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## PRODUCTIVITY ANALYSIS OF FLOOR HERONING WORKERS USING WORK SAMPLING METHOD

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### Abstract

Productivity is the ability to produce labor in completing the specified number of workers and determines the success of project implementation. Determination of minimum production through worker productivity analysis needs to be considered because it is correlated with the time of completion of work and affects the amount of project implementation costs required. The purpose of this study was to determine the productivity of iron workers in the construction project of the Aysha Islamic Hospital - Perum Accropolis Karadenan Cibinong Bogor. The method used for measuring productivity is work sampling with a productivity assessment approach of 12 (twelve) floor plate iron workers. The productivity value of iron workers varies every day, on the second day the lowest productivity is 28.85 Kg/Hour-Person and 33.55 Kg/Hour-Person on the thirteenth day being the highest productivity value. The average productivity obtained is 31.02 Kg/Hour-Person with a Labor Utilization Rate (LUR) of 74.27% over a span of 7 hours for 14 days.

**Keywords:** Productivity, Work sampling, Reinforcing

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## **Introduction**

Productivity is the ability to produce labor in completing the specified quantity of workers and determines the success of project implementation. Productivity in construction can be understood in various ways such as performance factor, production rate, unit-person-hour rate and many others (Jarkas, 2010)(Joshi & Shrestha, 2019)(Lawaju et al., 2021). Productivity is a fundamental factor that affects the performance of competitiveness in the construction industry (Rizky & Nugraheni, 2019). The lower the productivity, the greater the chance of work delays. On the other hand, the higher the productivity level, the lower the chance of delays (Muchdarsyah, 2003)(Prasetyo et al., 2017). Determination of the minimum production of workers needs to be considered because it correlates to the time of completion of work and affects the amount of costs required. According to (Rahmat & Soekiman, 2018) in his research explains that the value of worker productivity in the field varies in each region. The Bogor area is an area of effective productivity value in several compositions of workers and sub occupations than other areas such as Manado, Kupang, Lamongan, Semarang, and Riau. According to (Sedarmayanti, 2009) The six main factors that determine work productivity are: 1). Work attitude; 2). Skill Level; 3). The relationship between the workforce and the leadership of the organization; 4). Productivity Management; 5). Labor Efficiency; and 6). Entrepreneurship

The achievement and volume of work carried out by workers are the main indicators in measuring productivity. One method of measuring worker productivity is Work sampling. Work sampling is an easy method in determining the productivity level of a worker. This measurement method is used to determine standard time, productivity in service activities, determine time for non-

productive activities, and others (Diniaty & Febriadi, 2015). According to (Jono, 2015) work sampling is a technique of collecting data on the work process. Taufan (2018) mentioned that the work sampling method has a high level of accuracy, because the data collection is taken directly from the workers. The work sampling approach method is one of the best methods that can be used in measuring productivity, especially iron work. Work sampling or also known as activity sampling is a productivity measurement and analysis technique by applying statistical principles, both for all activities that are effective or not, by taking random samples (but must be able to represent the entire population) and then analyze it further (Pilcher, 1992)

Some of the advantages of the work sampling method for the productivity approach are (Andi, 2003): (1) does not cost a lot of money compared to continuous observation, (2) does not require special training and expertise from observers, (3) provides an adequate level of statistical accuracy, (4) can include the participation of supervisors and foremen, (5) provides less distraction to workers than continuous direct observation, and (6) provides an indication of how effective workers are on the project as a whole.

This productivity study was aimed at 12 floor plate iron workers in the construction project of the Aysha Islamic Hospital - Perum Acropolis Karadenan Cibinong Bogor. Measurement of field productivity is expected to be an illustration of the planning or management of project human resources, especially iron workers in achieving the ideal time and cost target.

