Wandahl, S., Pérez, C. T., Salling, S., Hansen, C. H., Nielsen, M. K. & Nissen, T. (2023). Daily huddles' effect on crew productivity. *Proceedings of the 31st Annual Conference of the International Group for Lean Construction (IGLC31),* 1255–1266. doi.org/10.24928/2023/0183

DAILY HUDDLES' EFFECT ON CREW PRODUCTIVITY

Søren Wandahl[1], Cristina T. Pérez[2], Stephanie Salling[3], Cecilie H. Hansen[4], Magnus K. Nielse[5], and Tom Nissen[6]

ABSTRACT

Construction labor productivity has always been a key focus point in construction management, particularly for the operational part of the management, i.e., the site managers. Nonetheless, it seems that research on the site managers' tasks and time use is sparse. In the large lean toolbox, several approaches to improving labor productivity and management efficiency are present. One is the Daily Huddle. The objective of this research is to investigate the relationship between Daily Huddles and crew productivity. The research design is case-based, as two cases are analysed, one without and one with Daily Huddles implemented. Data based on Work Sampling of both crew and site manager are collected and analysed. The results show a remarkable distinction in the two cases in both site manager time use and crew productivity. However, a scientifically valid conclusion cannot be reached based on two cases only, thus limitations in the current research design and suggestion for future research are discussed as a contribution to the lean construction society. The practical implication of this study is that the benefit of Daily Huddles has been showcased.

KEYWORDS

Daily huddle, Flow, Productivity, Work Sampling

INTRODUCTION

The interest in understanding labor productivity on the national, project, and individual levels in construction has existed for decades (Abdel-Wahab & Vogl, 2011; Neve et al., 2020a). However, measuring productivity requires data from both earned value (output) and the value of resource use (input), which makes it highly resource-demanding to collect productivity data. Therefore, researchers are searching for other variables that can be used as predictor variables for construction labor productivity. One of these is Direct Work (DW), which is the share of work time that is used for value-adding activities (Handa & Abdalla, 1989; Wandahl et al., 2021). Neve et al. (2020b) investigated this relationship on a project level and found in detail the relationship between value-adding and non-value-adding activities and how these impact productivity through the lenses of transformation-flow-value (Koskela, 2000).

The Work Sampling (WS) technique has been used for decades to collect data on the amount of value-adding work time, referred to as DW (Gong et al., 2011; Salling et al., 2022). WS is a

[1] Professor, Department of Civil & Architectural Engineering, Aarhus University, Denmark, swa@cae.au.dk, https://orcid.org/0000-0001-8708-6035

[2] Assistant Professor, Department of Civil & Architectural Engineering, Aarhus University, Denmark, cristina.toca.perez@cae.au.dk, https://orcid.org/0000-0002-4182-1492

[3] Research Assistant, Department of Civil & Architectural Engineering, Aarhus University, Denmark, stsa@cae.au.dk, https://orcid.org/0000-0001-7088-6458

[4] MSc thesis student at Department of Civil & Architectural Engineering, Aarhus University, Denmark

[5] MSc thesis student at Department of Civil & Architectural Engineering, Aarhus University, Denmark

[6] MSc thesis student at Department of Civil & Architectural Engineering, Aarhus University, Denmark

quantitative approach where data is obtained through direct observations of how workers use their time on the construction site. In general, WS has been applied to improve, often single construction projects regarding efficiency, construction labor productivity, and construction cost and time. In this research, WS is used as an indicator for efficient production.

Lean construction promotes a mindset and provides an extensive toolbox that can be adopted in the management, planning, and production control of construction projects to improve efficiency. One tool is Daily Huddles (DH). A DH is when a team meets before production begins to follow up on yesterday's production and talk about the production of the day. This is typically done in the morning, either in the work zone or at the site office. The purpose of the huddle is to improve alignment and solve problems efficiently, thus making sure that the crew can produce efficiently during the day and particularly improve the startup of the production. In industrial production and manufacturing, short DH plays an important role in day-to-day management and is widely adopted.

Neve et al. (2020b) demonstrated five system behaviors for "low performing" construction production systems, where one was a low share of DW around the start and stop of production, particularly at the start of the workday and at the end of the workday. A vast amount of research has identified and ranked factors influencing construction productivity in general, e.g. (Hamza et al., 2022; Hasan et al., 2018; Naoum, 2016). The results often mention planning systems, communication systems, leadership style, and team integration as high-ranked enablers/disablers for productivity. This is aligned with the purpose of the DH. When reviewing the literature on productivity enablers, it shows that the role of the site manager is under-researched. Site managers are responsible for the operational planning and running of construction activities and have a large interface and communication with the crew. The tasks of the site manager can have a significant impact on crew productivity (Binninger et al., 2018). Therefore, it is relevant to investigate how the site manager spends their working hours at the start of the production and to investigate a potential relationship with construction productivity.

RESEARCH OBJECTIVE

The objective of this research is to investigate the relationship between the site manager's time use and crew productivity in the first two hours of the day. The investigation is based on two case studies, one where DH was implemented and one without DH.

Before explaining the data collection and data analytic methods, a short theoretical introduction to the site manager and DH are presented.

