



A Mobile-based Application for Performing Assembly on the Construction Sites in a Decentralized Manner

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Abstract

The culture of morning assembly in the construction sites in Japan is in practice for a long period of time. The traditional morning assembly of the construction site is the gathering of all the construction workers in one place before starting the work of that day and listening to the information delivered by the site manager. The site manager explains the work, safety declaration, disaster's information, emergency exit, etc. using the bulletin board. Morning assemblies in construction sites are crowded, unorganized, unproductive, and pose a significant challenge for the management team. The problem of forgetting the assembly contents, not paying attention to the manager, unable to listen to the contents of the assembly are the major problems of traditional morning assembly. Besides these, the morning assemblies are known to be hotspots of Coronavirus infection as well. So, with the aim of making the morning assembly safer, organized and to aid boost of workers' productivity, we propose an application that can be used to organize the morning assembly in an organized and decentralized manner. This application can be used by the construction workers to check the morning assembly information on their own smart devices. The application includes all the information about the assembly and the user can access the application inside the site whenever they want to recall the assembly information. The application is developed in such a way that fake access to the site's information is avoided by using the QR code scan tool linked with the GPS data. The application was tested at multiple sites, and we receive various comments from the construction sites which prove that it will be possible to improve safety and productivity compared to the existing morning assembly.

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1. Introduction

The morning assembly known as "Chourey" in Japanese is the first task to be performed every day on the construction sites before starting everyday work. At the construction sites, everyone who works in the construction sites gathers at a place in the early morning and listens to the tasks, safety measures, emergency routes, disasters example, safety declarations, etc. explained by the site manager before starting everyday work.

The traditional morning assembly scenery is shown in Fig.1 [1]. The traditional style of morning assembly was conducted by gathering all the construction workers at a place where the construction site manager stood in front of all the workers and give instructions using the bulletin board and displays. In the current situation of the COVID 19, it is necessary to avoid the gathering of many people in the same place for controlling the risk of infection [2].

In addition, the traditional style of morning assembly was not so effective and the problems like “difficulty in listening and understanding the morning assembly contents”, “difficulty in seeing the morning assembly bulletin board”, “forgetting the assembly contents during work”, “going to the bulletin board area for checking the contents”, “leakage of sites privacy”, “data collection problem on user access and safety declaration” [3] etc. These types of problems are also one of the factors for decreasing the productivity of the construction management works [4].

To overcome these problems, the construction sites were always in need of a system that will solve the above-mentioned problems and difficulties. Therefore, we came up with a “Smart Morning Assembly” application that allows the construction workers to check the contents of the morning assembly within the working time and anywhere at the construction site range. This type of application will be used on a smart device which results in the operation of diversified morning assembly, reduction of gathering time, and the productivity of the entire workplace will be improved [5].

The application consists of various security functions for protecting and maintaining the privacy of every site. In this paper, we will be describing the “Smart morning assembly” application’s features, technical ideas, high-security features, and its implementation and testing in various construction sites. We will show the testing results and the effectiveness of this application for increasing the productivity of construction sites.



Fig.1. Construction site manager briefing to site worker during the morning assembly

2. Application Overview

The “Smart Morning Assembly” application is an application for performing every day’s morning assembly via smartphone. In this application, the individual e-site can be created for every construction site. The person who creates the e-site is the site-admin of the e-site, who has the authority to upload the contents of the morning assembly using a PC or smartphone. The contents created by the site-admin are made visible to the users using the smartphone at the designated time zone and range from the designated construction site. The site-admin can upload the contents like images, text, videos, and PDF files in the site-admin mode as shown in Fig. 2.

The site-admin will create a QR code for the designated construction site which will be scanned by the users (construction workers) via smartphone while entering the construction site to view the morning assembly contents uploaded by the site-admin as shown in Fig. 3 [6].

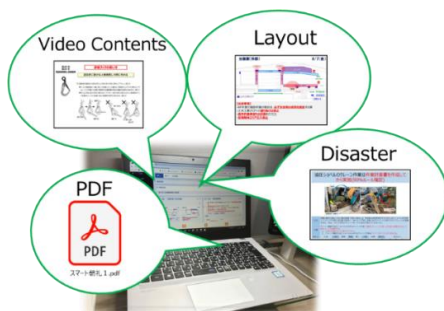


Fig.2. Contents type to upload on assembly app.

