

Samarawickrama, Sumanthri, et al (eds), 2018, "Sustainability for people - envisaging multi disciplinary solution": *Proceedings of the 11th International Conference of Faculty of Architecture Research Unit (FARU), University of Moratuwa, Sri Lanka, December 08, 2018* Galle pp. 271–279. ©

LABOUR PRODUCTIVITY IN PLASTERING WORKS IN SRI LANKAN CONSTRUCTION INDUSTRY

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Abstract

The prospect of labour productivity in Sri Lankan construction industry has been attaining increasing attention as the industry suffers multiple problems related to its workforce. Thus, the need of productivity improvement is essential for successful project completion. At the same time, plastering works encounter in high number of labour productivity issues in the industry, where, the wastage is comparatively high. Therefore, this study explored the correlation between factors affecting the labour productivity and the productivity in plastering work. The literature specified certain factors, which influence the productivity of the labourers within the site. Even though many factors exist in the industry, mainly twelve factors had been categorised under five main headings, such as; management factors, site and resource management factors, project characteristics factors, workforce characteristics factors and external characteristic factors. Research approach for this study was as exploratory mixed method design where a quantitative analysis was enhanced with qualitative review of survey data. The data for the research study were collected through work studies from sites and interviews with professionals in the industry. Subsequently, the analysis was done with the aid of statistical technique and content analysis technique, while, MS Excel and SPSS were the tools used for the analysis. Quantification of labour productivity was expressed in research findings with the help of work studies. The findings revealed the correlation of each factor towards the productivity of labourers in plastering works. However, some factors had positive relationship and some other factors had negative relationship. Thus, the professionals must consider the correlation in order to improve the productivity within the site. Based on the analysis, solutions were recommended in latter part of the research.

Keywords: *Affecting factors, Labour, Labour productivity, Plastering, Work-study*

1. Introduction

Importance of labour productivity in construction arises from its impact on completing projects within their targeted time and cost (Thomas, 1991). For instance, contractors have often focused on labour productivity rates as the primary source of the overall success or failure of a project (Missbauer & Hauber, 2006).

Contractors at the bidding stage of a project are interested in knowing site labour productivity figures, to estimate the labour cost component of the project. Thereafter, if the contract is awarded to the contractor, the company needs to ensure that the estimated level of productivity is achieved or improved (AbouRizk, Knowles, & Herman, 2001). Alan (1987) stated that productivity is commonly defined as a ratio of a volume measure of output to a measure of input use. Improving productivity is a major concern for any profit-oriented organization, as representing the effective and efficient conversion of resources into marketable products and determining business profitability (Wilcox, Stringfellow, Harris, & Martin, 2000).

Teo, Abdelnaser and Abdul (2009) believed that building material wastage on construction sites account for cost overruns and any improvement in building materials management on construction sites has the potential to enhance the construction industry's performance with cost saving benefits. Ameh and Itodo's (2013) research results indicated that the most wasteful building material during construction operation is mortar from plastering/rendering, since it has 40 to 70 percentage of labour involvement. Further Gihan, Ahmed, and Adel (2010) found that labour force has major role in material wastage by the way of re-work, poor material handling, poor workmanship and etc. in plastering work. This seems that labour productivity should increase in order to achieve the project success.

Lema (1995) stated that the factors influencing construction productivity have been the subject of inquiry by many researchers. In order to improve productivity, a study of the factors affecting it, whether positively or negatively, is necessary. Making use of those factors that positively affect productivity and eliminating factors that have a negative effect, will ultimately improve productivity. As there is no any studies focus on plastering productivity, this study aimed to increase labour productivity in Sri Lankan construction industry.

2. Factors Influencing Labour Productivity

It is necessary to determine, whether factors affecting labour productivity act in a positive or negative way (Enshassi, Mohamed, Mustafa, & Mayer, 2007). If all factors having an impact on productivity are identified, it will also be possible to forecast productivity (Lema, 1995).