SITE MANAGERS

In the construction industry, site managers are responsible for the day-to-day on site running of a construction project. Site managers are also referred to as construction managers, contract managers, or building managers. They are often responsible for a sub-part of the construction tasks, often divided by trade, i.e., carpenter, foundation, mason, etc. Site managers are required to keep within the time and budget and are involved in both quality control, health and safety checks, and inspection of work carried out. Thus, site managers have a large interface and communication with crew, and the way the site manager plans, manages, and supports the construction project can have a huge influence on crew productivity (Binninger et al., 2018; Fraser, 2000; Koskenvesa & Sahlstedt, 2012). Neve et al. (2020b) argue that the site manager often has a position and holds the insight necessary to be able to overcome daily problems and positively affect both crew and project productivity.

Research addressing site managers in the construction industry is one of the most marginalised fields of interest in construction management studies (Styhre & Josephson, 2006), and most literature has a negative slant. Site managers are depicted as a professional group exposed to conflicting demands and objectives, operating in a complicated environment. For instance, Djebarni (1996) writes: "*Site managers carry out one of the toughest and hardest jobs in the construction process. Site management is characterised by a high work overload, long working hours, and many conflicting parties to deal with, including the management, the subcontractors, the subordinates, the client, etc. This trait of the job makes it very prone to stress*" (Djerbarni, 1996, p. 281).

As described, site managers' tasks are very versatile, as they include dealing with problems arising daily, planning ahead, and accounting for changes that have happened. Thus, some tasks are focused on past production (e.g., claim management, accounting), others are future oriented (e.g., planning, purchasing), and some tasks are focused on present time (e.g., logistics, information, unforeseen events). There is a trend that more and more of the site manager's time is spent on administrative tasks, and less time is spent on facilitating the crew on site. Johansen et al. (2021) report on the site manager's role and defines the concept of visible site management as when the site manager spends time on site assisting the crew with, e.g., answering questions, clarifying production, coordination with other crews, etc. In other words, visible site management is when the site manager focuses on the present time, i.e., the production of the current day, instead of past or future production.

In addition, Johansen et al. (2021) concluded that, especially during the morning start-up, it had a large effect on crew productivity when site managers were visible on the site. Neve et al. (2020b) and Neve et al. (2021) confirm that construction labor productivity is particularly low in the morning and after breaks. Therefore, if the site manager can better facilitate production in the time around production start, it is likely that this could improve productivity. This points towards the implementation of DH, where the site manager assembles his crew every morning.

DAILY HUDDLES

The definition of huddle is to gather or pile together, in this context meaning that people, often in a crew, meet in an informal way. Huddles are also recognized in sports, e.g., during time outs, before starting a play, etc. Daily refers to the frequency, i.e., on a daily basis. It is common to experience different frequencies, like weekly huddles or huddles every two weeks.

The Lean Construction Institute (LCI, 2022) defines a Daily Huddle as "*A daily huddle is a daily check-in for members of a team. It is a method to communicate and measure progress of a team's work plan. Daily huddles allow members to tackle problems prior to missing goals. They also allow the team to review accomplishments from the previous day and to set expectations for the coming day.*" Sometimes, the daily huddle is named differently, e.g., as morning huddle, stand-up meeting, foreman meeting, or even weekly work plan meeting. The important part is not the time of the day, or whether participants are standing or sitting, rather, it is the focus of the activity. In a DH, the focus is on alignment, proactive planning of the day's production, and agility in solving short-term problems fast. The DH meetings are reported to have a short duration of 5 to 20 minutes (Jimenez et al., 2020; ThinkProductive, 2023).

Research on the topic shows a range of purposes for DH. ThinkProductive (2023) defines the content of the huddle as to check in on one another and outlining plans for the day, and to achieve alignment. The communication aspect of the huddle is also stated by Oladiran (2017) and Mastroianni and Abdelhamid (2003), who describe the purpose as improving the communication between the project manager and the foremen, resulting in a high level of commitment from workers on-site. Others report that DH meetings are used in construction to develop and improve assignments (Salem et al., 2004) and to plan and coordinate tasks (Noorzai, 2022). Paez et al. (2005) further add that DH meetings look for immediate actions that ensure the completion of highly variable assignments. Fuemana and Puolitaival (2013) describe the DH as an important part of production planning and control, as the follow-ups on plans are accompanied by DH, where the team control, plan, and rearrange production to minimize waste. This is aligned with Jimenez et al. (2020), who describes that DH is applied to identify disturbances in the production flow to then rearrange tasks and minimize time losses. Time loss is by Kalsaas (2010) and Wandahl et al. (2021) linked directly to crew productivity. Thus, a causal link between DH and onsite productivity is present via the reduction of time waste.

Several studies report on the benefits of implementing DH. Salem et al. (2004) investigated the effect of implementing different lean construction tools and found that DH had the largest positive effect. In addition, they applied a survey among workers, where 67% reported that they found daily huddles to be value adding. Mariz et al. (2019) implemented DH in a civil engineering project and found that team involvement was a key factor in deploying daily management. Many problems were reported at the DH. Simple problems were solved with immediate team action and larger problems that needed further analysis were forwarded to the engineering team. Consequently, they reported that cost reduction of 7% was achieved. Johansen et al. (2021) reported from a project where, among other lean elements, DH was implemented. In this project, waste time was reduced by 19%. Noorzai (2022) described that the most effective lean technique to improve success factors in the construction phase is DH meetings.

