection	Social factors
Lack of prioritizing tasks	Previous work completed unexpectedly	
Lack of experience	Lack of common understanding	
Lack of funding	Incomplete instructions	
Novelty of project and complexity	Imperfect information	
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 labor		

When studying the emergence of 'new tasks', one can notice that the combination of several causes and planning behaviors can lead to multiple consequences. These can be categorized into three types as shown in Figure 2: 1) No emergence of 'new tasks' (indicated by 0), 2) The Emergence of 'new tasks' and executing them on time (indicated by N), or 3) the emergence of 'new tasks' that could not be made ready in the same week, nor executed, and thus not executed or postponed (indicated by 1 - N). In this study, "0" represents a successful coping with antecedents without the emergence of 'new tasks'. "N" represents the number of 'new tasks' that are executed in a certain week as a result of a quick response from the team when making 'new tasks' ready, taking into account the antecedents and employing appropriate planning behavior. As for "1 -N" type of consequences, these result from the failure to cope with certain antecedents and when the emerging 'new tasks' cannot be made-ready on time. These consequences negatively impact the progress of work.

For each antecedent, there can be various consequences depending on the planning behavior involved. Employing a contingency approach, along with a robust and 'quick response' planning system to cope with 'new tasks', is the best tactic to avoid minimal negative consequences on the project. This accentuates the importance of enforcing and encouraging positive planning behaviors. If such behaviors are positively enforced and are not only applied out of fear, they can promote strong and durable cultural changes (Dorgan, 2013). Furthermore, positive feedback by leaders can be an encouraging consequence and may lead to a behavioral change. The environment helps in changing employees' behavior and their mentality to better implement proper planning actions.

Typology of Planning Behaviors

The authors have investigated different planning behaviors observed on the case study projects and reported in literature. Behaviors of a similar nature were aggregated into one group; for example, all "make ready" behaviors were grouped into one the "making ready" family. The same applies to the other families: social networks and communication; construction as a production system; Safety management and risk analysis; learning, understanding, and continuously improving. Those families are neither exhaustive nor mutually exclusive; they were selected and grouped for convenience. The following presents the division of families and the logic behind these divisions:

Social Networks and Communication

This family of planning behaviors addresses communication actions that shape the structure of social networks on construction projects. Improving communication and coordination among the project's teams is an important construction planning role (Laufer et al., 1994). Open discussions and active team 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). Huddle meetings allow team members to share their views, discuss work progress, and solve problems (Aziz and Hafez, 2013). The quality and extent of information shared depends on the level of commitment of an individual to the project and also affects the person's reaction to other shared information (Phelps, 2012).

Construction as a production system

This family includes planning behaviors that contribute towards making construction an efficient production system by creating a continuous workflow on site that adds value and minimizes wastes. Koskela (2000) challenged the construction industry to start treating construction as a production system based on flow, transformation, and value (Koskela, 2000). Transformation is about managing tasks to deliver them as expected (Fauchier et al., 2013). However, improving production to include more value-adding activities and better flow can reduce waste in the construction process (Koskela, 1992). The quality of what is produced is highly important in production. For instance, the Japanese understanding of quality has evolved from only inspecting products to total quality control (TQC) in all the departments, involving workers and management, while covering all operations in the company (Shingo, 1988). Thus, quality has received wide attention in Japanese construction companies which was obvious during site visits to case study projects 2, 3, and 4. Quality management provides considerable benefits and is driven by standardization of work processes (Koskela, 1992; Shimizu, 1979 and 1984). Moreover, setting clear production goals through weekly work plans can help produce better results as "what gets measured, gets done" (Dorgan, 2013; Fauchier et al., 2013).

Making Ready

The planning behaviors in this family are related to removing constraints in construction planning (making prerequisites and resources available on time) to make tasks ready for execution. Making ready starts with screening and analyzing constraints taking into account lead times from suppliers (Ballard et al., 2007). The use of a pull system indicates which tasks should be made ready first. Additionally, expediting is sometimes needed to get selective attention from the supplier to remove constraints. Make-ready actions are developed for tasks produced by the lookahead planning process and are later assigned to team members.