Thomas, Skitmore, Lam, and Poon (2003) put emphasis on several predominant de-motivators affecting productivity of civil engineering projects, which are rework, overcrowded work areas, crew interfacing, tool availability, inspection delays, material availability and foreman incompetence. At the same time, Mojahed & Aghazadeh (2008) found major productivity factors which have an impact on labour productivity. The top five are skills and experience of the workforce, management, job planning, motivation, and material availability. Ovararin (2001) conducted a comprehensive review on the factors influence labour productivity on construction sites. That study resulted in his categorizing the influencing factors into seven main areas: project, management organization, site and resource management, labour and moral values, acceleration, changes and, external environment. An analytical study was done on these categories, and it was discovered that thirteen factors impart a strong influence towards labour productivity rates at construction sites in the United States of America. They are work planning and scheduling, competency of site supervisors, availability of construction materials, workforce availability, work sequence, congestion, repetition of similar work, communication failure, sub-contractor coordination, unpredictable weather conditions, access to work sites, scheduling of overtime works and, disruption to the workforce on construction sites (Rojas & Aramvareekul, 2003). According to the above mentioned factors the major categories are illustrated in below;

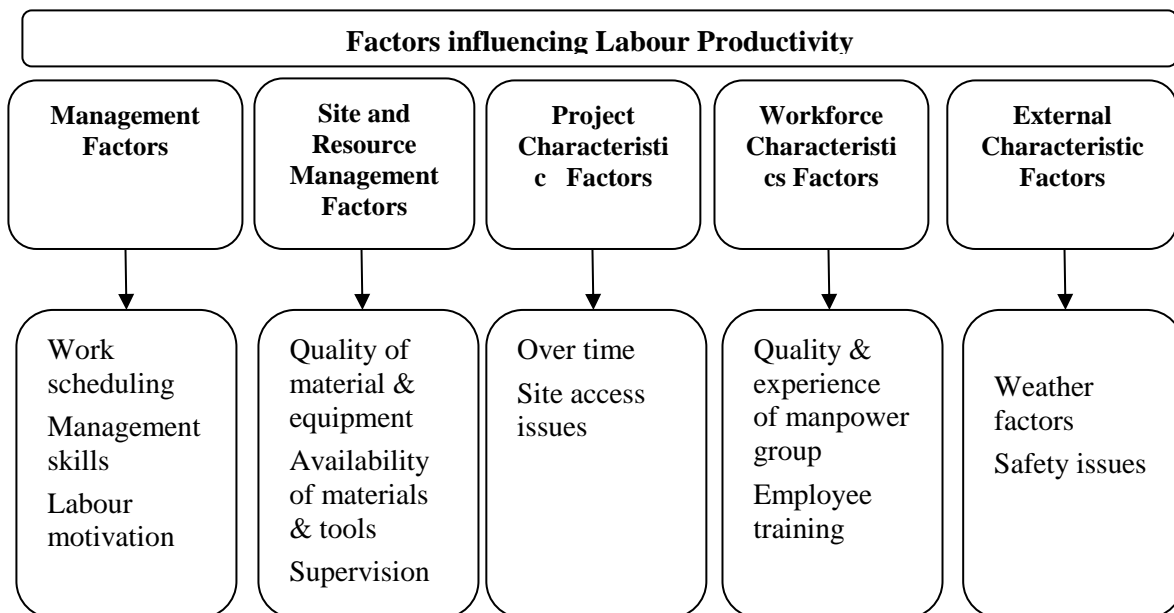


Figure 1: Factors influencing labour productivity (Source: Rowlinson & Proctor, 1999)

3. Research Methodology

Research approach for this study was a quantitative analysis enhanced with qualitative review of survey data, where it is named as exploratory mixed method design (Creswell, 2003). According to Punch (2005) research studies generally contain a number of different research queries. Hence, a research

method appropriate for one question may be inappropriate for another. Considering in this, the procedure was to first gather quantitative data through work studies to find out the productivity of the labourers in plastering works within the Sri Lankan building construction industry. Then qualitative review would be prepared based on the above findings. The review would be conducted from professionals through semi structured interviews to find solutions to increase productivity of Labourers in plastering works.

3.1 DATA COLLECTION TECHNIQUES

The technique used in this research is observation. The data collection process of this particular research comprised of two main components; work study and the semi structured interviews.

3.2 WORK STUDY

Work study is a systematic examination of the methods carrying out activities such as to improve the effective use of sources and to set up standards of performance for the activities carried out. Work study is a term which embraces the techniques of 'Method Study' and 'work measurement' which employed to ensure the best possible use of human and material resources (Rahman, 2007).