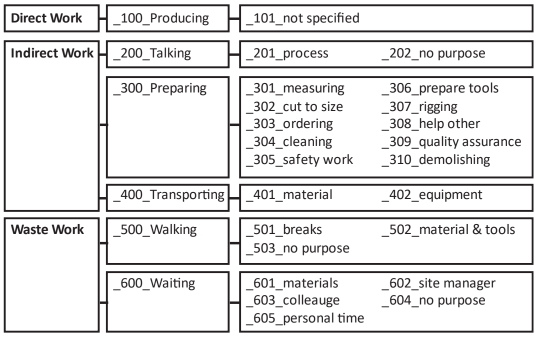
It is clear that DH is a part of the Lean philosophy and the Lean Construction application. Salem et al. (2004) argue that DH is part of the continuous improvement philosophy as it enables team members to improve collaboratively over time. Mariz et al. (2019) argue it can be viewed as part of the go-Gemba movement, as the site manager often conducts these huddles in the work zones or walks onto the construction site with the workers after the huddle. Several studies connect DH with the Last planner system, as DH focuses on achieving weekly planning for daily control through quick meetings with team members (Ballard et al., 2009). This view is aligned with Paez et al. (2005), who write, “*while Last Planner is a tool for managing operations, there is a need in construction for effective follow-up of highly variable events that affect assignments*” which then is referred to as the DH.

METHOD

The data collection is based on detailed Work Sampling (WS) as described in Salling et al. (2022). The WS technique has been used for decades to collect data on the amount of value-adding work time, often referred to as Direct Work (DW) (Gong et al., 2011). WS is a quantitative approach deploying direct observations to obtain data on craftsmen’s time consumption on the construction site. In general, WS has been applied throughout time to improve single construction projects regarding efficiency, construction labor productivity, and construction cost and time. In this research, WS is applied both on the crew and on the site manager responsible for the crew. It is conducted with two different categorizations of observations. Moreover, as outlined by the research question, the data collection is narrowed to only collecting data in the first two hours of each day.

WORK SAMPLING – CREW

Step one is to clarify the categories of the activities to be measured: in this empirical study, the activities can be direct work (DW), indirect work (IW), and waste work (WW). This study followed the classification of Salling et al. (2022) with six categories for DW, IW, and WW: (1) Production as DW; (2) Talking, (3) Preparation, and (4) Transport as IW; and (5) Walking and (6) Waiting as WW. For each category, subcategories are defined, representing the actual activities of the observed crew on the site. The observations were conducted by an observer following the site crew and for every 1-2 min noting what each worker of the crew was doing including four types of information: a timestamp, a location, the work category, and the subcategory from the activity list shown in Figure 1, left side. The observer used an electronic form in Excel to collect the data (Figure 1, right side).

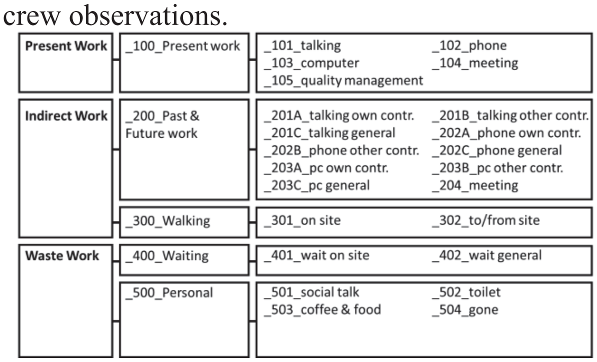


Number	Time	Category	Activity	Comment
1	07.01.03	_200_Talking	_202_no purpose	
2	07.03.59	_500_Walking	_501_breaks	
3	07.04.22	_200_Talking	_201_process	
4	07.04.35	_500_Walking	_501_breaks	
5	07.04.56	_200_Talking	_201_process	
6	07.05.03	_400_Transporting	_402_equipment	
7	07.05.37	_200_Talking	_201_process	
9	07.06.49	_300_Preparing	_310_demolishing	
10	07.08.49	_200_Talking	_201_process	
11	07.08.53	_300_Preparing	_310_demolishing	
12	07.09.46	_500_Walking	_502_material & tools	
13	07.09.59	_400_Transporting	_402_equipment	
14	07.10.16	_500_Walking	_503_no purpose	
15	07.10.37	_400_Transporting	_402_equipment	
16	07.10.49	_300_Preparing	_310_demolishing	
17	07.11.10	_200_Talking	_201_process	
18	07.11.25	_300_Preparing	_310_demolishing	
19	07.12.16	_300_Preparing	_310_demolishing	
20	07.12.34	_500_Walking	_502_material & tools	

Figure 1: Left: Taxonomy of categories; Right: Example of crew observations.

