Santos, M. F., Silveira, B. F.., & Costa, D. B. (2022). Location-Based Planning to promote safe distancing during construction activities. *Proceedings of the 30th Annual Conference of the International Group for Lean Construction (IGLC30)*, 410–420. doi.org/10.24928/2022/0144

LOCATION-BASED PLANNING TO PROMOTE SAFE DISTANCING DURING CONSTRUCTION ACTIVITIES

Mírian F. Santos[1], Bruno F. Silveira[1], and Dayana B. Costa[3]

ABSTRACT

Brazil has been harshly affected by COVID-19. Several decrees applicable at a national and local level have been emitted with general and specific protocols for construction activities aiming at social distancing. Location-Based Planning (LBP) is a valuable technique to size and allocate crews considering space availability; thus, there is an opportunity to test this production planning and control approach to support social distance at construction sites. This work proposes using LBP to verify and measure crews' conflicts at the construction site to keep social distance as part of the COVID-19 measurement. The research was designed into two phases: (1) characterization of the scenario regarding the implementation of social distancing measures based on surveys, and (2) identification of crews' conflicts in location-based planning and implementation of actions against Covid-19 based on a case study. The results indicated that the proposed LBP and the Minimum Distance Indicator (MDI) could help identify and reduce total and unsafe crew conflicts. The main contribution of this work is a practical implementation to verify the possibility and effectiveness of using LBP associated with indicators to promote social distancing at construction sites.

KEYWORDS

Location-based Plan (LBP), Indicator, Safe Distancing, Workers, Covid-19.

INTRODUCTION

Since the pandemic's beginning, Brazil has been severely affected by Covid-19, with many cases and deaths. Intense disease peaks occurred mainly from May to August/2020 and March to April/21. Aiming to contain the spread of virus dissemination, the Supreme Court decided on the autonomy of states and municipalities to determine measures to control the spread of Covid-19 (Supreme Federal Court of Brazil, 2020).

[1] Civil Engineer, Ph.D. Student, Graduate Program in Civil Engineering, Federal University of Bahia, Salvador, Bahia, Brazil, miriancfarias@gmail.com, https://orcid.org/0000-0003-4956-8652

[2] Civil Engineer Master, Graduate Program in Civil Engineering, Federal University of Bahia, Salvador, Bahia, Brazil, brunofalcon.s@hotmail.com , https://orcid.org/0000-0002-6381-0997

[3] Associate Professor, Graduate Program in Civil Engineering, Federal University of Bahia, Bahia, Brazil, dayanabcosta@ufba.br, https://orcid.org/0000-0002-1457-6401

Therefore, despite recommendations at the national level, including specific guidelines for the construction industry (Official letter SEI No. 1247/2020/ME of April 14, 2020, and by Joint ordinance nº 20, of June 18, 2020) in Salvador city-Brazil, and several decrees applicable to the local context were issued. The regulations determined general and specific protocols for construction activities. There were also recommendations from local sectorial entities, such as Sinduscon-BA (Construction Industry Chamber of the State of Bahia) and SESI Saúde-BA (Industry Social Service Institution- Bahia).

One of the effective ways to reduce the chances of infection and spread of the disease is adherence to physical/social distancing policies and personal protective equipment (WHO, 2020). However, in some construction sites, it was difficult to comply with the social distancing measures because part of the activities requires the proximity of workers for the effective execution of the task (Amoah and Simpeh, 2021). Also, to improve productivity, project managers and supervisors often assign different crews of workers to the same work area (Afkhamiaghda and Elwakil, 2020). Thus, it is essential to plan and control with proper management of the physical space available to execute the work packages.

Location-based planning (LBP) can make the workflow explicit, allow the simulation of alternatives to the sequencing of activities, and simultaneously provide information on when and where each activity should be carried out across production units (Kenley and Seppänen, 2010). Due to the uniqueness of the Covid19 pandemic and its impacts on construction, it is crucial to understand how this planning tool, already used by construction companies, can contribute to physical space and conflict management. This work aims to identify social distance measures applied in the construction sites as part of the COVID-19 measurement and use LBP to assess and measure crew conflicts to support social distance. For that, two indicators were proposed. The first one aimed to keep the size and allocation of crews considering space availability and verifying crew conflicts that could pose a risk to the worker. The second indicator proposed aimed to assess the effectiveness of the actions implemented during the planning.

