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Review Article:

Labor Productivity of Gypsum Plastering in Sulaimani City's Projects

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Abstract

In this study the labor productivity (LP) and the effects of main factors on LP in building projects in Sulaimani City practically on field sites were investigated for gypsum plastering (GP) works. Accordingly, the most important effective factors on LP were, height(h), number of skilled laborers (SkL) and Crew size (Cz). 30 practical data on field sites were practically observed.

The results showed that the minimum and maximum LP were between 10.53 and 23.73 m2/hr. The average LP was 15.2 m2/hr., while h=0-3 m, SkL=1-2 laborers and Cz=2-4 laborers. The study investigated that the h, SkL and Cz had a direct effect on LP, while it is found that the age and experience of laborers had a slight effect on LP. A model with a significant relation R^2 97.5% with the factors was found to predict the LP for gypsum plastering.

1. Introduction

The Kurdistan Region Government (KRG) allocated a huge budget and spent a massive amount of fund in the construction's fields annually. 30-60% of the total cost of the constructions was for labors.

The labor productivity (LP) was a very sensitive factor affecting the performance of the

construction projects. The LP for each type of work is different and would vary depending on their circumstances, the LP should be enhanced during the researches to obtain an accurate measurement of LP in the fields of the constructional works according to the different factors that affecting LP. (Aziz, J. S., 2015)

High growth of productivity especially of the labor productivity will affect all the economic and social activities. The labor productivity improvement in the industry will impact on the production capacity, quality of the produced commodities, reduction of costs, reduction of the prices of the investigation of the investment. (Mostahsan, Z. E., 2013)

The Gypsum Plastering (GP) is one of the most common finishing works, especially inside the buildings. The gypsum plastering is an economical type of the finishing works, easy to use, workable and have a nice view, therefore, this study focused on the finishing of the buildings using the Gypsum plastering. Limitations and hypotheses of the research can be summarized as following:

1- The research was limited only to find the LP of the first coat of the gypsum plastering, because it was the most common use in the Sulaimani City.
2- All the works of the constructions were under the engineering supervisory.
3- The owners were took all the responsibilities of (the laborer wages, materials costs, equipment renting costs, tools cost and providing transportation), therefore LP were not considered for (movements of the materials inside the work, the transportation and cost of the materials and the equipment).
4- The gypsum material was provided from the Bazian Gypsum Factory with the coordination (35.632561° N, 44.964601° E)
5- All the walls which were covered by the gypsum plastering were built up by hollow block concrete.
6- Ventilation: There was fresh air flow in the working area.

1.1. Research Aim

The aim of the research was to:

1- Study the actual and practical side of the LP on the sites of the first coat of the gypsum plastering in the Sulaimani City.
2- Identify and quantify the true factors that have direct effects on the LP upon the first coat of the gypsum plastering works.
3- Build up a model to predict the LP considering all the factors that have effect on the LP.
4- Find out the actual effect of each individual factor on the LP.
5- Find the impact of the existing factors that have effect on the LP (which were studied by the previous researchers) when they were exchanged to the factors that were considered in experimental part of this research.

2. Background and Literature Review

2.1. Definitions

a) Productivity can be defined in many ways. In construction, the productivity usually is a unit of work that is placed or produced per man/hour. The inverse of the productivity, man/hours per unit of work (unit rate), is also commonly used. Productivity is the ratio of the output to all or part of the resources that were used to produce the output. The output can be homogenous or heterogeneous. Resources comprise: Laborer, capital, energy and raw materials. (Attar A. A., 2012)

b) Efficiency is the ratio of the current work experience of the worker to the minimum required work experience. (Nasirzadeh F., Nojedehi P., 2013)

2.2. Literature Review

a) According to the study that was done on the previous researches, the LP was affected by more than 108 factors. Among them, there were 47-factors that were came up three times or more in the previous researches as summarized in Table 1, some of the factors had direct and dramatic effect, but the other some had a slight effect on the LP. (Hickson, B. G, 2014)

b) Skilled Laborers in Britain: The job that demanded skill which the worker usually had to be trained for, or the workers that provide this Laborer. (Collins English Dictionary, 2014)

c) Skillful, efficiency, skilled, expert refer to readiness and adroitness in an occupation, craft or art. Skilled implies having had long experience and thus having acquired a high degree of proficiency. Expert means having the highest degree of proficiency; it may mean much the same as skillful or skilled. (Dictionary.com, 1995)