WORK SAMPLING – SITE MANAGER

Very little research has been published on work sampling for site managers. Therefore, the authors developed a new taxonomy that suits the purpose of investigating the effect of DH. Several pre-studies were conducted to identify the most suitable taxonomy. First, the two case site managers were interviewed to understand their work. Based on this information, it was decided that the taxonomy should include a time dimension, i.e., whether the task of the site manager focused on past or future work (categorized as IW) or on today's work (categorized as Present Work (PW)). Second, a pre-observation round was conducted on case 1, and the results were discussed with the site manager. Thereafter, the final taxonomy, as depicted in Figure 2, was decided. The observations were conducted using the same procedure as for the crew observations.



No	Time	Contract	Category	Activity	Location	Comment
44	07:22:15	1-Own	_100_Present	103-Computer, mobi	Office	
45	07:22:35	2-Other	_200_Past&Future	201-Tale	Office	
46	07:23:06	1-Own	_200_Past&Future	203-Computer, mobi	Office	
47	07:23:57	2-Other	_200_Past&Future	201-Tale	Office	
48	07:24:13	1-Own	_200_Past&Future	201-Tale	Office	
49	07:24:54	1-Own	_200_Past&Future	203-Computer, mobi	Office	
50	07:25:21	1-Own	_200_Past&Future	203-Computer, mobi	Office	Holidayscheme
51	07:26:05	1-Own	_200_Past&Future	203-Computer, mobi	Office	
52	07:26:27	2-Other	_200_Past&Future	201-Tale	Office	
53	07:26:38	1-Own	_200_Past&Future	201-Tale	Office	
54	07:27:02	1-Own	_200_Past&Future	203-Computer, mobi	Office	Holidayscheme
55	07:27:27	1-Own	_200_Past&Future	201-Tale	Office	
56	07:27:58	1-Own	_500_Personal	501-Social snak	Office	
57	07:28:30	1-Own	_400_Waiting	402-Vente	Office	PC loading
58	07:29:24	1-Own	_100_Present	103-Computer, mobi	Office	
59	07:29:48	1-Own	_300_Walking	301-Til byggepladser	Site	
60	07:30:21	1-Own	_300_Walking	301-Til byggepladser	Site	
61	07:30:56	1-Own	_300_Walking	301-Til byggepladser	Site	
62	07:31:40	1-Own	_300_Walking	302-På byggepladser	Site	

Figure 2: Left: Taxonomy of categories; Right: Example of site manager observations.

This study collected data for 5 days and used a 95% confidence interval. The guideline of CII (2010) was followed to calculate the minimum number of observations needed to obtain the confidence interval based on the number of workers in the crew. This was calculated for each of the two cases and for crew observations and site manager observations, respectively.

CASE ONE – NO DAILY HUDDLE

The construction project is a combined renovation and extension of a commercial and residential building in the centre of a large city in Denmark. The contract form is a general contractor, and the project has a budget of 6 million EUR. The project started in 2021 and is expected to finish medio 2023. The subjects for observation were the carpenter crew and the site manager responsible for the crew from the general contractor. The carpenter crew consisted of 4 workers, and the observed tasks were mainly flooring, installing windows, and gypsum panel installation. The site manager's approach did not include any lean methods and was mainly reactive as opposed to proactive with regard to the crew.

CASE TWO – DAILY HUDDLE

The construction project was a deep renovation of a large campus facility with offices, lecturing rooms, and large genetic lab facilities, totalizing 11.000 m2, awarded as a general contract. The contract is 83 million EUR with a timeframe from 2021 until ultimo 2024. The subjects for observation were the carpenter crew (around 15 workers) and the site manager responsible for the crew. The contractor was the same company as in case one. Crew tasks were mainly roofing work, mounting doors and windows, and gypsum panel installation. On this project, the site manager was very proactive and engaged in the crew's work. He facilitated DH every morning in the site office. The duration was 10-15 minutes, with the following topics: follow up on yesterday's work, talking about today, organising materials, informing about changes, etc.

RESULTS

In the following, WS data will be presented for each case respectively.

CASE ONE – NO DAILY HUDDLE

In case one, the site manager did not implement DH. Table 1 describes the data collected during the one week of WS for the carpenter crew, and Table 2 shows the data for the site manager responsible for the carpenter crew.

Table 1: Work Sampling data for the carpenter crew

		Direct Work	Indirect Work			Waste Work	
$\bar{p}$	(%)	8.0%	72.2%			19.8%	
n		91	823			225	
		Producing	Talking	Preparing	Transport	Walking	Waiting
$\bar{p}$	(%)	8.0%	20.0%	41.0%	11.2%	14.5%	5.3%

Table 2: Work Sampling data for the site manager

		Present Work	Indirect Work		Waste Work	
$\bar{p}$	(%)	12.5%	74.0%		13.4%	
n		115	679		123	
		Present	Past & Future	Walking	Waiting	Personal
$\bar{p}$	(%)	12.5%	69.9%	4.1%	1.4%	12.0%

As learned from the tables, the DW of the crew and the PW share for the site manager are both relatively low. A DW share of 8% is not uncommon but low compared to other studies. Wandahl et al. (2021) investigated 474 cases of work sampling data in construction, and only 2% has a DW share of less than 10%. The carpenter crew has a very high share of IW, 72.2%. In other words, the crew spends more than 2/3 of their time to understand, prepare and make ready to produce. In the same time frame, i.e., the two first hours of the working day, the site manager spends more than 2/3 of his/her time on work activities concerning past work, like claims and quality management or future work, such as planning, coordinating, or purchasing. He spends 12.5% of his time on today's production. Table 3 shows the most frequent subcodes in the observations.