Fig.3. site worker (user) scanning the QR code using the smartphone.

The QR code is used for security purposes as well. The information can only be accessed after scanning the QR code of the respected e-sites within the designated browse range from the construction site and the designated time [7]. To avoid the fake access, the application consists of a function where the site- admin can change the QR code at any time.

3. Application

"Smart Morning Assembly" is a solution that distributes the venue and time of the morning assembly by consolidating the morning assembly activities on e-site into one smartphone. As an effect of the application, we can expect diversification of morning assembly operations, reduction of personnel transportation time, efficiency of information transmission, and improvement of productivity of the entire workplace.

The problems related to the morning assembly in the construction sites along with the merits of using "Smart Morning Assembly" application are shown in Fig. 4. The special features of this application are described as follows.

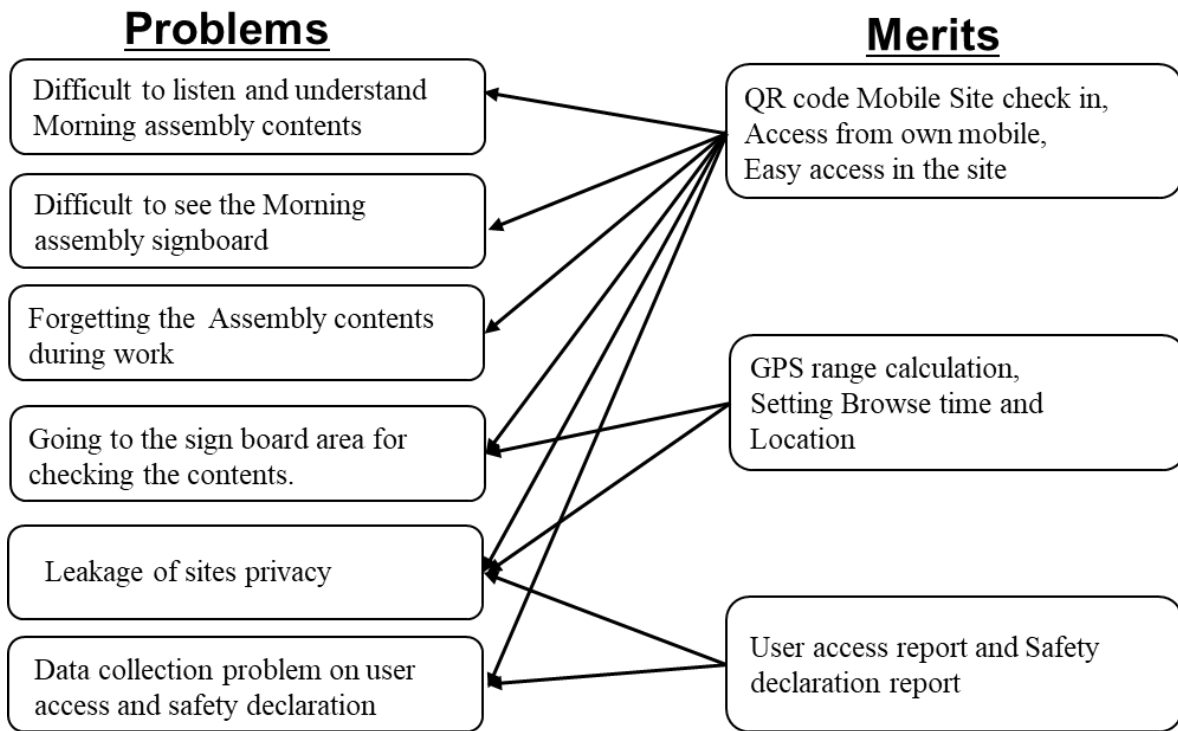


Fig.4. Relation of the Morning assembly problems and the merits of using Smart morning assembly app.

3.1. Designated Roles

This application consists of 3 designated roles, they are user, site-admin, and sub-admin. The description of the designated roles is as follows.

3.1.1. User

The users are the construction workers who work on the construction sites. Anyone who creates the account in "Smart Morning Assembly" application by setting the email address and password becomes the user. The user can log in to his application page by his login details, after the user is logged in to the application, the QR code button appears, and the user has to click the QR code button to scan the QR code for the specific sites and access the site information. The image showing the login page, and user screen before and after scanning the QR code are shown in Fig.5.