2.3. Factors affecting the labor productivity

The factors affecting the construction productivity are rarely constant, the surrounding circumstances will make the factors vary from country to country or project to project. The factors will be varied even within the same project. The factors can be classified in to two categories: external and internal. The external factors contained the factors that were out of the control of the firm's management. The internal factors included management, technology, laborer, and laborer's unions. (Enshassi, A., etal, 2014). Another study investigated that the increase in the age affected the LP by 73%, and the confined space affected the LP by %53 (Ugulu, R. A., & Allen, S., 2017). Some studies concluded that some selected factors considered to be the major factors that had effect on the LP, those were (Crew size, the skill and the experience of the laborers),(Kisi, K. P., 2015). Working Space, skill of the workers, the weather, the temperature and the LE were considered to be the important factors that had effect on the labor productivity. In case that the amount of labors exceeds a case depended maximum value lack of working area was negatively affected the LP. The lack of the working space was defined as the ratio of the required working area to the available area. (Nasirzadeh F., Nojedehi P. 2013).

2.3.1. Studies that depended on the Experimental Attempts

As a result of the study of the previous researches, it was rare to see any conducted research where the LP was calculated in the practical way depending on the tests and measurements on the sites. It was noticed that there was a huge gap in the previous studies, due to the lack of implementing the practical way of the measurement of the LP on the sites for the gypsum plastering. Many studies were performed, but depended on the questionnaires survey, except for the two researches that had measured the gypsum plastering LP as 4 m^2/hr. of a suspended slab with the thickness of 15 mm of the coat (Enshassi, A., etal, 2011), (Park, H. S, 2006).

Studies in different countries had conducted and included the same factors that were mutual in this study. In the previous researches, only limited factors were considered. Those limited factors were turned up each three times or more in the previous researches. The relative important

index proportion (RII%) of the factors according to the previous studies were summarized in the Table 1. Accordingly, the 6-most important factors were sorted out based on their RII%, from the highest to the ranking. And the 6 factors were (Years of Experience, Age of the Laborer, number of the Skilled Laborers, height of the wall, Working Space and the Crew size) with their RII% of (85.8, 73.4, 72.5, 65.4, 59.2, 58.9 % respectively).

3. Methodology

3.1. Experimental Attempts

Four constructional sites had been selected, they were different in types such as (Multistory, commercials and houses). Overall 30 practical data were gathered. The LP have been measured and recorded on the sites. The dimension of the selected sites was deferent, each floor of the multistory buildings was consisted of four apartments, and the area of each flat was between 100-120 m2, the gypsum plastering was done for all the places of the flat except the bathes. The commercial building was consisted of first floor of a structural building in three floors, the first floor was consisted of two halls with dimension of 6*10 m and two rooms with dimension of 5*6 m. moreover the house were consisted of 150 m2 area and the gypsum plastering was performed to the rooms with 4*5 m and bathes 1.2*2m.

An inspection data sheet had been prepared to facilitate recording of all the available data on sites; The starting and ending point of each work were usually different. Gypsum plastering usually started after 5:00 am and was finished in different times before 6:00 pm. The inspection data sheets were filled out for the items and the necessary notes were recorded.

The procedure of data collection lasted for 8 hours per day for 6 days a week from the start to end of the works. At the beginning of each work activity, the time span was measured and recorded using stopwatch. The stopwatch was used from the start to the end of each work. Then the dimensions of the product were measured using measuring tape. Other data and factors that had effect on the LP, were also recorded on the inspection data sheet as summarized in Table 3.

An inspection form was filled out for each work recording the six-main important factors on daily bases. The 6 main factors were: (Age of the skilled laborers (Ag), years of experience of the skilled laborers (Ex), height of the work (h), Space of the works (WkS), Crew size (Cz) and number of the skilled Laborers (SkL)). In addition to that an extra of five other secondary factors were also considered and recorded. They were: (the labors nationality, the period of the payment basis, the weather, the temperature and the material type of the walls).

The LP for each individual work had been calculated by measuring the time durations and the area of the surface of the product for each single attempt. And they were all recorded on the data sheet.

Then the LP had been calculated for each individual work using the LP Equations No. 1.

$$LP = \frac{Output}{Work\ (hour)} \quad (1)$$

(Shehata, M. E., & El-Gohary, K. M.. 2011), (Attar, A. A., etal, 2012), (Odesola, I. A., etal, 2015)

The LP for each work had been calculated considering the time durations and the product area.

A summary sheet was prepared including all the factors using the statistical equation no. 2.