The crew has most observations of talking about the process (16.3%) and measuring (7.73%). This clearly indicates that there are parts of the production which is not clear for the crew.

Table 3: Most frequently observed activities for the crew and the site manager.

Sub codes for crew		Sub codes for site manager	
_200_Talking_201_process	16.3%	_200_past/future_201A_talk own	3.05%
_200_Talking_202_no purpose	3.69%	_200_past/future_201B_talk other	8.29%
_300_preparing_301_measuring	7.73%	_200_past/future_201C_talk general	11.9%
_300_preparing_302_cut to size	7.55%	_200_past/future_202A_phone own	1.20%
_300_preparing_304_cleaning	2.55%	_200_past/future_202B_phone other	4.91%
_300_preparing_305_safety work	5.88%	_200_past/future_202C_phone gener.	6.76%
_300_preparing_306_prepare tools	5.00%	_200_past/future_203A_pc own	1.96%
_300_preparing_307_rigging	3.51%	_200_past/future_203B_pc other	1.42%
_300_preparing_308_help others	2.19%	_200_past/future_203A_pc general	24.1%
_300_preparing_310_demolishing	6.41%	_200_past/future_2004_meeting	6.32%

For the site manager, the most frequently observed category was using the computer (24.1%). It is also clear that the site manager spends more time on other contractors and general topics than on own contracts, both for talking (cat. 201), phone (cat. 202), and computer (cat. 203).

Both Direct Work for the crew and Present Work for the site manager is stable after approximately 700 observations, and with good 95% confidence intervals. The confidence interval shows that for the carpenter crew, DW = 7.99 ± 0.97%. A DW interval of [7.02-8.96] has been observed from data point no. 651 and onwards. For the site manager's PW share (Figure 3, right), the confidence interval is equally good with PW = 12.54 ± 1.37%. A PW interval of [11.17-13.91] has been observed from data point no. 590 and onwards.

Average day curves illustrating the time distribution for the carpenter crew and the site manager are depicted in Figure 3 to show variation over time, and to identify possible trends.

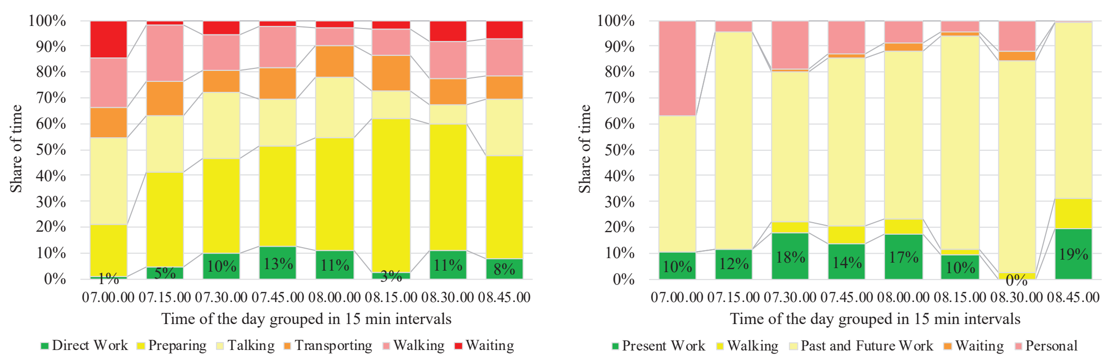


Figure 3: Left: Day curves for the crew; and Right: the site manager.

Figure 3 confirms the descriptive data from Table 1 and 2, showing that the performance, both in terms of DW and PW, is low. Moreover, two distinct patterns are observed. For the carpenter crew a pattern of DW starting very low at the beginning of the day and then slowly rising, is identified. The second pattern is seen on the curve for the site manager, who has a low and uniform distribution of PW. Most of his work time is spent on past or future work.

CASE TWO – DAILY HUDDLE

For case two, the site manager conducted DH every morning with the carpenter crew as described in the method section. Table 4 describes the work sampling data for the carpenter crew, and Table 5 shows the data for the site manager responsible for the carpenter crew.

Table 4: Work Sampling data for carpenters.

		Direct Work	Indirect Work			Waste Work	
$\bar{p}$	(%)	28.2%	56.4%			15.4%	
n		791	1584			431	
		Producing	Talking	Preparing	Transport	Walking	Waiting
$\bar{p}$	(%)	28.2%	16.0%	23.5%	17.0%	13.0%	2.3%

Table 5: Work Sampling data for the site manager.