## **Literature Review**

Schwalbe translated by Dimiyati & Nurjaman (2014), Alaie, Dizaji, et al., (2012) explains that a project is a temporary endeavor to produce a unique product or service. Projects can be interpreted as an organized effort or activity to achieve

goals, objectives and expectations using available budget funds and resources that must be completed within a certain period of time in accordance with quality. (Nurhayati, 2010)(Elizar et al., 2020)(Andriani et al., 2017). The project is a process of resources and the existence of certain funds in an organized manner to become a steady development result in accordance with the initial goals and expectations by using the budget funds from the project, so that it becomes a resource that is available within a certain period of time in accordance with its function to meet needs. consumer (Dipohusodo, 1996)(Ahuja, 1994). Good performance of any construction project refers to that it is free from defects, the right things at the right time and continuous improvement of the project. (Chilwal & Mishra, 2018).

Assessment of productivity in the construction industry has been a challenging task for a long time due to the involvement of a large number of stochastic variables such as labour-intensive work, unique character and uncertainty. Productivity means "how much and how well we earn from the resources used"(Bernolak, 1997)(Boy, 1986)(Leonardy & Sekarsari, 2020). Productivity is also defined as "how an entity uses its resources to produce outputs from inputs" (EnShassi, Mohamed, Mayer et al., 2007)(Alwi, Hampson, et al., 2002).

It refers to the ratio between the total number of inputs in terms of resources consumed and outputs in terms of finished products (Hanna, Chang, Sullivan et al., 2006). However productivity is defined by many authors, generally, it is well defined as the output produced per unit of resource input. Labor productivity has been identified as an index to measure work efficiency (Ameh & Odusami, 2002). Equipment and material costs are usually negligible as they are prone to lower variation in short term projects but highly variable labor productivity adds to

managerial concerns (EnShassi, Mohamed, Mayer et al., 2007). Increased productivity can only be done by humans using work measurement methods (Dalela, 2002)(Luu, Kim, et al., 2008). Therefore, labor is an important factor in measuring productivity (Elizar et al., 2020). Labor productivity is the number of units or rupiahs of goods (produced) per one worker per unit time (per hour, per day, per month or per year).(Simanjuntak, 2005). From time to time, worker productivity will change under different conditions (Yanti, 2017). Traditionally, labor productivity has been interpreted using hours worked and physical output (Groover, 2007).

Construction projects in the development process are influenced by various factors such as project management, project resources, service users, job changes, excess quantities of materials, labor, equipment and environmental conditions during the development process so that construction projects have a high probability of experiencing construction waste. (Dell Isola, 2003). Project management is the art of giving direction to other people in the form of work. In this definition, it can be understood that construction management is a way to achieve a goal by organizing people towards their work so that it is structured and systematic. Project management is a science in terms of leading an organization which consists of planning, organizing, implementing and controlling limited resources in achieving the desired goals and objectives. (Leonardy & Sekarsari, 2020).

Project human resources are workers from a number of construction works according to their portion and potential. Construction workers or project human resources are supervisors, implementers, and planners. The project human resources are more detailed as follows:

- a) Skilled workers
- b) Skilled technician
- c) Experts and professionals

- d) Skilled managerial staff and expert managerial staff
- e) Professional staff.

One of the important elements in running a project is the workforce which has a considerable influence on the cost and time of completion of a project. However, more attention, effort and thought is needed in the management of manpower, namely humans, who are complex and difficult to predict resources in manpower management. In workforce management there is a decision-making process related to:

- a. The number and size of the workforce is a stipulation.
- b. Recruitment and division of labor into working groups.
- c. The composition of the workforce for each type of work.
- d. During the project the number of workers must be controlled.
- e. Planning, scheduling, directing and supervising labor activities.

According to Gusmadi in (Dharmawan, 2020), The main problem in manpower for service providers or implementing contractors and similar companies with sharply fluctuating business levels is how to form a balance between the number of workers and the number of jobs available from time to time. In addition, it is not cost effective to procrastinate and have a large workforce when employment levels are declining to low levels. Vice versa, if there are many jobs available, it is difficult to find construction project workers. Thus, a good and systematic planning is needed starting from the number, types of skills, composition of the work group (labor mix), schedule of activities, to sources of labor providers.