In this, the multi variable liner regression was calculated, two tails of F-test were checked through the Analysis of Variance (ANOVA) test. Correlation (R^2), the P-value, and the standard

deviation were all measured for all the frequented data as they were summarized in the Table 2.

$$y = z+aX1+bX2+cX3+\ldots \quad (2)$$

y : Multi variable liner regression

a, b, c : Constants

X1, X2, X3 :Variable Factors

3.1.1. The First Coat of the Gypsum plastering in the National Style (GP1_Iq)

A total of 30 data had been gathered and recorded from the sites. The variable factors of (h, SkL, Cz, Ag, Ex and Cty) were all considered. The procedure of the work was as follow:
Covering the walls with the thickness of 2cm of the Gypsum Plastering. The work was fulfilled according to the following steps :(Iraqi Ministry of Planning, 2015), (Iraqi Standard Guide, 2012).

a) All the walls were washed and cleaned up by water before the covering starts.

b) The walls were rendered with a prime coat using scrapers to spread the cement mortar on the wall in the ratio of 1:4 (cement to sand). This would make the wall obtain a ruff surface to facilitate the paste of the gypsum plastering.

c) Vertical gypsum shimming was made by vertical leveled shims 5*2 cm each 60-80 cm with gypsum plastering to ensure the vertical alignment of the walls.

d) After waiting a day or more, covering the walls with the first coat of the gypsum plastering were started using the trowels. Then after a period of 1 -2 minutes, the skimming and adjustment to that layer of the gypsum plastering were performed using the rulers and then smoothened by the steel trowels.

3.2. Theoretical works

Tried to look for the similar subjects within the previous researches to find the RII% of the factors that were affecting the LP, moreover searched for the factors that were considered by the previous researchers. This research was considered (h, SkL, Cz, Ag, Ex, Cty), then the impact factors (Relative Important Index Proportion). A (RII%) for each factor were found, then all the factors were sorted out according to their RII% that were found by the previous researchers.
It was investigated that there were 47 different factors affected the LP, only those factors were considered in this research that were came up 3 or more times in the previous researches, and they were (h, SkL, Cz, Ag, Ex, Cty). The RII% was calculated for the previous researches as shown in the Figure 1.

4. Results And Discussion

4.1. Experimental Works

4.1.1. The Effects of the Factors on the Labor productivity

Data analysis depended on the statistical analysis tests and the equations. ANOVA test had been performed for Gypsum plastering in the national Style, the relationship between the LP and the factors had been found using the R^2 (Linear Multi Regression) and the significant F was tested, in addition to two tail for F-test and calculate the P-value for all factors, with using confident interval 95%. the R^2 >60%, F ≤ 5%, P-Values < 5%.
As a result, overall statistical indicators as (R^2, F, P-value) presented the correlation between each factor with the LP, and relationship between overall factors and LP.

Different types of buildings such as multi-storeis, commercial buildings and the houses, different number of skilled and non-skilled Laborers were included, various ages and years of experience and various height of buildings included in the works. The LP had been measured, and standardized. The standardized Statistical Process Control (SPC) had been used to check the normality of the data, ±1Standard deviation (STD), ±2STD, ±2.5STD and ±3STD had been indicated on the LP charts. As a result, it had been notified that 93.3% of the gathered data were concentrated between (-2STD to +2STD) and 6.66% were outlier concentrated between +2STD to +3STD, therefore the distribution of the data considered to be the normal distribution, it could be considered as an acceptable data as shown in the Figure 2.

4.1.1.1. Checking liner multi regression for the first coat of the gypsum plastering in the national style.

The relationship between the LP of Gypsum plastering in National Style and the factors considered as strong relation according to the R^2=97.1%, the significant F=8E-13 and the P-Values of the factors (h, , SkL, Cz, Age, Ex.) were (2E-04, 3E-13, 1E-12, 3E-13, 7E-11) sequentially, the values of minimum, maximum and average LP had been found. In addition to the STD and Coefficient of Variance (C.v). have been measured as summarized in the Table 2.

a) Effect of the height on the labor productivity

The Height had a significant effect on the LP. The LP for the height of (0-2) m without using scaffolding, was between (12.65-23.73) m^2/hr, while the minimum LP ($LP_{min.}$) and maximum LP ($LP_{max.}$) were slightly decreased through using scaffolding at height of (2-3) m to (10.53 and 16.27) m^2/hr as shown in Figure 3.