		Present Work	Indirect Work		Waste Work	
$\bar{p}$	(%)	28.1%	61.2%		10.7%	
n		224	487		85	
		Present	Past & Future	Walking	Waiting	Personal
$\bar{p}$	(%)	28.1%	49.0%	12.2%	1.5%	9.2%

As learned from the two above tables, the DW of the crew and the PW share for the site manager are both high, and around industry average Wandahl et al (2021). The carpenters spend around 1/3 of their time on preparing and talking about the work before producing. The site manager uses 49% of his time on dealing with past and future work. Compared to case one, the site manager on case two uses three times as much time on walking. This is because he spends time on the construction site among the crew. Based on the detailed codes of the WS, Table 6 shows the most frequently observed subcodes.

Table 6: Most frequently observed activities for the crew and the site manager

Sub codes for crew		Sub codes for site manager	
_200_Talking_201_process	14.3%	_200_past/future_201A_talk_own	5.15%
_200_Talking_202_no purpose	1.71%	_200_past/future_201B_talk_other	11.8%
_300_preparing_301_measuring	6.91%	_200_past/future_201C_talk_general	0.00%
_300_preparing_302_cut to size	6.52%	_200_past/future_202A_phone_own	0.25%
_300_preparing_304_cleaning	2.64%	_200_past/future_202B_phone_other	1.76%
_300_preparing_305_safety work	0.43%	_200_past/future_202C_phone_gener.	0.00%
_300_preparing_306_prepare tools	5.31%	_200_past/future_203A_pc _own	26.1%
_300_preparing_307_rigging	0.64%	_200_past/future_203B_pc _other	2.26%
_300_preparing_308_help others	0.14%	_200_past/future_203A_pc _general	0.00%
_300_preparing_310_demolishing	0.68%	_200_past/future_2004_meetings	1.38%

As in case 1, the crew has most observations on talking about the process (14.3%) and measuring (6.91%). The most observed categories for the site manager are also similar to case 1; working in front of computer (26.1%) and talking about other contracts (11.8%).

Based on the data from Table 4 and 5, stabilization of both crew and site manager are analyzed. DW for the carpenter crew stabilizes after 2,000 observations and with a good 95% confidence interval. The high number of observations (compared to case 1) is due to the larger size of the carpenter crew. Direct Work ends with DW = 28.16 ± 1.80%. The PW category for the site manager is less stable. The Present Work share ends at PW = 28.14 ± 2.06%. Since observation no. 718, PW has been inside this confidence interval. Nonetheless, the data is considered valid and stable enough for further analysis.

Average day curves illustrating the time distribution for the carpenter crew and the site manager are depicted in Figure 5 to show variation over time, and to identify possible trends.

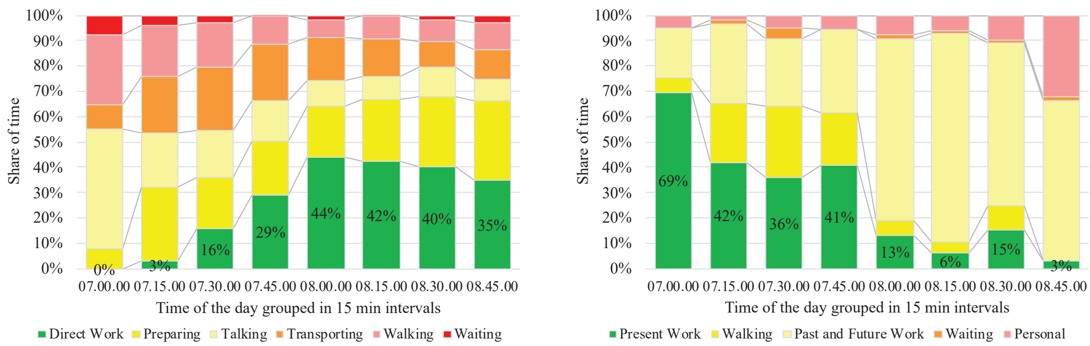


Figure 5: Left: Day curves for the crew; and Right: the site manager.

From the day curve of the carpenter crew (left side of Figure 5), it is visible that the workers take part in the DH from 07.00 to around 07.15. Their participation is registered as either preparing or talking (at the huddle meeting), depending on the crew is talking about work or talking in general. Some days, the Huddle was concluded faster than 15 minutes, whereafter the crew started walking and transporting material and tools to the production zone. For the site manager (right side of Figure 5), his engagement in DH is also visible. His participation in the DH is registered in the Present Work category. As mentioned, the huddle some days ended faster which creates indirect work from 07.00 to 07.15. After the Huddle, the site manager often walks to the construction site and joins the crew to assist and answer questions and address problems that might occur. After the first hour, the site manager typically concludes that work is running well (which can be confirmed from the DW=+40% from the crew), and he then starts planning for future work or follow-ups on past work, quality management, etc.

DISCUSSION

Case one and case two clearly show different results. Case two applied DH, and case one did not. Most interesting is the difference in how the site manager uses his time in the first two hours of the day, cf. figure 3 and 5. In case two, the site manager uses around 50% of his time to be productive and focus on present time activities. This is very different from case one, where the site manager uses 50% or more of his time on past and future activities and only uses 10-20% of the time on present activities. One reason for the difference is the DH applied every morning on case two. Another difference that provides insight is they sub activities the site manager is using his time on and how this is distributed over time. In case one, the site manager's time use is relatively uniform over time cf. figure 3, which is not the case for case two. Here the time use changes significantly during the day, cf. figure 5. In the first hour, the site manager uses around 50% of the time on today's activities, and after the first hour, the time use shift towards a focus on planning future activities and following up on past activities. The interesting result is that there seems to be a causal relationship between the site manager's time use and the crew's share of time on DW. This is most visible in case two. Comparing the left side (crew DW) of figure 5 with the right side (site manager's time use) shows an opposite pattern. This pattern is likely a consequence of the DH. The crew starts with a low DW, in fact, zero, because they use time on the DH. It is then seen that soon after the DH, the crew's productivity increases to a high and steady level.