RESEARCH METHOD

This study was developed in two phases: (1) characterization of the scenario regarding the implementation of social distancing measures based on secondary and primary data collection and (2) identification of crews' conflicts in location-based planning and implementation of actions against Covid-19 in a construction project. Figure 1 presents the research design.

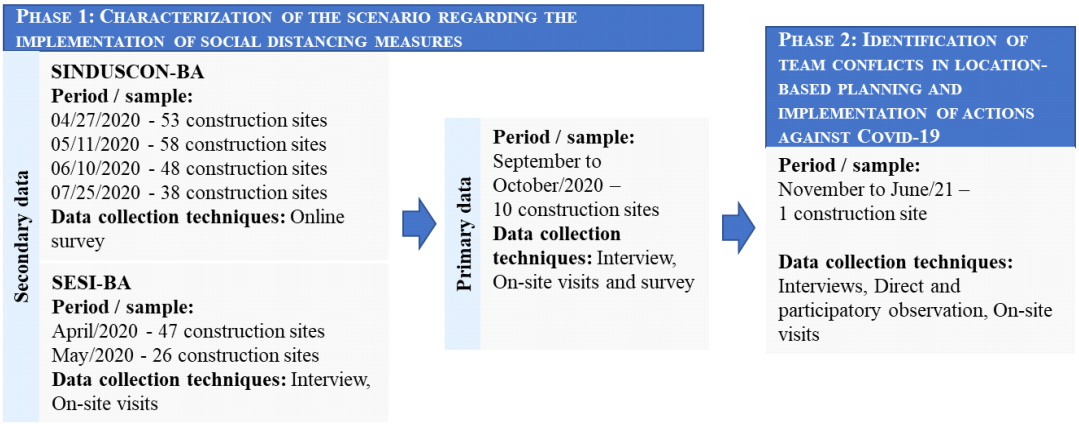

Figure 1: Characterization of the data collected

Phase 1: Characterization of the scenario regarding the implementation of social distancing measures

Secondary data

Secondary data collection was carried out from reports developed by industry entities in Salvador, such as Sinduscon-BA and SESI-BA. Most of the data from Sinduscon-BA was in bar graph format, and it was necessary to infer some answers through interpretation. The data from SESI-BA were made available in spreadsheets with questions, answers (yes or no), and, in some cases, a brief report on the sources of evidence that supported the participant's response. These reports were grouped by similar evidence to assist in interpreting the sources of evidence in each question when possible.

Primary data

Primary data was also collected from local construction companies. The Sinduscon-BA provided a contact list of 23 companies in the Metropolitan Region of Salvador with construction projects in progress. Ten of these companies agreed to participate in the data collection. In each company, a project was selected; if there was more than one project, the interviewees chose the participating construction site. Table 1 shows the profile of the ten construction sites studied.

Table 1: Profile of the construction sites studied

No. of sites	Buildings type	No. of sites	Building system	Area (M²)	No. of sites	Construction phase	Workers
8	Residential	**5**	Reinforced concrete masonry and drywall	Min. 2.000	**7**	Infra / Supra structure	Minimal 15
1	Hospital	**2**	Concrete wall		**6**	Fences / Coatings	
1	Mixed	**1**	Reinforced concrete and masonry	Max. 64.992	**6**	Installations/ Finishes	Maximum 280
		1	Structural masonry				
		1	Reform				

At each construction site, interviews were carried out with construction managers about the projects' characteristics and changes in production planning and control due to Covid-19. In addition, ten safety personnel (safety technicians or engineers) were interviewed about the safe distancing measures embraced and their main implementation difficulties. Moreover, visits occurred in six of the ten construction sites to collect data through photographic records and interviews with workers. During the six visits, questionnaires with closed questions were applied to workers asking about their perception of the health and safety measures adopted in their work environment. Two workers were interviewed per visit, totaling 12 workers interviewed. The profile of all respondents is shown in Table 2.