Using scaffolding decreased the $LP_{min.}$ from 12.65 to 10.53 m^2/hr., by a proportion of 16.8%. moreover, using the scaffolding decreased the $LP_{max.}$ from 23.73 to 16.27 m^2/hr. by a proportion of 31.4 %. The height had a significant effect on the LP, as the average rate of LP ($LP_{average.}$) under the height (0-2) and (2-3) m were (17.0 and 14. 7) m^2/hr.

b) The effect of the number of the skilled laborers (SkL)

considered as a slight effect on LP. Using 2-SkL slightly increased $LP_{min.}$ from 10.53 to 15.2 m^2/hr. as shown in the Figure 4.

c) The effect of the crew size (Cz) on the LP.

Increasing the Cz from 2 to 4, changed the LP, using the Cz of three laborers, increased the LP from 10.53 to 17.55 m^2 /hr, whilst using 4 Cz number of labor, changed the LP from 15.19 to 23.73 m^2/hr. and this is an increase of the $LP_{min.}$ from 10.53 to 15.19 m^2/hr. and increased the $LP_{max.}$ from 17.55 to 23.73 m^2/hr. when the Cz increased from 3 to 4 as shown in the Figure 5.

d) The effect of the age (Ag) and the years of the experience (Ex)

on the LP considered as an insignificant effect on the LP as shown in the Figures 6 and 7.

4.1.2. Modeling

Model 3 was found through liner multi regression R^2= 97.4 to predict the LP. The model included the following factors (h, SkL, Cz, Ag, Ex and Cty). The range of each factor were indicated as summarized in the Table 2.

LP = (-52.36 – 2.079 * h – 16.168 * SkL + 7.763 * Cz + 3.093 * Ag – 1.709 * Ex – 5.308 * Cty) (3)

To ensure the efficiency of the found model, a comparison between the results of the predicted LP and the actual experimental LP was conducted. The actual experimental LP which were gathered from the sites, were compared with the predicted LP, which were found through the newly invented model. 30 different data of the experimental LP were taken from 30 different samples as summarized in 7 columns in Table 3. In both, the experimental and the predicted LP, the same factors were used. The independent factors are the actual experimental LP from the field sites, and the dependent factors is the predicted LP. The coordination points compound of x- axis (which were the actual experimental LP from the field sites), and the y-axis (which were the predicted LP). As a result, the trend line between the experimental and the predicted LP was drawn. The R^2 (the sensitivity of the trended line) value was 96.4%, as shown in the Figure 8. The procedure of calculating and checking the accuracy of the model was as follow:

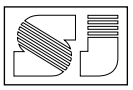
4.1.3. Model accuracy check procedure (MACP)

1- All the experimental data samples were labeled from 1 to 30 as shown in column 2 in Table 3.
2- The site measurements of factors were recorded in column 3 in the same Table 3, and applied codes for country as 1 for Iraqian and 2 for Iranian laborers.
3- The factor's coefficients resulted from the liner multiple variable regression previously were recorded in column 4 in the same table 3.
4- The factors in column 3 multiplied by the coefficients of column 4 and recorded in column 5.
5- All the results in column 5 were collected and recorded in column 6 and nominated as the LPPredicted.
6- The actual LPactual were recorded in Column 7.
7- A Graph was drawn between the column 6 and 7, which were the LPPredicted. and LPactual. The x-axis was the LPactual and the y-axis was the LPPredicted.
8- A linear trend line was drawn for the drawn chart showing the accuracy or compares between the LPactual that were gathered from the sites and the LPpredicted that were calculated from the Model 1. As the result of R^2 was 96.4% it means that the LPPredicted was near from the LPactual.

4.2. Theoretical works

Comparing with the previous studies, the RII% for each individual factor were found. A total of 108 factors were found. Only 47 factors among the total of 108 factors were frequently repeated 3 times or more in the previous studies. The average of the RII% for the individual factors were found. All the factors were sorted out according to their RII% from the greatest to the least as summarized in the Table 1.

The six most important factors that were mutual between this and previous studies and turned up three times or more in previous researches were Ex, Age, SkL, h, WkS and Cz. These six factors were affected the LP according to the previous researches and they were sorted out according to their (RII%) from the greatest to the least as 85.81, 73.68, 72.47, 65.57, 59.20 and 58.87% consequently as shown in the Figure 2.



5. Conclusions

The study concluded that there was a significant relationship between the LP and the six factors (h, SkL, Cz, Ag, Ex and Cty). Moreover, using the predicted model, turned out that the sensitivity of predicted LP was R^2 =96.4%.

- The effect of the height on the Labor productivity: The height had a significant effect on the LP. When the gypsum plastering performed on the scaffolding, the $LP_{min.}$ and $LP_{max.}$ were decreased by 16.8 and 31.4%. The $LP_{average.}$ was decreased from 17 to 14.7 m^2/hr. using scaffolding.