The above results must be considered with some limitations. Firstly, only two cases are the basis for the result. This is insufficient to draw a scientifically valid conclusion, however, it indicates a clear tendency that is worth further investigating. However, this study has developed a methodology that allows for collecting more case studies to further examine the trend. The use of detailed WS increases the validity and paves the road for arguing for a causal relationship between DH and crew DW rates. A second limitation is that the analysis shows a delayed effect of the DH. This can be explained with a causal explanation, that improved production conditions will improve the share of time used on DW, however not instant. Conducting ad DH will not immediately improve crew share, the effect might be delayed. The results from case two show that the effect is visible after some hours, but the effect on the rest of the day is not investigated in this study, which calls for further investigation. A third limitation is that the DW share of the crew and the site manager cannot be isolated, with DH being the only variable. Other and unknown variables could influence DW shares, however, these variables cannot be excluded from the analysis. For instance, the effects of social constructs and trust, in general, will likely influence DW. A fourth limitation is that the two cases were very different in crew size, and the effect of large vs small crew cannot be isolated in this analysis. More studies with various crew sizes are needed. However, methodologically, crew size does not influence DW rates, or stabilization of DW, as smaller crew sizes just require a longer duration of data collection to achieve the same amount of data points.

The relevance and impact of this study are both related to academia and industry. For industry this research demonstrates the benefit of DH, even taking the above-mentioned limitations into account. Previous research has also concluded positively about the use of DH, however, few studies have succeeded in quantifying and measuring this cause-and-effect relationship. For research purpose this study can serve as a first run study on how to measure the effect of DH. The dissemination of the learnings from this study is of value for designing future studies on measuring the effect of DH. Moreover, DW data is not Construction Labour Productivity, however, DW is a valid indicator for Construction Labour Productivity as it shows the resource use, i.e., the denominator of the Construction Labour Productivity equation.

CONCLUSION

The objective of this study was to investigate the site managers' time use and its impact on crew productivity. For that purpose, the study conducted a review of both site managers and their time usage and on Daily Huddles, as one prominent approach for improving crew productivity. The review concluded that scarce research has focused on site managers and their impact on project success. Several studies report on the effect of Daily huddles, however, often the reports are based on logical arguments rather than data.

In continuation of the above, this research designed a method based on a case study to investigate the effect Daily Huddles has on crew DW shares. An adaption of the work sampling method to suit site manager data collection was designed and tested. The result of the two case studies, one with and one without Daily Huddles implemented, clearly show a difference in site managers time usage and crew's share of time spent on DW activities. Conducting Daily Huddles seems to have a measurable effect on crew DW rates, even though the study includes some limitation.

ACKNOWLEDGEMENT

This research was supported by grant 0217-00020B from Independent Research Fund Denmark. The authors are thankful for the economical support. Also, the authors are thankful to the contractor, the site manager, and the carpenter crew on the two case studies for allowing data collection.

REFERENCES

Abdel-Wahab, M., & Vogl, B. (2011). Trends of productivity growth in the construction industry across Europe, US and Japan. *Construction Management and Economics*, *29*(6), 635-644. doi.org/10.1080/01446193.2011.573568

Ballard, G., Hammond, J., & Nickerson, R. (2009). Production Control Principles. *17th Annual Conference of the International Group for Lean Construction*, Taipei, Taiwan.

Binninger, M., Dlouhy, J., Schneider, J., & Haghsheno, S. (2018). Analysis of the Activities of Site and Project Managers – Implications From the Perspective of Creating Value. *26th Annual Conference of the International Group for Lean Construction*, Chennai, India. doi.org/10.24928/2018/0315

CII. (2010). *Guide to activity analysis (IR252-2a)*.

Djebarni, R. (1996). The impact of stress in site management effectiveness. *Construction Management and Economics*, *14*(4), 281-293. doi.org/10.1080/014461996373368

Fraser, C. (2000). The influence of personal characteristics on effectiveness of construction site managers. *Construction Management and Economics*, *18*(1), 29-36. doi.org/10.1080/014461900370924

Fuemana, J., & Puolitaival, T. (2013). Last Planner System – a Step Towards Improving the Productivity of New Zealand Construction. *21th Annual Conference of the International Group for Lean Construction*, Fortaleza, Brazil.

