INSTANTASK: DESIGNING A VISUAL APPLICATION FOR ENABLING AGILE PLANNING RESPONSE

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ABSTRACT

In modern construction projects, reliable planning is of paramount importance. However, despite good planning practices, new tasks not mentioned on the lookahead schedule frequently appear during the week of execution. These new tasks are an added burden to the work plan and will ultimately impact construction workflow. The purpose of this paper is to introduce the concept of "Instantask", as a mobile application addressing this problem. "Instantask" attempts to facilitate an agile response to these unplanned tasks by making them visible to its users as soon as they are noticed and recorded. The users represent all concerned project participants: managers, site engineers, foremen, and tradesmen. The proposed application aims at enhancing fast, clear, and effective coordination between users to mobilize the action plan needed to address these new tasks on site. Additionally, the application will track and document the emergence of these tasks to improve future planning activities. The paper presents a prototype user interface of the application. The benefits of using "Instantask" are tested by conducting a social network analysis comparison via SocNetV. The paper highlights that firms already adopting lean construction practices or those companies in the beginning stages of implementing them would greatly benefit from this application.

KEYWORDS

Instantask, visual management, new/emergent tasks, lookahead, Last Planner System.

INTRODUCTION

Modern construction projects face the constant pressure for shorter durations and risk complexity and uncertainty throughout their life cycle (Koskela, et al., 2002). And the challenge in modern projects lies mainly in the difficult coordination of activities and tasks. In modern construction projects, implementing a Last Planner System (LPS), which is a production planning and control system, is an essential method to increase

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the workflow reliability (Hamzeh, 2009). LPS will help reduce the complexity and uncertainty of tasks scheduled in the lookahead planning and weekly work plan. However, problems in any planned schedule arise when new tasks or unforeseen changes appear at the week of their execution on site. These new tasks emerge during the week execution of the previously planned activities. Proceeding in the tasks execution without full removal of constraints is a main reason behind the appearance of new tasks (Hamzeh, et al., 2012). For instance, having constraints on site can be related to uncertainty, lack of planning, lack of information, or pressure for fast action (Hamzeh, et al., 2012). These tasks require a significant effort to execute them and hinder the overall project progress. In such cases, adhering to the initial schedule set will be very challenging.

Having an agile response to these unforeseen tasks is a potential solution to this frequent problem. According to Hamzeh, et al. (2012), shortening the communication time between the site and the decision making entity is a must in order to increase agility and quick responses to unexpected problems.

In this paper, the concept of a visual application will be introduced as a solution to this problem. The application will try to enable a flexible response to these unplanned tasks by making them visible to all. The paper will investigate how making new/emergent tasks visible would encourage a collaborative effort and facilitate coordination between all parties to these unplanned tasks more effectively and in a timelier manner. In addition to reporting, the application would also document the emergence and the evolution of these problems, which facilitates learning from previous experiences and preventing and/or resolving more effectively in future projects. The features of the application will include:

- Report new/emergent tasks that are in scope but had not been pre-identified due to bad short-term planning

- Make these tasks visual to facilitate agile response by whoever is free and is using the app

- Document these emerging tasks to promote learning and prevent similar tasks from being unforeseen in the future

This research paper will present the prototype user interface of the visual software and its key features mentioned above. It is important to note that when discussing new tasks that arise on site, the terms "new task", "emergent task" and "new/emergent task" are used interchangeably in this paper.

LAST PLANNER SYSTEM (LPS) AND NEW/EMERGENT TASKS

For the purpose of the application, the most relevant planning levels in the LPS are the lookahead and the weekly work plans. The lookahead plan process is concerned with the breakdown of tasks into the operations level, identifying constraints, and removing constraints by assigning activities for the operations execution plan (Ballard, 2000). The corresponding time span of the lookahead planning varies between 2 and 6 weeks. As for the weekly work plan process, it mainly deals with the work assignments for a week's time. It is important to note that it is at the levels of the lookahead planning and the weekly work plan in particular that the problem of new/emergent tasks appears. At the week of execution of planned construction tasks, new/emergent tasks are added to the weekly work plan. These tasks are considered to

be part of the original scope of work, but that had not been identified due to lack of foresight at the lookahead planning level. This means that they have not been broken down or made ready systematically. Consequently, they are assumed to require additional effort to execute, and will hinder the progress of the workflow more, compared to tasks that had been foreseen and broken down normally (Hamzeh, et al., 2015). The cause of the emergent tasks can be related to failure to account for the necessary prerequisites to complete a certain job, or failure to clear all of the constraints affiliated with a specific task. It is important to note that these new tasks are of the same "granularity", or level of detail, as the tasks in the weekly work plan, and thus can be incorporated into it.