- Effect of the number of the skilled laborers (SkL) on the Labor productivity: Increasing the number of SkL from 1 to 2, slightly increased the $LP_{min.}$ from 10.53 m^2/hr.by a proportion of 44.3%

- Effect of the crew size (Cz) on the Labor productivity: Decreasing the Cz from 4 to 3 number, slightly decreased the $LP_{min.}$ from 15.2 by a proportion of 30.7%. Whilst increasing the Cz from 3 to 4 number, dramatically raised the $LP_{max.}$ from 17.55 by a proportion of 35.2%.
- A direct effect of age on the LP was not found for the SkL ages between 26-35 years old.

- A direct effect of the experience on the LP were not found for the years of experience between 5-14 years.

- The research concluded that the factors affected the LP and were used by other researchers were different from the factors that were used in this research.

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إنتاجية العمال لعملية البياض بالجص في المشاريع بمدينة السليمانية

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المستخلص

في هذه الدراسة تم ايجاد إنتاجية العمل وتأثيرات أهم العوامل الرئيسية التي تؤثر على إنتاجية العمل لأعمال البياض بالجص لمشاريع البناء في مدينة السليمانية بطريقة عملية ميدانية في مواقع البناء. بناءً على ذلك ، أظهرت النتائج إن أهم العوامل الرئيسية الفعالة على إنتاجية العمل كانت : أرتفاع الجدار وعدد العمال الماهرين وحجم الطاقم. تم أخذ 30 بيانات عملية ميدانية في مواقع العمل. أثبتت الدراسة أن الحد الأدنى والأقصى لإنتاجية العمل كانا يتراوحان بين (10.53 و 23.73) م2\ساعة وبمعدل (15.2) م2\ساعة عندما كان الأرتفاع بين 0-3م وكان عدد العمال الماهرين يتراوح بين 1-3 عمال وحجم الطاقم كان يتراوح بين 2-4 عمال. كما وأثبتت الدراسة أن أرتفاع الجدار وعدد العمال الماهرين وحجم الطاقم له تأثير مباشر على أنتاجية العمل ، بينما كان عمر وسنوات الخبرة للعمال الماهرين لهما تأثير طفيف على أنتاجية العمل. كما تم أستنباط معادلة دقيقة بنسبة أنحدار 97.5% (R^2) من خلال الأرتباط المعنوي بين العوامل وإنتاجية العمل ، وذلك لفرض التنبأ بأنتاجية العمل لأعمال البياض بالجص.

الكلمات المفتاحية: البياض بالجص ، أعمال التشطيبات الداخلية ، إنتاجية العمل، قياس إنتاجية العمل ، سنوات الخبرة.

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Table 1: Factors affecting LP and their impacts according to theoretical way in previous researches and 3 or more frequently used. (Source: Researcher)

	Ser. No.			Ser. No.
Factors	Country	Year	Author	Title
		Average RII%	10-Countries	
RII (%)	Sudan	2017	Osman et al. (2017)	Estimate of Labor Productivity in Sudanese Construction Industry
RII (%)	Pakistan	2015	Tahir M. A, et al, (2015)	Faftors Affecting Labourer Productivity in Building Projects of Pakistan
RII (%)	Egypt	2014	Hafiz, S. M., (2014)	Critical factors affecting construction Labourer productivity in Egypt
RII (%)	India	2014	Thomas, A. V., & Sudhakumar, J. (2014)	Factors Influencing Construction Labourer Productivity: An Indian Case Study
RII (%)	Spain	2014	Robles, et al., (2014)	Labourer Productivity in the Construction Industry-Factors Influencing the Spanish Construction Labourer Productivity
RII (%)	Trinidad and Tobago	2014	Hickson, et al.,(2014)	Factors affecting Construction Labourer Productivity in Trinidad and Tobago
RII (%)	Egypt	2012	El-Gohary, et al., (2013)	Factors Influencing Construction Labourer Productivity in Egypt
RII (%)	USA	2013	Gundecha, M. M. (2013)	Study of factors affecting labor productivity at a building construction project in the usa: web survey.
RII (%)	Gaza	2007	Enshassi, et al., (2007)	Factors affecting labour productivity in building projects in the Gaza Strip
RII (%)	Hong Kong	1997	Chan, D. W., & Kumaraswamy, M. M. (1997)	A comparative study of causes of time overruns in Hong Kong construction projects
	Frequency			Frequency

(Supplement for Table:1)