The achievement of labor activities in carrying out their work can be interpreted as productivity. In general, productivity is a comparison between output and input. In the world of construction, Productivity is workers and can be compared as a comparison between labor output and hours worked. Productivity is defined as the

ratio of output to input, the ratio of production output to total resources used (Firman Kresna & Dewita, 2016).

To better understand the notion of productivity, several formulations were taken from reference books, including:

- Olomoaiye, Jayawardane, dan Harris, (1998)

$$P = \frac{Po}{Pi} \dots\dots\dots(1)$$

Information:

P = Productivity

Po = Output (Quantity of workers)

Pi= Input (labor, management, materials, money, and tools).

- Dipohusodo (1996)

$$P = \frac{HK}{JK} \dots\dots\dots(2)$$

Information:

P = Productivity

HK = Weekdays

JK = Working hours

- Bartol, dan Martin (1998)

$$P = \frac{Po}{Pi} \dots\dots\dots(3)$$

Information:

P = Productivity

Po = Output (goods and services produced)

Pi =Input (Labour+Capital+Manpower+Technology+Materials).

Performance in a work system can be determined by the performance of the work which is in the form of the level of effectiveness of workers in completing a

job. Therefore we need a method in a job to calculate the level of effectiveness, one of which is by sampling work (work sampling).

Productivity measurement techniques vary with each having advantages and disadvantages, several productivity data collection techniques include: Time and Motion Study, Productivity delay model method, work sampling, and several other techniques. The work sampling approach method is one of the best methods that can be used in measuring productivity, especially construction work in various sub jobs (Firman Kresna & Dewita, 2016).

The work sampling method with the productivity rating approach is a concept of measuring productivity for several groups of activities, including: effective, essential contribution, and ineffective. LUR recapitulation is obtained through the following equation.

$$LUR = \frac{\text{Effective} + \frac{1}{4} \text{Essential Contributory}}{\text{Total}}$$

Information:

- Effectivet = Activities that contribute directly
- Essential Contributory = Activities that do not directly have an impact
- Ineffective = Activities that have absolutely no impact (Unproductive).

Iron work is one of the most influential jobs in a number of construction project processes, namely structural workers. This work is a form of construction that has a fairly important meaning in the strength of a building structure.

Iron work is one of the jobs that can affect several series of construction project processes, namely structural workers. One form of construction that has a fairly important meaning in the strength of the structure of a building is iron work (Dharmawan, 2020).

According to (Center for Competency Development and Construction Training of BPSDM Kemen PUPR, 2006) in the procedure and technique module for the manufacture and installation of steel/reinforcement concrete that the weaving/assembling and installation of iron/reinforcement concrete is carried out according to the type of use and classification.

On the floor reinforcement, initially the weaver will take measurements. The distance from the axis to the axis of the reinforcement is marked on the formwork using chalk. After the first layer of reinforcement is installed, the second layer of reinforcement can be installed as well. Then the first and second layers of reinforcement are installed sequentially, then all of the cross bars or part of them are tied together by cross-linking.

### Methods

The main data obtained using the work sampling method was formulated through several stages of research. The use of work sampling method is very suitable for the type of work to be carried out in this study, namely work that is not repetitive (not repeated) and has a relatively long cycle (Santoso & Supriyadi, 2010). In this study divided into secondary and primary data. Primary data are: worker data, iron work volume, LUR data and weather. As for secondary data, such as: Project data (Structure work drawings), retrieval forms and other supporting data.

The data that has been obtained from observations in the field/project is then processed to determine the value of worker productivity on iron work. The LUR calculation for iron work is analyzed through calculations by recapitulating the overall data first. The number of effective, contributory, ineffective workers is summed based on their classification. The total value of each job is used for calculating LUR on iron work.