Table 2: Profile of Respondents and time of interviews per construction project visited

Project	Safety personnel	Time (min)	Construction Managers	Time (min)	Project - Worker A	Project - Worker B
#1	Technician	26	Civil Eng. – Site Manager	15	Inspection	Bricklayer
#2	Technician	18	Civil Eng. - Site Manager	6	Electrical installations	General foreman
#3	Engineer	16	Civil Eng. - Site Manager	18	-	-

Project	Safety personnel	Time (min)	Construction Managers	Time (min)	Project - Worker A	Project - Worker B
#4	Engineer	45	Civil Eng. - Site Manager	9	Signalman	Quality Control
#5	Technician	17	Civil Eng. - Site Manager	6	-	-
#6	Technician	27	Civil Eng. - Site Manager	12	Pipeline Anchoring	Gas Installation
#7	Technician	25	Civil Eng. - Site Manager	4	Carpenter	General foreman
#8	Technician	12	Coordinator	17	Air-conditioning installation	Facade plastering
#9	Technician	23	Coordinator	22	-	-
#10	Technician	20	Construction Director	7	-	-

Phase 2: Identification of crew conflicts in location-based planning and implementation of actions against Covid-19

The LBP implementation was carried out at Project 1 (Table 3) of Construction Company A, which is a medium-sized Brazilian company with around 34 years of market experience and more than 30 thousand housing units delivered. The case study at Construction Site 1 took place from January 2021 to June 2021.

Table 3: Characterization of the construction site

Project 1 Description
Built Area: 22.585 m²
Total 220 units - 1 Tower - 27 Floors
Construction Deadline: 22 months
Constructive Technologies: Concrete wall structure

The case study involved the analysis of available documents (designs, spreadsheets, and planning files) related to the production planning and control of Project 1. Moreover, it involved participation in the ten weekly work planning (WWP) and three lookahead planning meetings with an average of 1.5h.

Based on a preliminary data analysis, it was identified the need to understand, considering the information from the master plan that already exists for Project 1, if the sizing of the crews was according to the space where the activity would be carried out. That means if the space of the work environment allowed the minimum social distancing adequate for the number of workers allocated in the crews assigned.

Considering the minimum distance recommended by the WHO (1.5 meters), it was calculated what would be the Minimum Area (MA) needed available in the environment for each employee, considering a circumference of 1.5 meters in radius (MA = 7.07 square meters). Thus, a Minimum Distance Indicator (MDI) was created to compare with MA, where: MDI=AA/TNW (AA = Available Area in the workplace; and TNW = Total Number of Workers in the crew). In practical terms, the result of this indicator informs the area available for each employee, which necessarily needs to be a value greater than the calculated MA.

First, the MDI was defined for each activity based on the workplace area (apartment, half-floor, or full floor), the list of activities from the master plan to be carried out, and the number of workers required for each activity. Based on these indicators, the crew's conflict was analyzed in terms of unsafe and safe crew conflict. So, if MDI >MA, it was a safe conflict; otherwise it was an unsafe conflict.

Then, during the WWP, the MDI was calculated for activities executed in the same place and time. For this, when there were conflicts, the sum of the TNW of each activity in the same AA was used to calculate the MDI. One of the limitations of the MDI is that it does not consider the movements of workers in the workplace, assuming that they would be careful not to crowd, as they would have enough workspace.

A second indicator was developed to understand whether the actions against COVID-19 implemented in this study (rescheduling of activities, resizing crews, raising awareness, etc.) were effective. This indicator is named Crew Conflict Indicator (CCI), where: CCI=TCC/TAP (TCC = Total Crew Conflicts; and TAP = Total Activities Performed). The Total Crew Conflicts was the sum of safe and unsafe conflicts regardless of whether the workers were on the same crew. This indicator provided information about the historical activities percentage with crew conflict compared to the total number of activities. Figure 2 shows a summary and example of MDI and CCI calculations.