Safety Management and Risk Analysis

This family addresses planning actions or behaviors that contribute to safety and risk management on construction projects. Safety planning should be included as an important procedure when preparing the project schedule (Aziz and Hafez, 2013). The integration of risk management such as task hazard planning into construction planning is a basic step in avoiding failures and reducing accidents and injuries.

Learning, understanding and continuously improving

The planning behaviors in this family reinforce individual as well as organizational learning, understanding, and continuous improvement. When employees are fully involved in communicating, resolving issues, and evolving together, they can contribute to the growth of the company (Liker, 2004). As noticed on 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. When examining Japanese construction companies, it is evident that continuous improvement (Kaizen) is embedded in their organization's culture. To improve the system, the team 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). Training workers, bringing external experts, and hiring leaders who follow this philosophy can encourage employees to get involved in the improvement process (Aziz and Hafez 2013; Alarcon and Seguel, 2002; Dombrowski and Mielke, 2013).

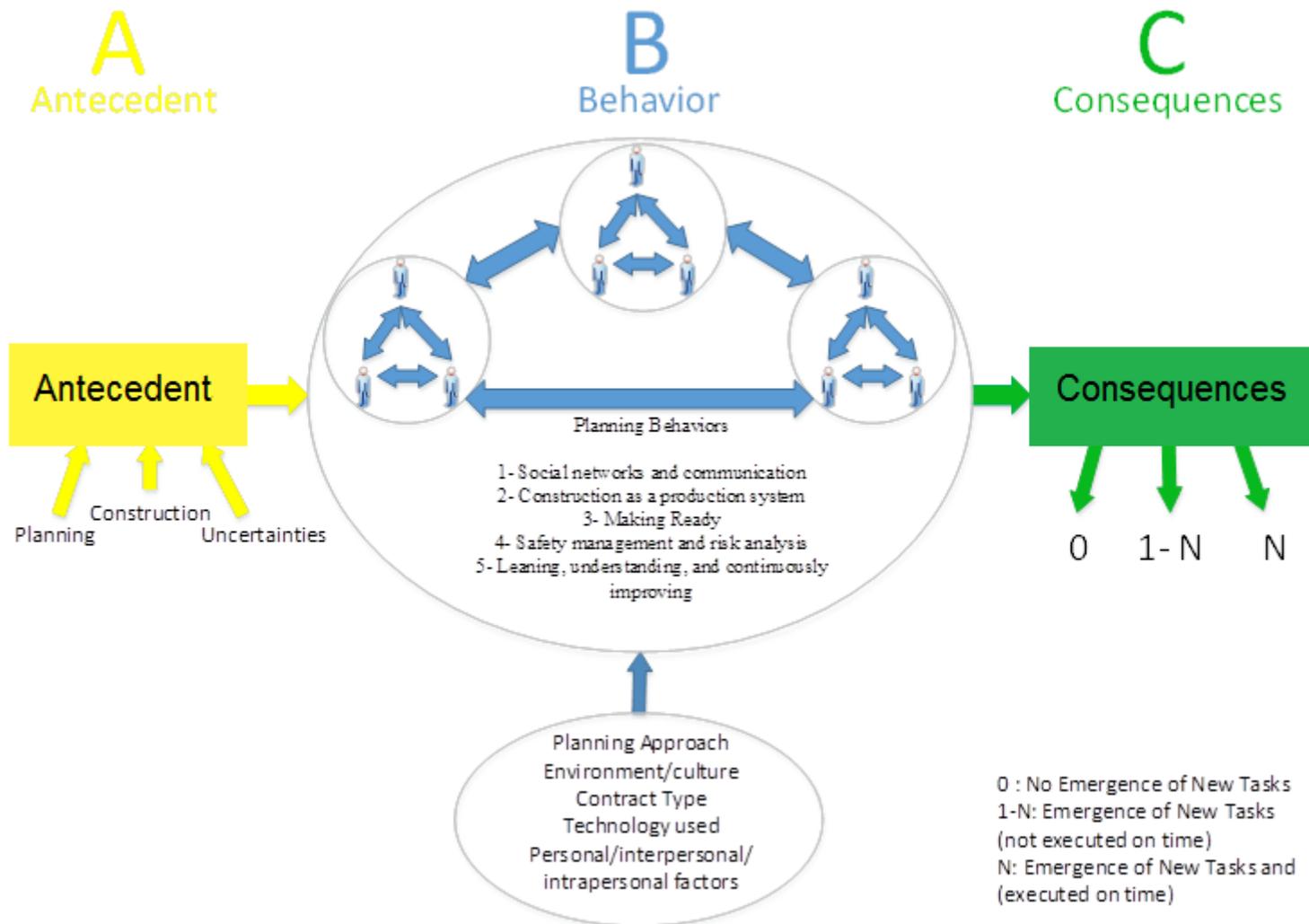


Figure 2: An ABC model to describe the emergence of 'New' tasks in weekly construction planning

Results and Analysis

Assessment

After tracking the planning behaviors on case study projects and dividing them into families, an assessment of each behavior in each family was performed. The behaviors were categorized based on observations, interviews, data collected, and project's characteristics. Table 3 presents a summary of the planning behaviors monitored as well as a rating for each observed behavior. Results from cases 2, 3, and 4 (in Japan) were grouped together because they all embody similar cultural characteristics. A qualitative assessment rate (5: very strong; 4: strong; 3: neutral; 2: weak; 1: very weak) was given for each behavior based on the collected data on case study projects as follows:

- “Very Strong” when the collected data shows 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 applied 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

Analysis

The assessment presented in Table 3 is not necessarily generalizable for the whole construction industry, but it shows the strength of the planning behaviors on the projects studied. There is a great difference in the planning behaviors between the case study projects. An explanation of these differences across families is presented:

Social networks and communication

The planning behaviors within this family are generally weak on case study 1 and very strong on the case studies 2, 3, and 4. This is strongly affected by the culture, the work environment, and the planning approach employed on each project. When visiting projects 2, 3, and 4, the supervisors acknowledged the importance of commitment planning and reliable promising, attributing the success of this approach to the Japanese culture. On the other hand, the engineers and foremen on project 1 blame each other for the lack of reliable promises and commitment planning, reflecting weak communication between project parties.

Construction as a production system

Although this family of planning behaviors is generally weak on case study 1, some behaviors are strong such as the ‘recognition of uncertainties’ and the ‘allocation of buffers’. However, the excessive adjustment of plans and the over-sizing of buffers can give a leeway for teams to deviate from the schedule and rely on buffers instead of meeting the deadline. Moreover, while the schedule of case study 1 includes important

project milestones and is generally clear, the implementation plan is not reliable enough (low PPC). Case studies 2, 3, and 4 show strong planning behaviors related to this family because the construction industry has adopted the workflow management practices inspired by the Toyota production system.

Making Ready

Results from case study 1 highlight the lack of reliable promising as a major obstacle for making tasks ready as a result of the late arrival of needed information, equipment, or material. Therefore, expediting is ranked as very strong as it is usually used as an agile response to unexpected events. The team usually works under pressure to deal with problems that occur unexpectedly. Contrariwise, case studies 2, 3, and 4 show a strong application of the making-ready process and a good relationship with suppliers that is based on reliable promising.

Safety management and risk analysis

Case study projects 2, 3, and 4 employ skilled labors which only reduce the risk of safety accidents on site, particularly when using special equipment. In comparison, labors on case study project 1 have a low skill level, come from different countries, are not well educated about safety, and are not fully aware of the risks associated with site work.

Learning, understanding, and continuously improving

Project 1 is employing fast problem solving and agile response to counterbalance the lack of sound planning. However, the philosophy of continuous improvement and seeking long term goals is not embedded in the culture of this project, unlike projects 2, 3, and 4.