1	Experience of labourers*	85.81		89.0	84.0		83.2	90.0	93.3	88.0	84.2	74.8	8
2	Lack of Labourer supervision	84.00			84.0		70.2	95.0	87.4		83.4		5
3	Payment delay	82.67		83.0	87.0		82.5	85.8		79.0	78.7		6
4	Clarity of technical specifications	82.23			79.3		86.4	81.0					3
5	Shortage of materials	79.59	93.8	72.0	72.0	44.0		83.3	90.3	100.0	89.5	71.5	9
6	The extent of variation/change orders during execution	79.05			72.4			81.7		88.0		74.1	4
7	Construction manager's lack of leadership	77.67		70.0	80.0	80.0		88.3	88.4			59.3	6
8	Unrealistic scheduling and expectation of Labourer performance	77.33			68.0		75.1	91.7	74.5				4
9	Motivation of Labourer	77.26		74.0	83.3		77.5	82.5			69.0		5
10	Site restricted access	77.15	90.6		63.3		72.1	71.7		88.0			5
11	Construction method	74.64	84.4	64.0	75.6	75.6	65.5	83.3	86.6		62.1		8
12	Inadequate lighting	74.21	78.1	63.0						91.0	64.7		4
13	Insufficient supervision of subcontractors	73.75					81.0		69.1		71.8	73.1	4
14	Age of labourers*	73.68		81.0					78.1	73.0	62.6		4
15	Drawings and specifications alteration during execution	73.32		84.0		36.0			76.6	90.0	80.0		5
16	Labourer disloyalty	73.17		74.0						67.0	78.5		3
17	Rain	72.90			68.5		64.4	85.8					3
18	Skill of Labourer*	72.47			86.9	32.0	83.2	87.5	93.3			51.9	6
19	Inspection delay by the engineer	72.15		60.0	74.8			68.3		80.0	77.6		5
20	High quality of required works	71.67		61.0						86.0	68.0		3
21	Rework	71.60		81.0	73.8	30.0	73.2	84.2		84.0	75.0		7
22	Design changes	70.97							74.3	83.0		55.6	3
23	High Temperature	70.33			76.7		69.5	64.8					3
24	Accidents as a result of poor site safety program	69.47		77.0	69.5	27.6		73.3		97.0	72.4		6
25	Unsuitability of storage location	68.90			73.5		75.4	57.5			69.2		4
26	Unavailability of suitable tools	68.90				28.0		81.7		97.0			3
27	Bad weather condition	68.67		80.0		34.0	63.3		79.7	91.0	64.0		6
28	Unavailability of safety engineer on site	68.07		64.0						87.0	53.2		3
29	Lack of training offered to operatives	67.65		63.0				83.3		74.0	50.3		4
30	Working overtime	67.61		74.0	81.1	22.0	69.8	66.7	74.9	90.0	62.4		8
31	Poor project planning and scheduling	67.14				33.0	78.1		84.5		74.7	65.4	5
32	Rest time(s) during the work day	66.63		65.0			62.7		72.2				3
33	Absenteeism	66.24		78.0		35.0			77.2	86.0	55.0		5
34	Height of the work*	65.57					64.4		73.6		58.7		3
35	Lack of providing Labourer with transportation	64.67						60.0		78.0	56.0		3
36	Incomplete/revise drawing	63.00		69.0		33.0				87.0			3
37	Poor relations between Labourer and supervisors	62.75		84.0		29.0				75.0		63.0	4
38	Lack of experience of supervisor	62.63				30.6	83.2					74.1	3
39	Inadequate safety plan	62.15		76.0		30.0	75.0				67.6		4
40	Low quality of raw materials	62.08		69.0		30.0				78.0	71.3		4
41	Design complexity level	60.02				25.0	66.9	72.5		78.0		57.7	5
42	Labourer interference and congestion	59.63				25.0	73.9	72.5			67.1		4
43	Space of work*	59.20		70.0		29.0		67.5			70.3		4
44	Crew size*	58.87			73.8	27.0		75.8					3
45	Communication problems between site	58.74			29.0	34.0	80.9	85.8				64.0	5
46	Tool and equipment shortages	56.77		63.0		32.0					75.3		3
47	Lack of periodic meeting with Labourer	51.60		71.0		27.0					56.8		3

(*) *The factor was mutual between previous researches and this study, came up three time or more in the previous researches.*

Table 2: Modeling and checking their efficiency. (Source: Researcher)