### Results and Discussion

Calculation data is recapitulated as a whole by doing the average productivity in units of Kg/Hour-Person. The following is one of the recapitulation data on the average productivity of workers on the 4th (fourth) day of iron work, July 8, 2021, the construction project of the Aysha Islamic Hospital - Perum Acropolis Karadenan Cibinong Bogor:

Table 1. Recapitulation of Worker Productivity in Iron Works July 08 2021

No	Tanggal Pengamatan	Jam Pengamatan		Durasi (Menit)	Total Pekerja (Orang)	Hasil (Kg)	Produktivitas (Kg/Jam)		Rata - Rata Produktivitas (Kg/Jam-Orang)
		Awal	Selesai				12	1 Orang	
67		08.00	08.20	20	12	111,34	334,02	27,84	
68		08.20	08.40	20	12	122,47	367,42	30,62	
69		08.40	09.00	20	12	128,04	384,13	32,01	
70		09.00	09.20	20	12	128,04	384,13	32,01	
71		09.20	09.40	20	12	133,61	400,83	33,40	
72		09.40	10.00	20	12	133,61	400,83	33,40	
73		10.00	10.20	20	12	133,61	400,83	33,40	
74		10.20	10.40	20	12	128,04	384,13	32,01	
75		10.40	11.00	20	12	128,04	384,13	32,01	
76		11.00	11.20	20	12	116,91	350,72	29,23	
77	Hari Ke-4	11.20	11.40	20	12	111,34	334,02	27,84	30,62
78	Kamis	13.00	13.20	20	12	116,91	350,72	29,23	
79	08/07/2021	13.20	13.40	20	12	122,47	367,42	30,62	
80		13.40	14.00	20	12	128,04	384,13	32,01	
81		14.00	14.20	20	12	133,61	400,83	33,40	
82		14.20	14.40	20	12	133,61	400,83	33,40	
83		14.40	15.00	20	12	128,04	384,13	32,01	
84		15.00	15.20	20	12	133,61	400,83	33,40	
85		15.20	15.40	20	12	122,47	367,42	30,62	
86		15.40	16.00	20	12	111,34	334,02	27,84	
87		16.00	16.20	20	12	100,21	300,62	25,05	
88		16.00	16.20	20	12	89,07	267,22	22,27	

The recapitulation of productivity data for iron workers is contained in graphic images for 14 (fourteen) days of observation.

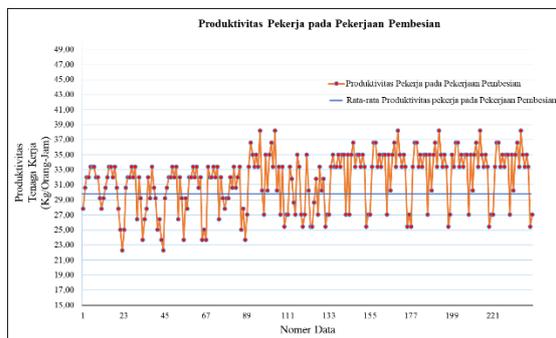


Figure 1. Recapitulation of Iron Work Productivity

The average value of worker productivity on iron work at the Aysha Islamic Hospital Development Project -

Perum Acropolis Karadenan Cibinong Bogor was obtained at 31.02 Kg/Hour-Person with a span of 7 hours for 14 days.

The productivity value of iron workers varies every day, on the second day (Tuesday 6 July 2021) the lowest productivity value is 28.85 Kg/Hour-Person and 33.55 Kg/Hour-Person on the thirteenth day (Saturday 17 July 2021) to be the highest value. The average daily productivity performance (Kg/hour-person) is shown in the following figure.

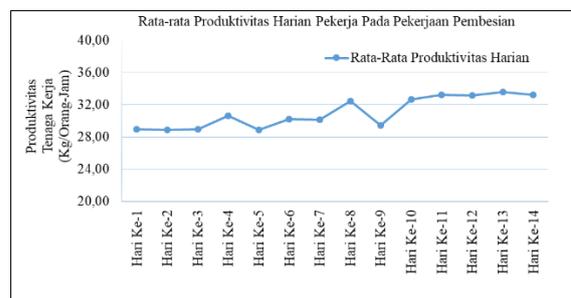


Figure 2. Daily Iron Work Productivity Recapitulation

Based on 3696 types of activities during fourteen days of field observation, each type of activity has a value of 2580 effective, 660 contributory, and 456 ineffective. The LUR value is 74.27%.