STATE OF THE ART IN LEAN CONSTRUCTION SOFTWARE

Table 1 presents several lean construction software that were surveyed, along with their features. This list is not intended to be comprehensive, and emphasis was placed on more recent software, especially applications that offer a mobile companion app.

Table 1: Lean Construction Software

Application	Functionality Description
Kanbanize; Kanban tool; SwitftKanban	• Process Visualization • Workflow Management • Communication and collaboration with different parties • Analytics and performance tracking • Mobile companion application available
LeanKit	• Features similar to those of Kanbanize • Real-time schedule updates using Primavera P6 integration
SimpLean (Faloughi, et al., 2014)	• Features similar to those of Kanbanize, excluding analytics • Display of task constraints and maturity • Drawing viewer • Simple user interface intended to facilitate adoption
KanBIM (Sacks, Radosavljevic and Barak, 2010)	• Display of task location by overlaying Kanban cards on BIM • Display of work packages, task constraints and maturity • Focuses on the control workflow
VisiLean (Dave, 2013)	• Features similar to those of KanBIM (with BIM integration) • Focuses on production planning and scheduling
RCM-Plan (González, Alarcon and Ulloa, 2010)	• Prediction of project participant performance • Multidimensional interactions' view of several production parameters
WorkMovePlan (Choo, 2013)	• Display of work package, space scheduling, and constraint information • Automatically updating shared schedule • Planner can explicitly allocate space, including workspaces, laydown areas, storage areas, access paths on a daily basis

THE NEED FOR A NEW TASK REPORTING TOOL

Currently existing lean construction software has thus far focused on providing systems to optimize execution of planned and well-defined tasks, and on making these systems visual and collaborative (Sacks, Radosavljevic and Barak, 2010). However, while the solutions for these aspects are well developed, there has been no dedicated solution offered to the specific problem of mitigating or enabling an agile response in real-time to the emergence of new tasks. Nor has there been a tool that is explicitly designed to require a very small barrier to entry (in terms of usability) and minimal effort to keep using it. There is a need to address this gap because some tasks are so critical that even a response at the weekly level is too late, and thus they require a real-time response.

RESEARCH METHOD

This paper proposes a new visual management application that presents a solution to the problem of emergence of new tasks in the construction industry. The specific aims behind this research are: (1) understand the conditions (when and why) in which this tool can be used in the construction industry, (2) develop the prototype user interface of the application, (3) introduce and describe how this tool can be used, (4) assess the benefits of using the proposed application.

To meet these objectives, the research process consisted of review of relevant literature, examination of numerous and diverse mobile applications, development of the application's user interface, and evaluating the effectiveness of the proposed solution. The survey of various lean software applications familiarized us with the presentation aspects and user interface features of mobile applications. The evaluation of the application's effectiveness consisted of a social network analysis of a hypothetical case modeled using the software "SocNetV".

THE APPLICATION

OVERVIEW OF INSTANTASK

As previously mentioned, Instantask is a visual mobile application that aims to facilitate an agile response to emergent tasks. Specifically, for a given emergent task, it will do this by: (1) making the new/emergent task visible to all users, (2) identifying the task's constraints, (3) identifying the owner(s) of the constraints, (4) assigning the task to the owner(s) of its constraints, (5) integrating the new/emergent task into the weekly work plan, (6) monitoring and updating the task's status.

Instantask also aims at promoting learning for improved future project performance; this objective is accomplished by collecting data to be reviewed by project participants.