Model 1	**LP = (-52.36 - 2.079 * h - 16.168 * SkL + 7.763 * Cz + 3.093 * Ag - 1.709 * Ex - 5.308 * Cty)**							
(GP1_Iq)	**Average**	**Min**	**Max**	**Unit**	**R^2 %**	**Significant F**	**STDV**	**C.v**	**P-Value**
LP	15.20	10.53	23.73	m^2/hr.			2.86	0.19	2E-01
Height (m)	2.56	0.00	3.00	m			0.51	0.20	3E-02
No. of Skilled Labor	1.32	1.00	2.00	No.			0.48	0.36	7E-04
Crew size	3.04	2.00	4.00	No.	97.1	8E-13	0.89	0.29	8E-02
Age	32.72	26.00	35.00	years			3.49	0.11	6E-02
Experience	12.68	5.00	14.00	years			2.61	0.21	8E-01
Nationality (Cty)	1.68	1.00	2.00	Cty			0.48	0.29	5E-09

Table 3: Compensation of the model 3 for the first coat of gypsum plastering in Iraqi style. (Source: Researcher)

1	**2**	**3**								**4**							**5**							**6**	**7**
		Factors								**Coefficients**							**= Coefficients x Actual numbers**							**ΣConstant+ Coefficients**	**Actual**
ser. No.	**Sample no.**	**Height (m)**	**Country**	**H code**	**SkL (No.)**	**Cz (No.)**	**Age (years)**	**Ex (years)**	**Country code**	***Constant***	**h**	**SkL**	**Cz**	**Age**	**Ex**	**Cty**	**Constant**	**h**	**SkL**	**Cz**	**Age**	**Ex**	**Cty**	**$LP_{predicted}$ m^2/hr**	**LP_{actual} (m^2/hr)**
1	2	0-2	Iraq	2	1	4	30	13	1	-52.4	-2.1	-16.2	7.8	3.1	-1.7	-5.3	-52.4	-4.2	-16.2	31.1	92.8	-22.2	-5.3	23.64	23.73
2	5	0-2	Iraq	2	1	3	26	5	1	-52.4	-2.1	-16.2	7.8	3.1	-1.7	-5.3	-52.4	-4.2	-16.2	23.3	80.4	-8.5	-5.3	17.18	17.55
3	19	0-2	Iran	2	2	4	35	14	2	-52.4	-2.1	-16.2	7.8	3.1	-1.7	-5.3	-52.4	-4.2	-32.3	31.1	108.3	-23.9	-10.6	15.93	16.30
4	20	0-2	Iran	2	2	4	35	14	2	-52.4	-2.1	-16.2	7.8	3.1	-1.7	-5.3	-52.4	-4.2	-32.3	31.1	108.3	-23.9	-10.6	15.93	16.30
5	21	0-2	Iran	2	2	4	35	14	2	-52.4	-2.1	-16.2	7.8	3.1	-1.7	-5.3	-52.4	-4.2	-32.3	31.1	108.3	-23.9	-10.6	15.93	16.30
6	15	0-2	Iran	2	2	4	35	14	2	-52.4	-2.1	-16.2	7.8	3.1	-1.7	-5.3	-52.4	-4.2	-32.3	31.1	108.3	-23.9	-10.6	15.93	15.87
7	18	0-2	Iran	2	2	4	35	14	2	-52.4	-2.1	-16.2	7.8	3.1	-1.7	-5.3	-52.4	-4.2	-32.3	31.1	108.3	-23.9	-10.6	15.93	15.87
8	17	0-2	Iran	2	2	4	35	14	2	-52.4	-2.1	-16.2	7.8	3.1	-1.7	-5.3	-52.4	-4.2	-32.3	31.1	108.3	-23.9	-10.6	15.93	15.50
9	16	0-2	Iran	2	2	4	35	14	2	-52.4	-2.1	-16.2	7.8	3.1	-1.7	-5.3	-52.4	-4.2	-32.3	31.1	108.3	-23.9	-10.6	15.93	15.19
10	9	0-2	Iraq	2	1	3	28	11	1	-52.4	-2.1	-16.2	7.8	3.1	-1.7	-5.3	-52.4	-4.2	-16.2	23.3	86.6	-18.8	-5.3	13.11	12.65