3.2.1 Time measurement study

Time measurement study is also called work measurement. It is essential for both planning and control of operations. Time study refers the application of techniques designed to establish the time for a qualified worker to carry out a specified job at a defined level of performance (Rahman, 2007). The work study focused on nine building construction projects consists 4 residential building, 2 office building, 1 car park, 1 hotel building and a factory building which were carrying plastering works on site. Complete time measurements of the works were recorded in order to carry out the research study. The data collected with the help from supervisors and the labourers.

3.3 SEMI STRUCTURED INTERVIEW

The main objective of the interviews is to identify the solutions to increase productivity of labourers in plastering works in the Sri Lankan building context. According to Sekaran (2003), when interviews are conducted in semi-structured manner, it permits to adapt the queries necessary, clarify doubts and ensure that the response is appropriately understood by repeating and rephrasing the questions. Therefore, semi-structured interviews would be conducted with 10 professionals in construction industry includes project managers, site engineers, planning engineers and technical officers to achieve objective of the research. At the same time, labour interviews also covered to ensure the validity of data.

4. Research Findings and discussion

Research findings collected from the work study and interviews. Complete time measurements of the works were recorded in order to carry out the research study. The data collected with the help from supervisors and the labourers. Identified factors related to labour productivity has been compared with literature findings and discussed under this section.

4.1 WORK SCHEDULING

Construction professionals stated that schedule compression may effects the labour productivity either positively or negatively. During a schedule compression period, labourers are motivated by the company to work efficiently and effectively in order to achieve target on time. Thus, the productivity rate will tend to increase more. On the other hand, more resources are scheduled by project planners to the work in a compression period. As a result, non-productive time of labourers has a tendency to rise. Construction professionals always consider about this non-productive time of labourers, because, it effects the productivity rate. They held that outdated schedules, schedule communication errors, complicated programme and lack of details are main reasons of productivity loss.

In plastering works, some skilled labourers have a capacity to complete more areas in one day, but some skilled labourers have not that capacity. As same as, work pressure may reduce their working capability. Therefore these matters should be considered in work scheduling on site.

4.2 MANAGEMENT SKILLS

Several projects mainly concern on early finish of works. Thus, the managers drive the labourers to do the work on time. It results high productivity and reputation to the firm. Yet, workers are highly paid by them to achieve the target. It may reduce organization's profit margin. Interview respondents said that they appoint sub-contract labourers to finish projects as soon as possible. In addition to that managements hire labourers for low cost and get high profit on it. However, their working speed much lesser than highly paid workers.

Table 2: Data regarding average income of gang per hour

Site	Direct/ Sub Labour	Average Income of gang per Hour (Rs/hr)	Total productivity (m ² /hr)	Total productivity (m ² /Rs)
A1	Direct	84.72	0.46	0.0054
A2	Direct	80.56	0.39	0.0048
A3	Direct	83.33	0.45	0.0054
B1	Sub	141.67	0.59	0.0042
B2	Sub	137.50	0.63	0.0046
B3	Sub	141.67	0.65	0.0046
C1	Sub	133.33	0.71	0.0053
C2	Sub	127.78	0.58	0.0045
C3	Sub	133.33	0.73	0.0055

Table 02 obviously stated that average productivity of direct labourers little bit higher than sub-contract labourers in terms of money. On the other hand, hourly productivity rate of the direct labourers is much lesser than sub-contract labourers. Moreover it will result in late completion of projects and it will directly affect to the company reputation. Selecting suitable labour gang to the suitable area is another important thing in management. Interviewees pointed out that a good manager can get maximum output from the average level workers. In a critical plastering area, managers can appoint efficient work force to get higher productivity. In certain instances, inefficient management may waste the labour resource.

4.3 LABOUR MOTIVATION

Labour motivation is also one of the factor which affects the labour productivity. The respondents said that empowering employees is one way to encourage employee motivation, whereas empowerment can be achieved in the way of salary level, timing of payment, provision of transportation, proper communication etc. At the same time they held that unmotivated workers can cause loss of productivity associated with excessive down time and lack of concentration.

As per collected data, average productivity level of the labourers is increasing in accordance with average salary level. With attention to first instance, where skilled labourers get 800 rupees, average productivity level was very low compared to other ones. As a result, they work for long hours beyond the limited working hours to get more money. For example, in the site A3 workers were working routinely from 8 am to 10 pm anyhow it will increase the total output. On the other hand it will decrease the productivity of the labourers.