Fig.5. Login Screen, User screen image before and after QR code scan

3.1.2. Site-admin / Sub-admin

In this application, the user can create a new e-site by getting the authorization key from the system administrator. After inputting the authorization code, the user will input the required field such as site name, construction period, GPS Range (browse range), browse time, and site address to create a new e-site. The site-admin has the right to perform overall tasks related to the smart morning assembly application.

Similarly, the site-admin has the authority to generate and update the QR code to be used in the construction sites. The system flow of the site-admin role from creating the site profile to QR code printing is shown in Fig.6. It is possible to edit the related information of the e-site whenever the changes are required. All the information related to the e-site including the site name, construction period, browse range, browse time, site address, and the QR code can be edited whenever it is required. The application uses the cloud server for saving all the related data and information of the e-site.

The content updates in the sites are carried out in shifts, so it was necessary to assign site-admin privileges to multiple admin etc. The site-admin can assign the sub-admin in the sites for doing the related works on behalf of site-admin.

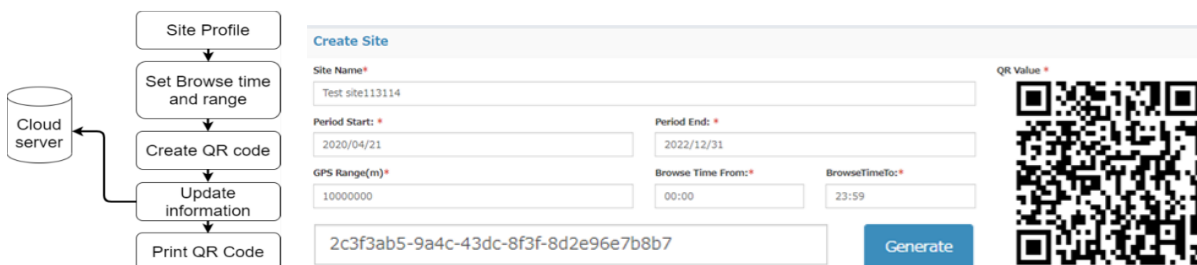


Fig. 6. System flow of the site-admin role from creating site profile to QR code print.

4. Proposed algorithm

The structure of our proposed algorithm for the user to access the smart morning assembly application and view the morning assembly contents is shown in Fig. 7.

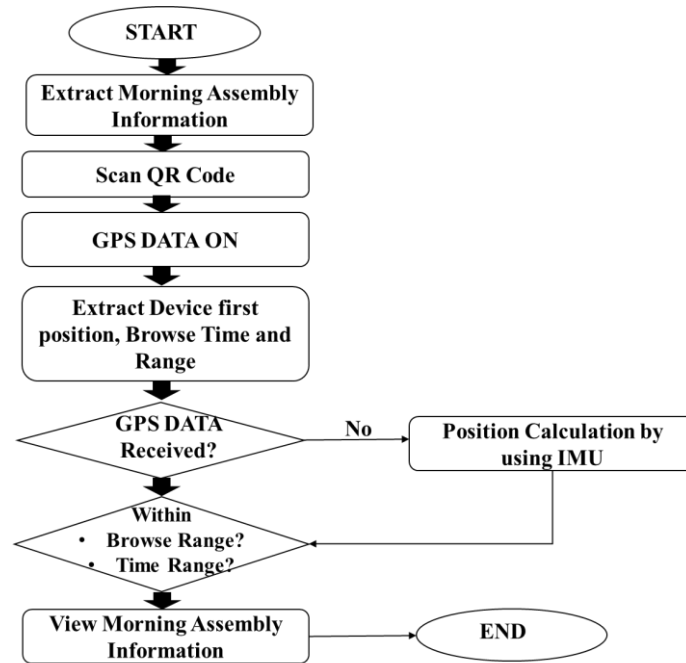


Fig.7. Proposed algorithm for the smart morning assembly application

The user (construction worker) whenever enters the site, they login to their account and scan the QR code on the site. When the QR code is scanned, the system checks whether the GPS data is enabled or not, if not then asks to enable it. In Parallel, the system detects the position of the device while scanning the QR code. Then, the system checks the browse range and browse time set by the site-admin, if the browse range and browse time are within the set values by the site-admin, the user will be able to view the morning assembly information. To maintain the privacy of the sites, we used this tool by calculating the latitude and longitude of the device using the GPS [8].