Keeping the app simple is vital to ensuring user engagement, compliance, and continued use. So we conceived of an app design consisting of a single page view. This page will contain a list of new/emergent tasks, sorted by their importance. Newly emergent tasks that are on the project's critical path are shown at the top of the list, and tasks that have been marked as completed are shown at the bottom. The main screen will also display each task's deadline. The color-coding of the tasks and their position on the screen is further explained in Table 2. In Instantask, each task is

described in terms of its status (critical/not critical), deadline, location, its "appearance time and date", the person who reported it, its constraints, the owners of its constraints, and its parent task. The parent task is the task from which the emergent task is derived, and is on the level of lookahead planning rather than weekly work planning. When the owner of a task's constraints is identified and entered in a task's description, that user is "tagged", and receives a notification that a new task has been added to his/her list of tasks. Further, whenever possible, the task will also contain a brief description. Users can access this information by pressing on the task's icon in the main screen. Any user can add a new task by pressing an appropriately located "+" button. Each user will have a separate username; this is to facilitate collaboration and enhance the social aspect of construction and to open up possibilities for other features, such as messaging. Users should indicate on the main view whether they are available to work. This status will communicate whether a user is "Available" or "Busy". If a new task is posted to the system, available users will get a push notification. Furthermore, if a new task is posted to the system, and this task is on the critical path, all users will receive a push notification (even if their status is "Busy"). The criticality of a new task is assessed and indicated by an automated check of the parent task's criticality.

The users of Instantask are Last Planners of all kinds: foremen, general foremen, superintendent, site engineer, section engineers and managers. However, for the purpose of the application, there are two types of users: (1) Site (non-management) users, denoted by "Site", (2) Management users, referred to as "Management". When a new task is completed any user can mark it as such. However, before it can be removed from the system, a Management user should approve this "completed" status.

Table 2: Status Description of Every Task

Status	Color Code	Position in Main List
Critical, not completed	Red	Top
Not critical, not completed	Blue	Middle
Completed, not approved	Green	Bottom
Completed, approved	N/A	Not in list

COMPONENTS OF USER INTERFACE

Main Screen

The application launches to the Main Screen. The main screen, as shown in Figure 1 below, is common to all users of the application and simply displays the new/emergent tasks documented. These are sorted according to criticality first, according to Table 2, and within each criticality level (i.e. within each color), the tasks are sorted by deadline (nearest first). On the main screen, users can choose whether to display all new/emergent tasks ("All Tasks") or only the tasks that they have been tagged in ("My Tasks"), by swiping the top layer where this designation is displayed. In addition to viewing the list of existing tasks, users can add a new task, tap on an existing task to edit it or view it in greater detail, and/or change their status ("Busy" or "Available") via the green slider in the bottom right corner. Also, users

can access peripheral features such as task search, and analytics, using the appropriate buttons in the top right corner of the main screen. These features will be described in the "Peripheral Features" section.

Add/Edit/View Tasks Screens

When a user adds a new task by touching the large "+" button, the application goes to the "Add New Task" screen. Here, the user inputs a short, descriptive task name, the parent task from which the new/emergent task derives, the task location (e.g. 3rd floor master bedroom), the task's constraints, the project participants responsible for these constraints, and any additional details the user might find relevant.

When a user adds a new task, he/she will have to choose from a list of parent tasks that is fetched automatically from the project main schedule. If the parent task is on the critical path, the task being reported immediately and automatically gets its status set to "Critical". Moreover, the task's deadline is also set accordingly.

The application will automatically fill in information about who reported the task and the date reported, since every user will have a unique username and profile.

Once a task is added to the system, it becomes visible to all users of the application. Clicking any task on the main page will lead to the "View/Edit Task" screen. This page shows task name, parent, location, and description as input by whoever reported the task, as well as the automatically generated entries "Date Reported" and "Reported by". It also contains additional information about the task criticality and its deadline according to the schedule. Moreover, it contains sections dedicated to task constraints and the people responsible for these constraints, or the constraints' "owners".

Any user can edit this information by touching the "Edit" button in the upper right corner of the screen. In this way, information will accumulate regarding a task's constraints and their owners. At the bottom of the page is the option to mark a task as "Completed". Any user can do this; however, a task is only removed from the main screen if a Management user has confirmed that the task is completed.