Table 3: Assessment of Planning Behaviors on case-study projects

Family	Behavior	Case-study 1	Case-studies 2, 3 & 4
Social networks and communication	Transparency / open communication (*)	2	4
	Trust / reliable promising (*)	1	4
	Collaboration (*)	3	5
	Huddle meetings: daily huddle, subcontractors and internal organization meetings (*)	3	5
	Identifying customer's view on value	2	4
Construction as a production system	Using small batches and one piece flow	2	5
	Total Quality Control	1	5
	Focus on project control	1	5
	Focus on construction methods	3	4
	Recognizing uncertainties and the need to continuously adjust planning (*)	4	5
	Defining clear production goals (*)	1	5

	Value stream mapping the process to eliminate non-value adding activities	2	3
	Identifying waste	3	4
	Promoting flow and predictable handoffs between workstations and trades	1	5
	Perform long term and short term planning (*)	3	5
	Allocate buffers (contingency planning) (*)	5	4
	Collaboratively agreeing production tasks for the next day or week	2	5
	Pull system & the use of flexible resources (*)	2	5
	Standardizing	2	5
	Operations design: Balancing load and capacity, performing first run studies.	2	4
	Quality criteria: definition, soundness, size, sequence, and learning	1	5
Construction as a production system	Using concurrent engineering: executing various tasks by multidisciplinary teams.	4	4
	Setting correct milestones	4	4
	Break down the tasks (*)	3	4
	Perform reverse phase scheduling	1	3
	Identify responsibilities (*)	2	5
	Prepare weekly work assignments (*)	1	5
Making Ready	Prepare a workable backlog (*)	2	3
	Screening (*)	2	3
	Analyzing and removing constraints (*)	2	5
	Confirming lead times	4	5
	Expediting (*)	5	3
	Provide equipment on time(*)	2	5
	Provide material on time (*)	1	5
	Follow up with design status (*)	4	4
	Provide a list of actions needed to make assignments ready when scheduled (*)	3	5
	Prepare pre-work (scaffolding) and shared resources (*)	4	5
Safety management	Allocating resources (*)	3	5
	Agile response to unexpected tasks (*)	5	4
Safety management	Plan conditions and work environment: safety and health plan for activities (*)	2	4

and risk analysis:	Safety meetings and briefings for labors	3	5
	Task hazard analysis (*)	2	4
	Use 5S principles to organize the workplace (*)	1	5
Learning, understanding, and continuously improving:	Setting standards	2	5
	Thinking systematically, discussing as a team, and deeply analyzing causes to solve complex issues(*)	3	4
	Assessing work periodically (*)	4	5
	Acting on reasons of plan failure	2	4
	Prioritizing Long term goals over short term goals	2	4
	Training workers and bringing external experts	1	4
	Go to site to check problems and analyze them (*)	4	4
	Measuring performance (like PPC and productivity)	2	5
	Fast problem detection by minimizing buffers and stocks, using KANBAN, 5S, one piece flow, and visual management and inspection (*)	2	4
	Fast problem solving: taking corrective actions and temporary counter measures to satisfy the customer (*)	5	4
	Making comparisons with pervious projects (*)	4	5
	Leadership and coaching: Competent people should lead the team to avoid errors and problems. (*)	3	5

(*) designates behaviors that increase the team's ability in identifying new tasks and having an agile responsiveness that brings them to completion.

To understand the performance of each family, results for each behavior were aggregated on each of the case studies. Using the evaluation shown in Table 3, a comparison between families of planning behaviors on case study 1, on one hand, and case studies 2, 3, and 4, on the other, was performed as shown in Figure 3. The average grade for each family(between 1 and 5) was calculated for all behaviors in the family, divided by 5, and then multiplied by 100 to get a percentage to describe overall performance.