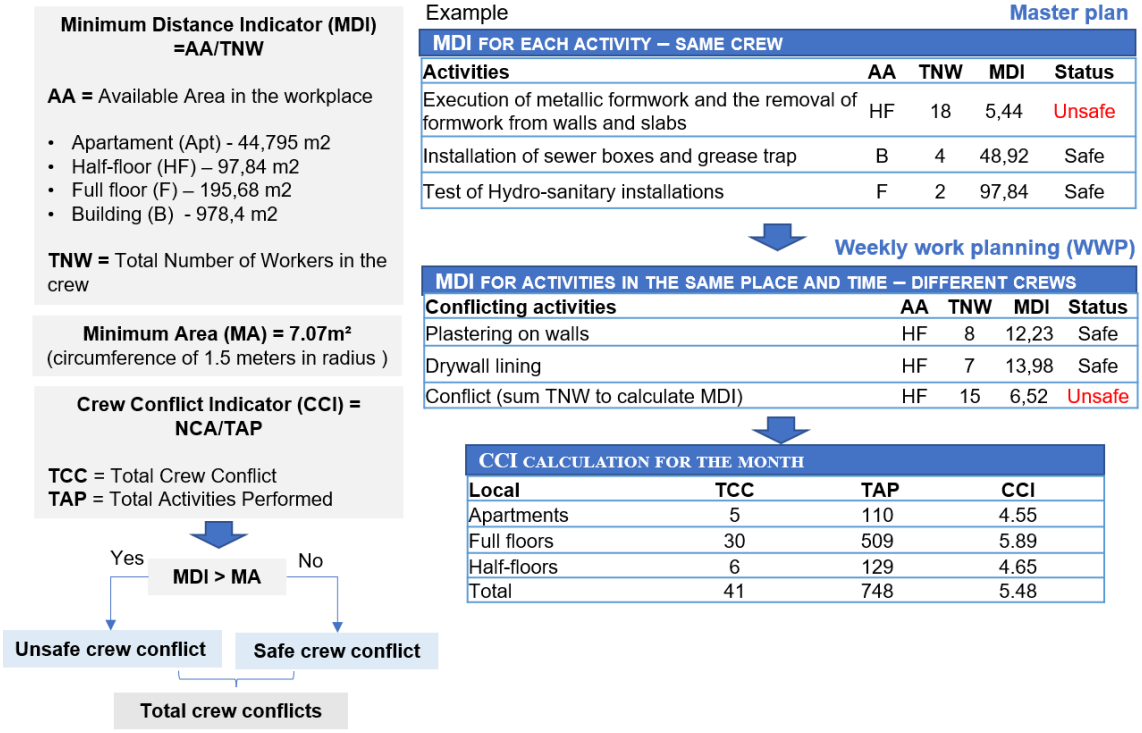

Figure 2: Summary and example of MDI and CCI calculation

RESULTS

This section presents the results obtained in the two main stages of the research.

Phase 1: Characterization of the scenario regarding the implementation of social distancing measures

Construction companies adopted several measures when the pandemic began in Brazil in 2020 to promote social distancing. From April to June / 2020, the Sinduscon-BA identified social distancing practices at the construction sites, such as removing the risk group, specific training for the workforce, and shift work schedules.

The social distance concern is also perceived in the data provided by SESI-BA, wherein the period from April to May/2020, the percentage of construction companies adopting administrative measures for workers in the risk group remained around 85%, and the prioritization of the home

office was about 77% in both months. Furthermore, all construction companies advised their workers to maintain a distance of at least one meter and used resources such as signaling, posters, and training to reinforce these actions to promote social distancing through isolation. According to Figure 3, the main practices to avoid agglomerations were the staggering work start and finish, changing rooms and dining hall (April – 50%, May – 62%), holding meetings in open space with social distance (April – 15%, May – 31%), and the absence or reduction of face-to-face meetings (April – 12%, May – 19%).

According to primary data collected with ten construction projects from September to October 2020, the safety specialists interviewed reported that the main measures adopted to promote social distancing were: Staggering work start and finish times, dining hall and changing rooms (100%), Changes in the site layout (90%), Removal of an employee from the risk group (60%) and social distancing signaling (50%).

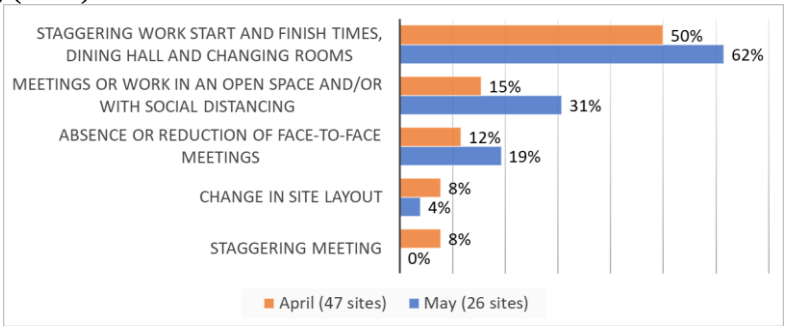

Figure 3: Actions to avoid agglomerations at the construction sites. Source: SESI-BA

Despite implementing the actions mentioned above, safety specialists reported some problems regarding combating the proliferation of COVID-19 in construction sites were still recurring. It was observed that half of these respondents reported having difficulties with maintaining social distance, mostly in activities, such as transporting materials (50%) and concreting (20%), because they still implied a space less than recommended.