The following is one of the data tables for the recapitulation of the proportion of worker activities on iron work July 08 2021.

Data No	Tanggal Pengamatan	Lokasi	Jumlah Pekerja	Effective	Contributory	Ineffective	Total
67		Lantai Tiga	12	7	2	3	12
68		Lantai Tiga	12	8	3	1	12
69		Lantai Tiga	12	7	3	2	12
70		Lantai Tiga	12	10	2		12
71		Lantai Tiga	12	11	1		12
72		Lantai Tiga	12	10	2		12
73		Lantai Tiga	12	9	2	1	12
74		Lantai Tiga	12	8	2	2	12
75		Lantai Tiga	12	8	2	2	12
76		Lantai Tiga	12	9	1	2	12
77	Hari Ke-4	Lantai Tiga	12	8	3	1	12
78	Kamis	Lantai Tiga	12	9	1	2	12
79	08/07/2021	Lantai Tiga	12	8	3	1	12
80		Lantai Tiga	12	8	2	2	12
81		Lantai Tiga	12	9	2	1	12
82		Lantai Tiga	12	9	2	1	12
83		Lantai Tiga	12	9	1	2	12
84		Lantai Tiga	12	9	2	1	12
85		Lantai Tiga	12	9	2	1	12
86		Lantai Tiga	12	8	2	2	12
87		Lantai Tiga	12	7	3	2	12
88		Lantai Tiga	12	8	2	2	12
<b>Σ Jumlah</b>				<b>2580</b>	<b>660</b>	<b>456</b>	<b>3696</b>
<b>Proporsi %</b>				<b>70%</b>	<b>18%</b>	<b>12%</b>	<b>100%</b>
<b>Total Kumulatif %</b>				<b>70%</b>	<b>88%</b>	<b>100%</b>	
<b>LUR %</b>						<b>74,27%</b>	

Figure 3 the LUR data obtained.

Tabel 2 LUR Recapitulation

Jenis Pekerjaan	Jenis Kegiatan	Jumlah Pengamatan	Proporsi	Total Kumulatif	LUR
	<i>Effective</i>	2580	70%	70%	
Pembesian	<i>Contributory</i>	660	18%	88%	74,27%
	<i>Ineffective</i>	456	12%	100%	

The proportion of ineffective activities is 12%, one of which is seen in field conditions because the weather is quite hot. the location of the iron work on the third floor is directly faced with the strong reflection of the sun's rays, causing workers to occasionally avoid hot weather to rest. However, this does not affect the value added to the presentation of the effectiveness of workers so that hot weather does not excessively affect the level of worker productivity. The graph below illustrates the proportion of worker activities on the construction project of the Aysha Islamic Hospital - Perum Acropolis Karadenan Cibinong Bogor.



Figure 4. LUR Proportion Graph Image

### Conclusion

Based on the results of the research that has been carried out, the authors take several conclusions, including the following.

1. The average productivity of floor plate iron workers in the construction project of Aysha Islamic Hospital - Perum Acropolis Karadenan Cibinong Bogor was 31.02 Kg/Hour-Person.
2. The productivity value of iron workers varies every day, on the second day (Tuesday 6 July 2021) the lowest productivity value is 28.85 Kg/Hour-Person and 33.55 Kg/Hour-Person on the thirteenth day (Saturday 17th). July 2021) became the highest value.
3. with a Labor Utilization Rate (LUR) of 75% and the proportion of ineffective activities of 12%.

### Recommendation

As for some suggestions based on the results of research that has been done, namely as follows.

1. Calculation of productivity so that it can be used as an illustration for planning or engineering HR management (human resources).
2. The next productivity calculation can be done by analyzing the workforce in various regions of Indonesia by taking into account the cultural elements and characteristics they have.

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