Gong, J., Borcherding, J. D., & Caldas, C. H. (2011). Effectiveness of craft time utilization in construction projects. *Construction Management and Economics*, *29*(July), 737-751. doi.org/10.1080/01446193.2011.595013

Hamza, M., Shahid, S., Bin Hainin, M. R., & Nashwan, M. S. (2022). Construction labour productivity: review of factors identified. *International Journal of Construction Management*, *22*(3), 413-425. doi.org/10.1080/15623599.2019.1627503

Handa, V. K., & Abdalla, O. (1989). Forecasting productivity by work sampling. *Construction Management and Economics*, *7*(1), 19-28. doi.org/10.1080/01446198900000003

Hasan, A., Baroudi, B., Elmualim, A., & Rameezdeen, R. (2018). Factors affecting construction productivity: a 30 year systematic review. *Engineering, Construction and Architectural Management*, *25*(7), 916-937. doi.org/10.1108/ECAM-02-2017-0035

Jimenez, A., Ilar, T., & Stehn, L. (2020). Keeping Track of Productivity in House-Building. *28th Annual Conference of the International Group for Lean Construction*, Berkeley, California, USA. doi.org/10.24928/2020/0072

Johansen, P., Christensen, S., Neve, H. H., & Wandahl, S. (2021). Lean Renovation – a Case Study of Productivity, Flow, and Time Improvements. *29th Annual Conference of the International Group for Lean Construction*, Lima, Peru. doi.org/10.24928/2021/0150

Kalsaas, B. T. (2010). Work-Time Waste in Construction. *18th Annual Conference of the International Group for Lean Construction*, Haifa, Israel.

Koskela, L. (2000). *An exploration towards a production theory and its application to construction. Ph.D.-thesis* Espoo.

Koskenvesa, A., & Sahlstedt, S. (2012). What is Seen as the Best Practice of Site Management? *20th Annual Conference of the International Group for Lean Construction*, San Diego, California, USA.

LCI. (2022). *Lean Construction Institute*. www.leanconstruction.org/lean-topics/daily-huddle

Mariz, R. N., Galvao, E. L., Picchi, F. A., Melo, R. S. S., & Barcelos, M. C. B. (2019). Daily Management Application in a Dam Construction Project. *27th Annual Conference of the International Group for Lean Construction*, Dublin, Ireland. doi.org/10.24928/2019/0193

Mastroianni, R., & Abdelhamid, T. (2003). The Challenge: The Impetus for Change to Lean Project Delivery. *11th Annual Conference of the International Group for Lean*

Construction, Virginia, USA.
Naoum, S. G. (2016). Factors influencing labor productivity on construction sites. *International Journal of Productivity and Performance Management*, *65*(3), 401-421. doi.org/10.1108/IJPPM-03-2015-0045
Neve, H. H., Lerche, J., & Wandahl, S. (2021). Combining Lean Methods to Improve Construction Labour Efficiency in Renovation Projects. *29th Annual Conference of the International Group for Lean Construction*, Lima, Peru. doi.org/10.24928/2021/0107
Neve, H. H., Wandahl, S., Lindhard, S., Teizer, J., & Lerche, J. (2020a). Determining the Relationship between Direct Work and Construction Labor Productivity in North America: Four Decades of Insights. *Journal of Construction Engineering and Management*, *146*(9), 04020110. doi.org/doi:10.1061/(ASCE)CO.1943-7862.0001887
Neve, H. H., Wandahl, S., Lindhard, S., Teizer, J., & Lerche, J. (2020b). Learning to see value-adding and non-value-adding work time in renovation production systems. *Production Planning & Control*, 1-13. doi.org/10.1080/09537287.2020.1843730
Noorzai, E. (2022). Evaluating lean techniques to improve success factors in the construction phase. *Construction Innovation*, *ahead-of-print*(ahead-of-print). doi.org/10.1108/CI-05-2021-0102
Oladiran, O. J. (2017). An investigation into the usage of lean construction techniques in Nigeria. *Journal of construction project management and innovation*, *7*(1), 1712-1725. doi.org/https://doi.org/10.36615/jcpmi.v7i1.120
Paez, O., Salem, S., Solomon, J., & Genaidy, A. (2005). Moving from lean manufacturing to lean construction: Toward a common sociotechnological framework. *Human Factors and Ergonomics in Manufacturing & Service Industries*, *15*(2), 233-245. doi.org/https://doi.org/10.1002/hfm.20023
Salem, O., Genaidy, A., Luegring, M., Paez, O., & Solomon, J. (2004). The Path from Lean Manufacturing to Lean Construction: Implementation and Evaluation of Lean Assembly. *12th Annual Conference of the International Group for Lean Construction*, Helsingør, Denmark.
Salling, S., Pérez, C. T., & Wandahl, S. (2022). *Breakdown Work Sampling*. *30th Annual Conference of the International Group for Lean Construction*, Edmonton, Canada. doi.org/10.24928/2022/0125
Styhre, A., & Josephson, P. E. (2006). Revisiting site manager work: stuck in the middle? *Construction Management and Economics*, *24*(5), 521-528. doi.org/10.1080/01446190600658743
ThinkProductive. (2023). *The Daily Huddle*. Think Productive. https://thinkproductive.co.uk/the-daily-huddle/
Wandahl, S., Neve, H. H., & Lerche, J. (2021). What a Waste of Time. *29th Annual Conference of the International Group for Lean Construction*, Lima, Peru. doi.org/10.24928/2021/0115