Due to the pandemic, the ten constructions sites interviewed highlighted the main changes in the activities schedule, as follows: Reduction of working hours (30%), Reduction of crews or the number of employees (30%), Execution of activities with a safe distance (30%), Redistribution of crews in different shifts (20%), and Redistribution of crews in different zones (20%). Furthermore, according to the interviewees, the planning meetings were mostly held in open, large, or ventilated places (50%). These meetings could also be held to maintain social distancing (20%) or reduce the duration or number of participants (10%). Another possibility was not to have the meetings at the construction sites and deliver the schedule to those in charge (20%).

In addition, according to 92% of the workers interviewed in the six construction sites, there was a precaution to maintain social distancing during planning meetings at the construction site. Half of the workers interviewed also reported changes in the execution of their activities to maintain a safe distance. However, most of them said that these changes did not affect their crew production (58%) or did not create difficulties for the services to be executed (92%). Due to the changes, the crews were distributed in different workplaces (33%), services were taking longer to be performed (17%) or there was a delay for the service to start (8%).

Phase 2: Identification of crew conflicts in location-based planning and implementation of actions against Covid-19

Figure 4 shows Total and Unsafe conflicts by different crews occupying the same workplace simultaneously in Project 1. In November and December/2020, 41 and 33 activities were executed

with real Total crew conflicts, respectively. To verify if it was a problem in terms of safe distance among workers, the Minimum Distance Indicator (MDI) was used to check the availability of space and the severity of these conflicts regarding social distance.

To understand if each activity represents a risk by itself, firstly, on January/21, the MDI was calculated using the master plan information. This indicator ranged from 5.44 to 782.72 m²/worker, and the only activity that had the MDI below MA recommended was the execution of metallic formwork and removal of formwork from walls and slabs (MDI = 5,44). From January/2021 to June/2021 was verified the Total Crew Conflicts and Unsafe crew conflicts to activities in the same place and time, both the real conflict (during the execution of activities) and the one planned according to the WWP, as can be seen in Figure 4.

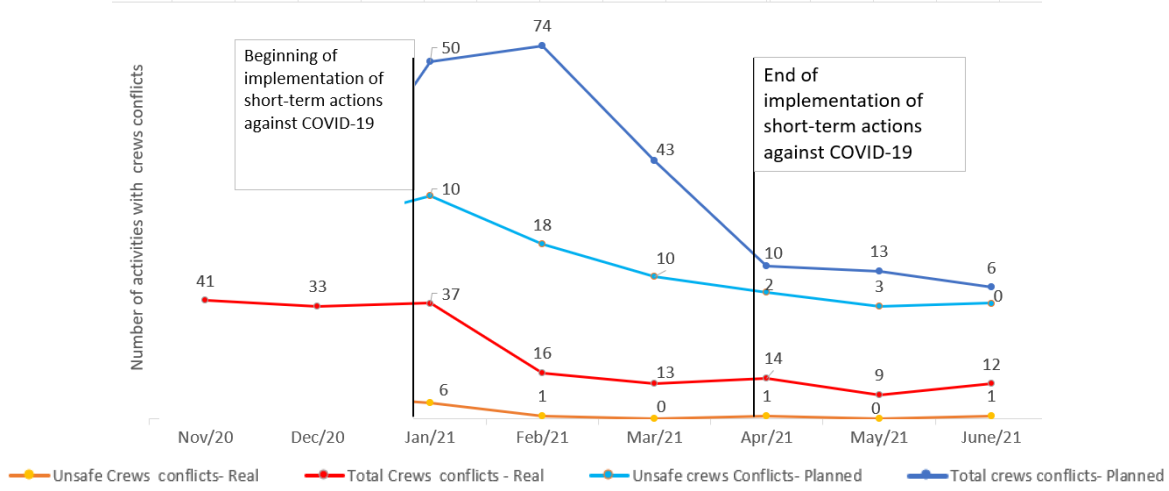

Figure 4: Crew conflicts before and after implementing actions against COVID-19

Therefore, due to the identification of Unsafe crew conflicts from January to March/2021, daily inspections and training of the crews was carried out, in addition to signaling the environments already occupied by crews to promote social distancing during the execution of activities at the construction site. These actions took place weekly and sought to outline strategies to reduce the contact between workers from different crews through the rescheduling of activities, resizing crews, and raising awareness of the planning team. During this period, a high incidence of Total and Unsafe crew conflicts was observed during WWP, but these were reduced when the workers carried out the planned activities. Figure 5 shows the frequency and month that these strategies were implemented.