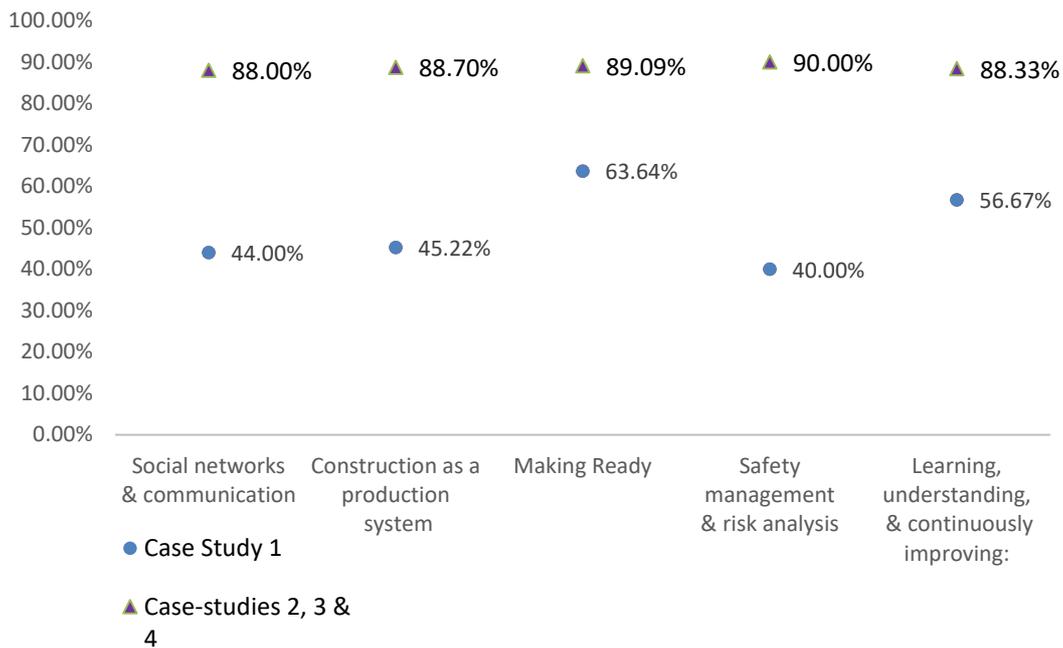


Figure 3: Performance per family for the case-studies

Results from Figure 3 show that the maximum performance rating was 63.64% for Making-Ready, and 56.67% for Learning, understanding, and continuously improving. As for case studies 2, 3, and 4, the performance rating was high for all planning families, but the maximum rating was 90% for Safety management and risk analysis, and 89% for making ready. As indicated in Table 3, all behaviors of the making-ready family are important to identify 'new tasks' and bring them to completion. Moreover, combining the performance rating across all families shows a combined performance rating of 52.57% for case study 1 and 88.87% for case studies (2, 3, and 4). A high combined rating indicates positive planning behaviors that help a team in making tasks ready for execution and also building an agile approach that can detect unexpected events and respond to them. Note that results calculated in this section are used for comparison purposes not to evaluate the success of these projects.

Discussion and suggestions for improvement

Several causes are attributed to the emergence of 'new tasks'. However, different teams react differently to similar causes or antecedents, and the associated planning behaviors result in different consequences and in various levels of emerging 'new tasks' (0, N, or 1 - N). The team's planning behavior is affected by five main factors: the planning approach, the environment or culture, the contract type, the technology used, and the personal, interpersonal, and intrapersonal capabilities of team members.

The planning approach implemented on a project has a huge impact on the team's planning behaviors. If the planning approach is not responsive, the team will face difficulties in dealing with 'new tasks' appropriately. In this approach, the sizable response time to react to antecedents cannot guarantee that task prerequisites will be made available on time to enable the execution of 'new tasks' during the given week without

delay. Nonetheless, if the planning process is very robust (implementing appropriate lookahead planning, performing proper task breakdown, removing task constraints on time) and the team fosters positive planning behaviors, antecedents will have minor effects on the project schedule, and fewer 'new tasks' will emerge. In this approach, the main goal of the team is to plan future work for minimal constraints and smooth workflow instead of just assessing and updating the progress of work with little concern for 'new tasks' that are left to be dealt with later on.