PERIPHERAL FEATURES

Analytics

In order to promote learning from planning oversights so that these are not repeated and planning performance can be improved, Instantask will collect data regarding new/emergent tasks. This data includes grouping the tasks by function (e.g. MEP, Masonry), by parent task, and by constraint. These groupings could help to identify problematic areas and prioritize their targeted improvement. For example, if in a given week, 10 new tasks were reported, and 5 of these tasks were constrained by the same constraint, then it would be apparent that the removal of this constraint ahead of time in future weeks would enable a more timely response to resolving new tasks as they appear. The same logic applies to parent tasks and functions.

Further, Instantask will sort new tasks by the time taken to resolve them. This, combined with the grouping options mentioned above, could guide prioritization of elimination of these planning failures. Furthermore, in the event that the same planning failures were to be repeated, this sorting could help in selecting which of the new/emergent tasks are to be executed first. For example, if in a given week, MEP-related new tasks required 6 hours to resolve, whereas masonry-related tasks required

2 hours, then it would be apparent that MEP-related planning failures should be addressed first. Moreover, if they are not addressed, and MEP-related planning failures do recur in the next week, then it would be evident that these need to resolve before masonry-related new tasks are resolved.

Finally, Instantask will gather information concerning user proactivity, for example, which users report the most new tasks, and which users resolve the most. This could help to identify top performers and could inform workload allocation.

Search

Instantask will have the ability to do a project-wide search of tasks. The search will return results based on keywords; users can search by parent task, location, tagged users, and task name. For example, entering a specific user's name in the search bar will return all the tasks in which that user has been tagged.

FLOW OF USE

The flow of use of the application is demonstrated in Figure 1 below. The figure illustrates an example of two typical use cases, namely: adding a new task and marking a task as completed. In the case of "Adding a new task", the steps required are:

(1) The user sees a new task (Task 6) on site and presses the Add Task button ('+'), on the main screen, to report it. This takes the application to the Add Task screen. (2) In the Add Task screen, the user inputs details about the task, as shown in the figure. Then, the user presses the "save" button, which returns the application to the main screen. (3) The main screen now includes Task 6. Its criticality (critical, as indicated by the red color) and deadline (June 27) have been fetched automatically from the project main schedule, since the user reported Task 6's parent task. The remaining tasks have been displaced, and can be accessed by scrolling downwards.

As for subsequent case of "Marking a task as completed", the steps involved are:

(4) The user has learned that Task 1 has been resolved. From the main screen, the user presses on Task 1, which takes the application to the View/Edit Task screen. (5) In the View/Edit Task screen the user presses the "Mark as Completed" button at the bottom. This returns the application to the main screen. (6) The main screen now shows only 2 unresolved critical tasks. Task 1 is now marked as "completed", as indicated by its green color and position at the bottom of the screen. It will remain visible until a Management user confirms that the task has indeed been resolved.

SOCIAL NETWORK ANALYSIS VIA "SOCNETV"

ANALYSIS METHODOLOGY

To examine the impact of Instantask on information flow within a project, a social network analysis was conducted. It is important to note that this analysis is of a hypothetical project, since the application has not yet been developed.

A typical project was assumed with the following agents (represented as nodes):10 crew leaders (nodes 1-10); 4 site engineers (nodes 11-14); 1 project manager (node 15); and 1 construction manager (node 16).

The links between nodes represent information flow between agents. This information is any form of communication, for example, a site engineer assigning a

task to a crew through its crew leader, or a site engineer sending a progress report to one of the managers. Two scenarios were analyzed: one base case and one scenario in which Instantask was used.

Figure 1: Instantask Flow of Use

In the base case, each engineer is connected to every other engineer, to the PM and CM, and to 4 crew leaders. Further, the PM and CM are connected to each other. However, the crew leaders are not connected to each other, reflecting the trade split organization that often occurs in projects. As is often the case in real projects, there is no direct link between crew leaders and either the PM or the CM; information must first pass through an engineer.

In the Instantask scenario, the network is a complete network; that is, every agent is directly connected to every other agent. This follows from the assumption that all project participants will have a smartphone and can therefore access the application. A visualization of each resulting social network is presented in the Figure 2 below.