The algorithm is designed in such a way that, when the GPS is lost suddenly, the system uses the IMU of the device (smart device) for calculating the position of the device and the distance from the scanned QR code. We are using a simple IMU algorithm for this system which is why the accuracy is not so good [9].

5. Testing and Evaluation

We tested the “Smart Morning Assembly” application daily in multiple construction sites for more than 6 months. Depending on the sites, the morning assembly contents vary, some sites were using only the videos, whereas some sites were using a lot of images and some sites were using both images and videos.

This app can also count the number of users, where and who scanned the QR code and get access to the site. The aggregated data is saved in CSV format. This CSV data can be used to identify who has accessed the site and who has checked the safety declaration. The graph showing the user access data for 6 months in a site with 300 workers is shown in Fig. 8. This application is a new trend for conducting the morning assembly via smartphone, Construction workers are not familiar to such types of applications that's why the user access decreased from 52% to 40% in the second month but after the announcement for users to use the smart morning assembly application every day, the access ratio of the application increases gradually to 92%. The remaining 8% are the ones who are not used to smartphones or don't have smartphones.

We found that continuous announcements are necessary to secure the number of access for each person. We also took an interview with the site managers regarding the usage of morning assembly application and received the comments stating the reduction of time and effort required for preparing the morning assembly contents.

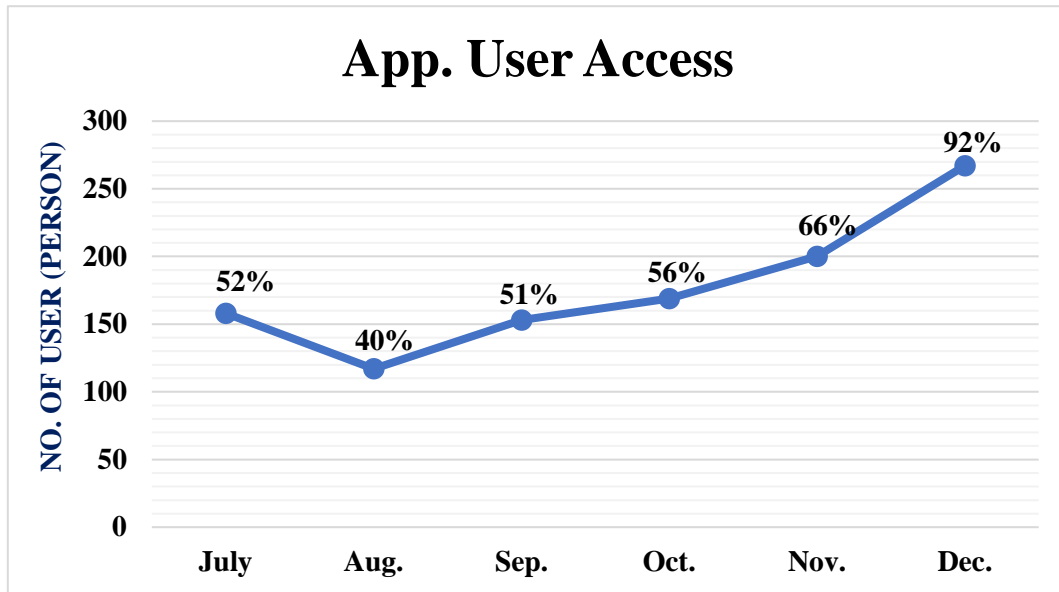


Fig.8. No. of users accessing the application for morning assembly contents.

5. Conclusions

The Smart morning assembly still have some issues to be solved but the application seems to be effective for increasing the productivity of the construction sites and bring a change in the morning assembly trend of the construction sites. This application has made it possible to convey information in real time without having to gather at the site, which was difficult until now."

This application solved the problem of protecting the secured information of the sites by using the QR code and accessing the GPS data for determining the location and position of the device within the range of the construction sites. In the future, by providing a work style that allows workers to manage thier time freely , we would like to improve productivity and attract a large number of human resources.

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