From April to June/2021, the monitoring of the actions was monthly. It was observed that after implementing measures to promote social distancing, there was a significant drop in the number of real and planned Total crew conflicts and Unsafe crew conflicts. The success of implemented actions is reflected in the reasons for schedule delay (Figure 6), which shows a slight reduction in the number of activities not performed as planned from November/2020 to June/2021. However, except for March month, there was a peak in activities not performed on time due to the increase in Covid-19 sick notes in the Metropolitan Region of Salvador.

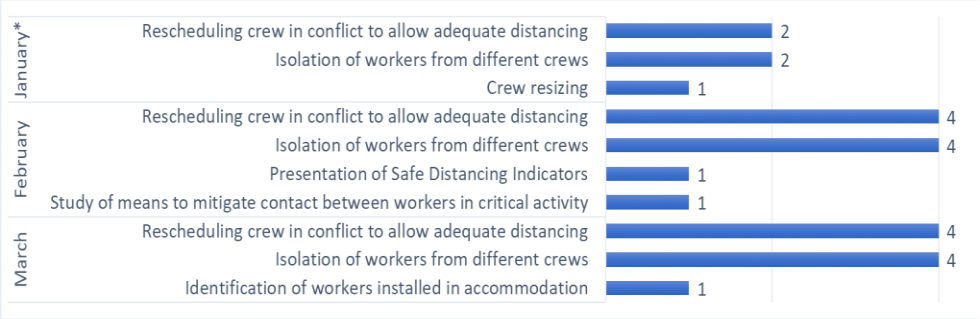

Figure 5: Actions to promote social distancing among workers

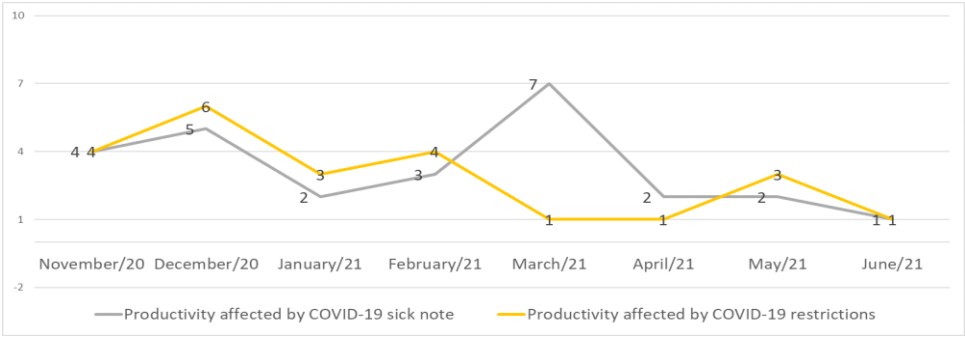

Figure 6: Activities not performed as planned and their causes

The positive effect of the implemented actions can be seen through the Crew Conflict Indicator (CCI), which has been decreasing over the months (Table 5). This means that the percentage of activities with real crew conflict when compared to the total number of planned activities was decreasing, regardless of whether they were unsafe or not.

Table 5 - Results of the Crew Conflict Indicator from Nov/2020 to Jun/2021

Months	Number of Conflicting Activity	Total Activities Performed	CCI (%)
November/2020	41	748	5.48%
December/2020	33	699	4.72%
January/2021	37	958	3.86%
February/2021	16	751	2.13%
March/2021	13	884	1.47%
April/2021	14	658	2.13%
May/2021	9	899	1.00%
June/2021	12	774	1.55%

DISCUSSION

The study shows the most implemented Covid-19 measures to social distance during the execution of construction activities in construction projects in Salvador Metropolitan Area -Brazil. In the face of nonconformities, corrective measures were taken. Nevertheless, it was still challenging to maintain the distance between the workers during the work performance in some activities. This problem was also highlighted by Olukolajo, Oyetunji, and Oluleye (2022). Thus, there was a need to implement other actions that involved changes in the crew's planning to minimize contact between workers.

According to Zakaria and Singh (2021), construction companies needed to ensure that the mobility and logistics of workers allowed safe movement in the execution of their tasks. These

authors identified that some companies are limited to a maximum of fifty percent compared to regular days. This study identified the implementation of actions regarding the redistribution of crews in different zones and reducing crews or the number of employees. Besides reducing working hours and the redistribution of crews in different shifts.

Although there were recommendations for prioritizing online meetings and limiting the interaction to the minimum necessary time (Olukolajo, Oyetunji, and Oluleye, 2022), some construction sites' presential meetings were conducted to inform the planning the workers. However, this study identified that care was taken to minimize the interaction between workers, such as holding meetings in open and ventilated places, safe distancing, and reducing the duration and the number of participants.