During the conversation with the labourers, they held that they were reluctant to work when payments are delayed or like to be delayed. Some instances they may go for strike to get reasonable solution. With regard this matter, professionals stated that salary delay may be occurred by the delay in payment due on an interim bill or insolvency of the contractor.

4.4 QUALITY OF MATERIAL AND EQUIPMENT

In the studies, it was identified that the common plastering mixes are 1:3 and 1:5. In some sites these mix proportions were not in accordance with mix proportions stated in BOQ. The main reasons for that were less experienced workers, ineffective supervision and so on. The workability of the mix should be ensured by mix proportions.

Table 3: Type of the mix vs. average productivity

Type of the mix	Nr of sites	Average productivity (m ² /hr)
1:3	06	0.62
1:5	03	0.50

Table 3 shows that mortar mix 1:3 has high workability than 1:5 mix. The first mix has high bonding capacity, thus the mortar easily bonds with the surface. As a result the productivity is higher in first proportion. Furthermore, selection of the appropriate type and size of construction tools often affects the required amount of time to complete the work, therefore, site managers/supervisors should be familiar with the characteristics of the major types of tools and equipment most commonly used in construction. During the conversation with the workers, they said that their own tools were more convenient to use for the works. A good trowel and hawk tool are necessary to apply the mortar on the surface. At the same time clear straight edge will help to level the mortar surface. If the length of straight edge is high, then the area coverage for the plastering work will increase within the given time. Therefore, total productivity of the work also increase. Further, plumb is also an important tool to ensure the verticality of the plaster. If the plumb is inaccurate, the rework will encounter in the site, which will reduce the total productivity of the work. In addition, smooth finish of the surface is guaranteed with the help of proper float. Workers always seek good tools to finish the work tidily, since they rely on it.

4.5 AVAILABILITY OF MATERIALS AND TOOLS

Availability of materials and tools also one of the factor which affects the productivity in severe manner. The respondents held that if the system cannot detect shortages far enough in advance of material needs, the result is last-minute shuffling of work crews. If the quality of materials supplied is sub-standard, either the material is rejected or it is used, but requires additional man hours to install. Rejected material must be removed and replacement material handled; both operations require unanticipated man hours which may affect the productivity of the labourers.

The professionals noticed that effect of poor material management is delays in delivery. These delays have an effect similar to errors in quantities, because the work flow is disrupted and must be re-planned. Disruptions cause lost time and necessitate non-productive work to remedy the situation. As same as the material management, location of the work also has an effect on availability of material. As per the work study, results are summarized below;

Table 4: Location of the work vs. Average productivity

Site	Location of the work (floor)	Hoisting method	Total productivity (m ² /hr)
A1	Ground	No	0.46
A2	6th	Mobile crane	0.39
A3	2nd	Mobile crane	0.45
B1	3rd	Mobile crane	0.59
B2	1st	Chain block	0.63
B3	Ground	No	0.65
C1	10th	Tower crane	0.71
C2	16th	Tower crane	0.58
C3	5th	Tower crane	0.73

According to the table 4, the flow of the productivity is not in a sequence manner. The reasons behind the instances are depend on some other factors described in the research. At the same time usage of equipment also has a significant effect in this regard. Most of the sites have either tower or mobile crane to hoist the materials to the correct position; as a result productivity may vary from site to site.

4.6 SUPERVISION

Supervision is a site management factor, which directly effects the labour productivity. The interview respondents said that direct supervision is much needed for the successful work completion on site. In the case, supervisor must have the competence to guide the labourers to achieve the desired goals, since, inefficient supervision may lead for reworks, slowdown of works, errors in the works and loss of profit. Sites, which have supervision, got higher productivity than the other ones. Putting plaster guide, checking plumb level, quality checking, guiding the labourers are the main areas of work supervisors to

perform. Thus, supervisors must accomplish their tasks in an efficient way to overcome the productivity issues.

4.7 OVERTIME

There is a contradiction exists among the professionals about the overtime factor relating to productivity; whether it affects or not. However, most of them noticed that working overtime will not give serious impact on productivity up to certain extent. Because, the normal working period is 8am to 5pm but workers can continue the work until 8p.m. or 9p.m. without losing their ability. Then, there could be loss of productivity beyond that time period due to some reasons, such as; loss of concentration, reduced supervision effectiveness, reworks, accidents and etc.