However, when 'new tasks' emerge due to uncertainties or construction problems, their constraints are not usually removed beforehand. This puts pressure on the team to make tasks ready (remove all constraints and prepare task prerequisites) during the week of execution. If most of the work is not made ready, the planner is only left with the choice of completing only what is ready and postponing the other tasks. Thus, to cope well with the emergence of 'new tasks', responsive or agile planning should be used. In responsive planning, only one general project plan is prepared, yet it is designed to be flexible to minimize the response time to changes (Faniran et al., 1997). Although traditional companies have more barriers toward agile project management (Conforto et al., 2014), a strong agile approach is hereby recommended to address the emergence of 'new tasks' by removing constraints and making tasks ready to enable timely task execution.

When studying the factors influencing the planning behaviors, culture and environment are the hardest factors to adjust. Cultural change is possible but is a complicated process; it takes a long time to change the way people think and execute things (Fernandez, 2013). Therefore, long-term investment in culture is needed where leaders should be trained and taught to apply the philosophy of continuous improvement and pass it on to team members and future leaders.

The project delivery approach and contractual setup can also have an impact on planning behaviors. Certain contract types, such as integrated Project Delivery, encourage coordination, communication, and risk sharing (Sun et al. 2015, El Asmar et al., 2013). When owners employ one contractual project delivery over another, they are impacting communication and cooperation between teams and subcontractors to enable a more robust planning system.

Employing technologies, such as BIM, promotes synchronous communication and coordination between team members. This can reduce delays by early removal of constraints through clash detection and help teams in communicating changes faster than the traditional methods. Other technologies can be used for better resource management such as Radio Frequency Identification (RFID) for material tracking and Just-in-Time delivery (JIT).

Team work and coordination requires certain personal, inter-personal, and intrapersonal skills. Personal factors are related to the person's own experience, personality, and way of thinking. Interpersonal factors depend on how a person relates to another person within the same group, for example, between engineers within the same department. As for intrapersonal relationships, they dictate the relation between people from different teams. The three factors combined can have an impact on team planning and communication between teams. Training and guidance can help improve these factors to a certain degree.

Conclusions

This study investigates, using case study research, the emergence of 'new tasks' in construction planning. To explain this phenomenon, an ABC model is developed to analyze the causes that contribute to emergence of 'new tasks', planning behaviors involved, and possible resulting consequences. The planning process is thoroughly studied on four projects in two countries to better understand antecedents, behaviors, and consequences. The causes behind the emergence of 'new tasks' are divided into three categories: the realm of planning, ongoing construction, and uncertainties. As for the planning behaviors, they were divided into five families: social networks and communication, making ready, construction as a production system, safety management and risk analysis, as well as learning, understanding, and continuously improving. The consequences were divided into three types: no emergence of 'new tasks', successful execution, and incomplete execution.

To improve planning behaviors, an organization has to work on several influencing factors such as the planning approach, environment or culture, contract type, technology used, and the personal, interpersonal, and intrapersonal capabilities of team members. It all starts with hiring leaders who follow the philosophy of commitment, dedication to work, and continuous improvement, and training them to improve the culture while being autonomous. The planning approach and the environment should also be improved where collaborative processes are implemented and enabled by new contract types that foster collaboration while sharing risk and rewards.

Researchers promote better planning to improve project performance. However, there is a limit to how much planning a team can implement. The use of the Last Planner System[®] will reduce the emergence of 'New' tasks, especially at the look ahead planning phase through better anticipation. However, due to the variability in construction, some tasks would still emerge at the weekly level. Therefore, to increase the robustness of the production system (which consists of people, technologies, and processes), a responsive planning system should be implemented to better cope with the emergence of 'new tasks' and attenuate their dire consequences. The system should enable teams to have an agile response and work fast on removing constraints to make 'new tasks', that emerge late in the process, ready for timely execution. Moreover, the planning system should also address the emergence of 'new tasks' by training teams to effectively improvise and make 'new tasks' ready on time prior to execution. However, further research is required on the subject of agile planning and improvisation.

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