The LBP (Location-Based planning) provides information on when and where each activity should be carried out (Kenley and Seppänen, 2010). According to Jones, Gibb, and Chow (2022), during the pandemic, there was an increase in the time spent planning jobs and tasks to ensure that there were not too many workers in each area. Besides that, lookahead meetings were held about the work order and the times when different workers would have access to a specific work zone. This management of work zones was also possible using LBP in this work. However, despite the changes in how tasks were performed or in the distribution of the workforce in different areas, it was observed that most workers reported there was no change in their productivity, or the changes did not make it difficult to carry out their work.

Jones, Gibb, and Chow (2022) also found that planning to manage work zones brought positive results, and some respondents reported that planning led to smoother tasks, as problems were addressed in advance. Therefore, the use of LBP in this study also allows to identify and reprogram in advance situations in which different crews would be working in the same place, avoiding conflicts between them. For this, the following actions were taken: (a) rescheduling crews in conflict to allow adequate distancing, (b) isolation of workers from different crews, (c) crew resizing, and (d) study of means to mitigate contact between workers in critical activity, that is, a simultaneous study of the teams to identify solutions to improve social distancing. These actions led to a significant drop in Total and Unsafe crew conflicts. This drop continued even after the end of weekly meetings, indicating a progressive learning effect by construction managers in developing WWP considering the restrictions of Covid-19. Moreover, the number of Total and Unsafe conflicts that existed during the execution of the activities was lower than those programmed in the weekly planning, indicating that the construction managers still managed the crews during the execution of the activities to improve social distancing.

Amoah and Simpeh (2021) highlighted that the execution of some tasks, such as erecting scaffolding on site, loading materials, loading and unloading materials cannot be implemented without probably having contact between workers. In this work, the critical activity was the execution of metallic formwork and the removal of formwork from walls and slabs, due to the heavy material transportation and assembling required.

LPB contributed to structuring the construction site in well-defined locations (Kenley and Seppänen, 2010). The amount of work of each activity in each location made it possible to define more clearly the size of the crew needed for its execution, including the minimum distance analysis. In addition, to allowing the extraction of relevant information (such as area data and location) for Covid-19 restrictions, the LPB brought the opportunity to think about the productivity of activities. That is if having several employees working in the same place can have a negative or positive effect on productivity as it can make it more disorganized and less efficient. One change

in the actual practice in the face of a delay in the schedule solves it by increasing the worker amount (Jones, Gibb, and Chow, 2022).

The resizing of the crews did not impact the productivity of the activities. There was no need for a reduction in worker number in the crews, except for the metallic formwork activity. However, this activity was not modified due to crew members residing in the same location. On the other hand, it was thought that scheduling the activities in a way that did not allow two crews in the same place would delay the project deadline. In practice, the buffers were sufficient to accommodate this new constraint added to the schedule, and the productivity was only affected by absenteeism related to Covid-19.

Using the LBP to identify critical activities conflicts made it possible to alert the management of the construction site and seek actions to mitigate the impacts of the high number of crew members per location. LBP also promoted an increase in transparency and communication (Lucko *et al*., 2014) by clearly explaining workplaces and identifying and visualizing conflicts between crews. In addition, it can make the workflow explicit, allow the simulation of alternatives for the sequencing of activities, and, simultaneously, bring information about when and where each activity should be performed along with the production units (Kenley and Seppänen, 2010).

As Project 1 studied already used the LBP, in this study was only necessary to include the analysis related to Covid-19 in the planning routines. At first, there was some resistance from the construction management team in using that information to modify the planning, since the project deadline was already being affected by other factors (such as late materials delivery) and to reduce crew conflicts, in some cases, the expanding of the crews' schedule was needed. Due to the support of top management, it was possible to implement the LBP to manage Covid-19 restrictions.

CONCLUSIONS

This work aimed to identify social distance measures applied in the construction sites as part of the COVID-19 measurement and use LBP to assess and measure crew conflicts to support social distance. First was presented a characterization of the scenario regarding implementing social distancing measures in a sample of a construction site in the Metropolitan Region of Salvador in Brazil. It was observed that the primary measures by frequency of adoption were: (1) Specific training for the workforce, (2) Staggering work start and finish times, dining hall and changing rooms, (3) Removal of the risk group, (4) Changes in the site layout, (5) Prioritization of the home office, (6) shift work schedules, (7) Social distancing signaling, (8) Holding meetings in open space, and (9) Reduction of face-to-face meetings. Furthermore, all these measures had increasing adoption over the studied periods.