During the work study, it is noticed that workers were working very slowly until the evening and seek for overtime to complete the job. Especially on sites A1, A2 and A3 had this situation. The obvious reason behind the situation can be identified as salary level. If the workers got low salary level then they will seek for overtime works to cover-up the insufficient salary level.

4.8 SITE ACCESS ISSUES

Site access must be cleared prior to commence the work, if not, the non-productivity time of labourers have a tendency to rise. Thus, productivity will fall down. Interviewees identified that interference to the convenience or planned access to work areas are due to blocked stairways, roads, walkways, insufficient man-lifts, or congested work sites.

Table 5: Place of plaster vs. Average productivity

Int/Ext plaster	Nr of sites	Average productivity
Int/Ext plaster	01	0.46
Internal plaster	05	0.63
External plaster	03	0.52

Site access may depend on the place where plaster is applied. External plastering has high difficulty and poor access than the internal plaster. Working space, scaffolding preparation and access permission are some reasons which should be considered in external plastering. *Table 5* illustrates the place of plaster vs. average productivity, while the high productivity (0.63) is achieved in internal plastering. Since there may be easy access in internal plastering than the external one.

4.9 QUALITY & EXPERIENCE OF MANPOWER GROUP

Workforce characteristic factors must be considered by professionals to achieve desired productivity of labourers. These factors consist with age of the labourers, experience of the workers, quality of the workers and size of the crew. Site manager should check and evaluate these factors in order to carry out the works.

Table 6: Age class vs. Average productivity

Age class (Yrs)	Nr of labourers	Percentage	Average productivity (m²/hr)
20-25	04	15.38 %	0.59
25-30	08	30.77 %	0.57
30-35	03	11.54 %	0.55
35-40	04	15.38 %	0.65
40-45	03	11.54 %	0.47
45-50	01	3.85 %	0.45
Over 50	03	11.54 %	0.43

As per the table 6, nearly 31% of workers in the age group 25-30 years and it exposed that the young generation's involvement in construction industry is become viable in nowadays. It's somewhat healthy to the industry, where, innovations, better improvements, self-motivation and quality of work may arise in that age period.

Table 7: Experience vs Average productivity of labourers

Experience class (Yrs)	Nr of Skilled labourers	Average (m ² /hr)	productivity
0-5	02	0.49	
5-10	10	0.60	
10-15	05	0.58	
15-20	18	0.46	

According to the table, it has revealed that the productivity will tend to reduce after 10 years of experience. This may be caused by aging of the labourers, less job satisfaction and less motivation. However, there is a quite higher productivity in 5-10 years' experience class.

4.10 EMPLOYEE TRAINING

The respondents held that the construction industry always seek for skilful labourers. Since, it can be achieved from proper education and training programmes. However, during the study it is noticed that the training programmes for plasterers is given only in the organisation A. Even though, the productivity is little bit lower than the other organisation. The managers of the organisation A explained that the benefit of the training programmes will focus on long term basis. Thus, it cannot expect the high productivity in short term period.

Method of learning also incorporate in productivity issue. Course based learning and the traditional learning are the two main methods of learning available in the industry. Some technical colleges provide the technical studies along with the training. At the same time, traditional method of learning is given by experienced labourers to unskilled labourers, thus, they will catch-up and become skilful workers in the industry. However, in the traditional method, skilled labourers are reluctant to teach their subordinates, since, they believe that the subordinates will catch their place in the industry.

Table 8: Method of learning vs. Avg. productivity of labourers

Method of learning	Nr of skilled labourers	Avg. (m ² /hr)	productivity
Course	04	0.54	
Traditional	14	0.59	

According to the *Table 8*, productivity from traditional method of learning is little bit higher than the course based learning. However, as per the professionals thought aforesaid, the benefits are planned in long term basis. In some sites, the workers are advised and trained to minimize the wastage in the work. The wastage reduction is incorporated with labour training, while, the well trained worker can judge how to execute the work with efficient way.

4.11 WEATHER FACTORS

Weather condition also is a factor which effects the labour productivity. The weather condition of the sites includes temperature, raining pattern, and humidity level and wind movement. Up to some extent weather conditions are unpredictable. In that case, it causes delays and disruption to the works. Thus, the productivity tends to fall down.