ANALYSIS RESULTS

The results from the social network analysis are best interpreted qualitatively. In the Instantask scenario, previously unconnected project participants became directly connected. In the base case, information must travel through an engineer to reach management from on-site crews, and vice versa. Instantask provides a way to skip the middleman if need be, giving information more freedom to travel by giving it more avenues. Furthermore, by using Instantask, the average number of links per user increases. The resulting higher degree of connectivity could potentially translate into timelier reaction to and resolution of new/emergent tasks.
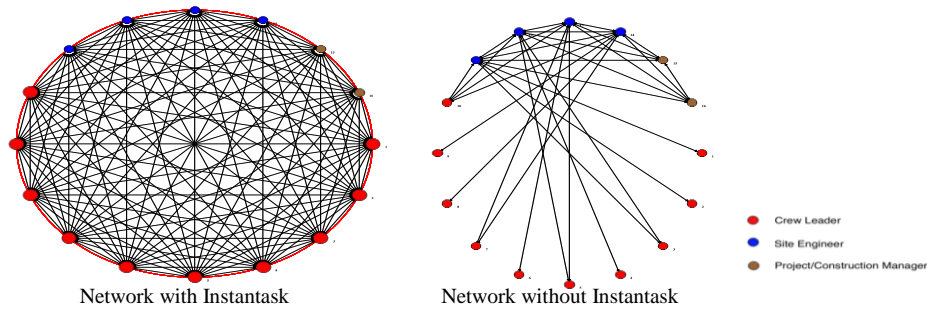
Network with Instantask   Network without Instantask

Figure 2: Results of Social Network Analysis

Finally, using Instantask decentralizes the project network. In the base case, some nodes had been central to the network; these nodes correspond to the site engineers through whom information must flow because the managers and crew leaders were not connected. This flattens the structure of construction projects, which is typically hierarchical, and increases the transparency between the concerned project participants. Figure 3 provides an illustration of this.
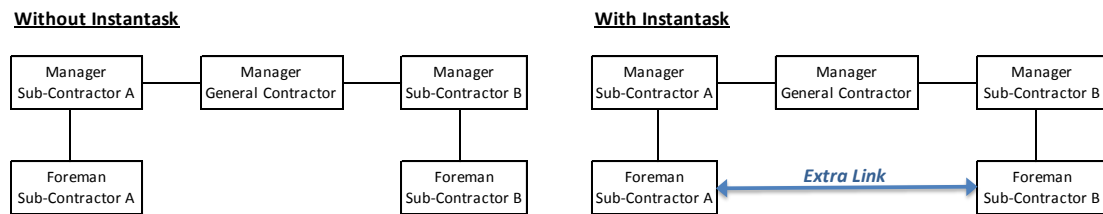

Figure 3: Illustration of the Benefits of Instantask

Because new tasks are assumed to require an extra burden to execute compared to normally broken down tasks (Hamzeh, et al., 2015), their accumulation can contribute disproportionately to project delays. Making them visible to all project participants immediately after they are reported (rather than delayed) increases the probability that they are dealt with promptly and effectively, thus decreasing their probable disruptive impact on project workflow. According to Hamzeh, et al., (2012), accelerating the communication time between site and decision-making entity can be achieved by delegating more authority to blue collar workers. This would increase quick response to deal with new/emergent tasks. Additionally, documenting their emergence and other data concerning them, as mentioned in the Analytics section, would serve to highlight key areas of improvement. This information provides a database for organizational learning, which would improve lookahead planning capabilities and thus decrease the expected number of new/emergent tasks in future projects.

CONCLUSION

While the work presented herein represents a step forward, there is still much work to be done. The analysis consisted of a theoretical examination of the benefits of incorporating a task-reporting tool, namely Instantask, using social network analysis. This analysis is presented in lieu of field data, as the mobile application has still to be developed. Once development of a working prototype has been completed, a pilot case study should follow in order to determine the application's effectiveness, as well

as to identify its shortcomings and address them for future iterations and the final version. This entails the selection of an appropriate project to use in the case study. Moreover, from a technical standpoint, the back-end software and hardware requirements still need to be addressed. The proposed system implies a project-specific nature, such that each user will need to be assigned to a project that is to be identified in advance. As such, each project may need to be allocated its own dedicated server. These details and other implementation details will be addressed once the application working prototype has been implemented.

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