Location-based planning was implemented at one of these construction sites to help identify the crew conflicts. It also implemented actions against Covid-19 for conflicts with an MDI below the MA. These actions have resulted in a reduction in both Total and Unsafe conflicts crews and a reduction in activities not completed on time due to sick notes and restrictions from Covid-19. As for recommendations for future studies, it is suggested to use digital technologies with LBP to help monitor safe distancing and automatize the identification and verification of conflicts between crews.

ACKNOWLEDGMENTS

This study is part of the project “Control of the spread of the SARS-CoV-2 virus in construction sites based on occupational safety and health actions and location-based production planning and

control", and is funded by the MCTIC/CNPq Public Notice /FNDCT/MS/SCTIE/Decit Nº 07/2020 - Research to face COVID-19, its consequences and other severe acute respiratory syndromes.

REFERENCES

Afkhamiaghda M, Elwakil E. (2020). Preliminary modeling of Coronavirus (COVID-19) spread in construction industry. *Journal of Emergency Management*, 18(7):9–17. https://doi.org/10.5055/JEM.2020.0481.

Amoah, C. and Simpeh, F. (2021). Implementation challenges of COVID-19 safety measures at construction sites in South Africa. *Journal of Facilities Management*, 19 (1), 111-128. https://doi.org/10.1108/JFM-08-2020-0061

Ballard, G. & Tommelein, I. (2016) Current Process Benchmark for the Last Planner® System. *Lean Construction Journal*, 57–89.

Biotto, Clarissa (2019). Integration of Overlapped Design and Construction Stages Through Location-Based Planning Tools [Doctoral dissertation, University of Huddersfield].

Brazil. Federal Ministry of Economics. Official Letter SEI nº 1247/2020/ME. Brasília, DF: Ministério da economia, 14 abr. 2020. Retrieved July 3, 2021, from https://www.gov.br/trabalho/pt-br/inspecao/covid-19-1/covid_19_construcao_civil_orientacoes_gerais.pdf.

Brazil. Federal Ministry of Economics. Joint Ordinance Nº 20. Brasília, DF: Ministério da economia, 18 jun. 2020. Retrieved July 3, 2021, from https://www.in.gov.br/en/web/dou/-/portaria-conjunta-n-20-de-18-de-junho-de-2020-262408085

Jones, W., Gibb, A.G.F. and Chow, V. (2022). Adapting to COVID-19 on construction sites: what are the lessons for long-term improvements in safety and worker effectiveness? *Journal of Engineering, Design and Technology*, 20 (1), 66-85. https://doi.org/10.1108/JEDT-11-2020-0473

Kenley, R. & Seppänen, O. (2010). *Location-Based Management for Construction*. Spon Press. Abingdon.

Lucko, G.; Alves, T.; Angelim, V.(2014). Challenges and opportunities for productivity improvement studies in linear, repetitive, and location-based scheduling. *Construction Management and Economics*, 32 (6), 575–594.

Olukolajo, M.A., Oyetunji, A.K. and Oluleye, I.B. (2022). Covid-19 protocols: assessing construction site workers compliance. *Journal of Engineering, Design and Technology*, 20 (1), 115-131. https://doi.org/10.1108/JEDT-03-2021-0131

Supreme Federal Court of Brazil. "STF recognizes concurrent competence of states, DF, municipalities and the Union in combating COVID-19". Retrieved March 3, 2021, from http://www.stf.jus.br/portal/cms/verNoticiaDetalhe.asp?id_HYPERLINK "http://www.stf.jus.br/portal/cms/verNoticiaDetalhe.asp?id%20Conteudo=441447"Conteudo HYPERLINK "http://www.stf.jus.br/portal/cms/verNoticiaDetalhe.asp?id%20Conteudo=441447"=441447

World Health Organization (WHO) (2019). Q&A on coronaviruses (COVID-19). [accessed 2022 Jan 14]. https://www.who.int/emergencies/diseases/novel-coronavirus-2019/question-and-answers-hub .

Zakaria, S. & Singh, A. (2021). Impacts of Covid-19 Outbreak on Civil Engineering Activities in The Malaysian Construction Industry: A Review, *Jurnal Kejuruteraan*, 3(3), 477-485.