Table 9: Weather condition vs. Average productivity of labourers

Weather condition	Nr of sites	Avg. (m ² /hr)	productivity
Normal	7	0.60	
Mild rainy	1	0.59	
Rainy	1	0.39	

According to the *Table 9*, in a rainy situation the productivity of the workers decreases than usual. Because, non-productive time of labourers is high in rainy conditions. However, site manager must aware of these situations and plan for the works regard to the site weather status. Labourers cannot do the external plastering work, when, rain falls severe in the site. Though, they can arrange the internal plastering works.

Humidity level also got effects in plastering work. The plasterers are required to wait for a period, allow to dry the surface after applying of plaster prior to level the surface. If the environment become saturated then the waiting period will tend to be long, thus, the productivity tends to decrease. Moreover, saturation becomes high in rainy season.

Furthermore, temperature also effects the labour productivity. The respondents said that too hot temperature or too cold temperature is not suitable for construction works. The work study results are summarized below;

Table 10: Temperature vs. Average productivity of labourers

Temperature	Nr of sites	Avg. productivity (m²/hr)
27	2	0.49
28	6	0.60
29	1	0.63

As per the *table 10*, the productivity become higher in accordance with site temperature. The higher productivity (0.63) is recorded at the temperature of 29° Celsius.

However, the contractor must be aware on the humidity level and the temperature. If the site environment becomes fully saturated at certain temperature, then there will be long time required to dry the surface. On the other hand, if the saturation becomes lower than usual, then the plaster will quickly dry after mixing. Thus, the mortar's adhesive efficiency will be reduced and consequently, it would not be suitable for plastering works. Therefore, engineers must forecast the weather conditions.

4.12 SAFETY ISSUES

Many professionals explained that the safety issues has positive effects on labour productivity. Some workers productivity may decrease with safety equipment in the way of taking certain time to adjust helmets, safety belts and gloves. However, it will reduce the accidents arise in the sites, thus, it is beneficial to the contractors as well as the workers.

Moreover, the respondents said that the construction is one of the most unsafe industries and the major causes of accidents are related to the unique nature of the industry, human behavior, difficult work-site conditions, and poor safety management, which result in hazardous work methods, equipment, and procedures. Preventing occupational injuries and illness should be a primary concern among both employees and employers.

In a construction site, safety may be categorized with the height of the work. The risk may be high in accordance to the height of work. Thus, the data arrived from the studies are tabulated below;

Table 11: Height of scaffolding vs. Average productivity of labourers

Height of Scaffolding (m)	Nr of sites	Avg. productivity (m²/hr)
2	6	0.61
12	1	0.59
21	1	0.39
60	1	0.58

According to the *table 11*, labour productivity has inverted relationship with the height of work. The safest place to work is in floor level, since it has discovered in the picture, where the high productivity (0.61) is recorded in the height of 2m. The interviewees stated that in the construction industry, the working environment is constantly changing sites that exist for a relatively short time as well as activities and inherent risks that change daily. Thus, the safety plan must circulated among the workers to cover all risky situations.

5. Conclusions

In conclusion, it can be affirmed that the aforementioned factors have significant impact on labour productivity in plastering works. However, the degree of impact may vary from factor to factor.

Thus, finding the correlation between productivity and the factors will help to predetermine the impact on labour productivity and, it leads to better improvements in the construction industry. It is expected that the findings of this research will assist professionals to be aware on labour productivity issues.

During the work studies and the interviews, it has revealed that the industry suffers from labour productivity. Thus, the solutions for increasing labour productivity are analysed on the basis of interviews and work studies.

Schedule the work on site with appropriate resources in order to avoid poor scheduling, Select proper gang (direct or sub contract) to the work area to ensure the proper completion and profit, Provide guidelines about the labour attitude to the site. Starting time of work, lunch and tea breaks and, over time should be strict by the management, motivate the workers by the way of financial and psychological terms. Offer gifts and incentives to the good workers. At the same time, talk personally with the workers and, identify their problems, Assign 'Quality Assurance' team to ensure the quality of the material and tools within the site, Practice 'waste management strategy' within the site to increase efficiency of the labourers, Ensure material procurement and management system is effective on site to reduce waiting time and work delay, Appoint qualified staff to the site, which will always increase the labour productivity, Forecast the climate conditions to avoid unnecessary struggles within the site

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