11	3	2-3	Iran	3	1	4	30	13	2	-52.4	-2.1	-16.2	7.8	3.1	-1.7	-5.3	-52.4	-6.2	-16.2	31.1	92.8	-22.2	-10.6	16.26	16.27
12	25	2-3	Iran	3	1	2	35	14	2	-52.4	-2.1	-16.2	7.8	3.1	-1.7	-5.3	-52.4	-6.2	-16.2	15.5	108.3	-23.9	-10.6	14.49	15.00
13	29	2-3	Iran	3	1	2	35	14	2	-52.4	-2.1	-16.2	7.8	3.1	-1.7	-5.3	-52.4	-6.2	-16.2	15.5	108.3	-23.9	-10.6	14.49	15.00
14	26	2-3	Iran	3	1	2	35	14	2	-52.4	-2.1	-16.2	7.8	3.1	-1.7	-5.3	-52.4	-6.2	-16.2	15.5	108.3	-23.9	-10.6	14.49	14.81
15	28	2-3	Iran	3	1	2	35	14	2	-52.4	-2.1	-16.2	7.8	3.1	-1.7	-5.3	-52.4	-6.2	-16.2	15.5	108.3	-23.9	-10.6	14.49	14.71
16	22	2-3	Iran	3	1	2	35	14	2	-52.4	-2.1	-16.2	7.8	3.1	-1.7	-5.3	-52.4	-6.2	-16.2	15.5	108.3	-23.9	-10.6	14.49	14.63
17	7	2-3	Iraq	3	1	3	26	5	1	-52.4	-2.1	-16.2	7.8	3.1	-1.7	-5.3	-52.4	-6.2	-16.2	23.3	80.4	-8.5	-5.3	15.10	14.62
18	30	2-3	Iran	3	1	2	35	14	2	-52.4	-2.1	-16.2	7.8	3.1	-1.7	-5.3	-52.4	-6.2	-16.2	15.5	108.3	-23.9	-10.6	14.49	14.60
19	27	2-3	Iran	3	1	2	35	14	2	-52.4	-2.1	-16.2	7.8	3.1	-1.7	-5.3	-52.4	-6.2	-16.2	15.5	108.3	-23.9	-10.6	14.49	14.46
20	24	2-3	Iran	3	1	2	35	14	2	-52.4	-2.1	-16.2	7.8	3.1	-1.7	-5.3	-52.4	-6.2	-16.2	15.5	108.3	-23.9	-10.6	14.49	13.95
21	23	2-3	Iran	3	1	2	35	14	2	-52.4	-2.1	-16.2	7.8	3.1	-1.7	-5.3	-52.4	-6.2	-16.2	15.5	108.3	-23.9	-10.6	14.49	13.33
22	10	2-3	Iraq	3	1	3	27	10	1	-52.4	-2.1	-16.2	7.8	3.1	-1.7	-5.3	-52.4	-6.2	-16.2	23.3	83.5	-17.1	-5.3	9.65	10.78
23	11	2-3	Iraq	3	1	3	28	11	1	-52.4	-2.1	-16.2	7.8	3.1	-1.7	-5.3	-52.4	-6.2	-16.2	23.3	86.6	-18.8	-5.3	11.03	10.76
24	6	2-3	Iraq	3	1	3	28	11	1	-52.4	-2.1	-16.2	7.8	3.1	-1.7	-5.3	-52.4	-6.2	-16.2	23.3	86.6	-18.8	-5.3	11.03	10.53
min	**2.0**	**0.0**	**0.0**	**2.0**	**1.0**	**2.0**	**26**	**5.0**	**1.0**														**min**	**9.6**	**10.5**
max	**30.0**	**0.0**	**0.0**	**3.0**	**2.0**	**4.0**	**35**	**14.0**	**2.0**														**max**	**23.6**	**23.7**
μ	**17.2**			**2.6**	**1.3**	**3.0**	**33**	**12.6**	**1.7**														**mean**	**1.6**	**1.6**
σ	**8.7**	**0.0**	**0.0**	**0.5**	**0.5**	**0.9**	**3.5**	**2.7**	**0.5**														**STD**	**2.6**	**2.6**
C.v.				**0.2**	**0.4**	**0.3**	**0.1**	**0.2**	**0.3**														**C.V**	**1.61**	**1.61**

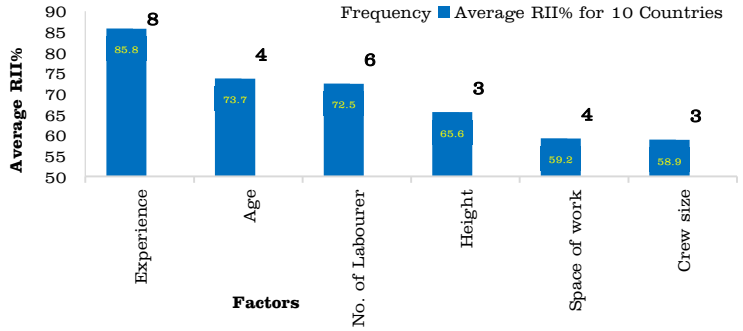

Fig. 1: Effects of six important factors and their RII% on LP that were mutual and came up three or more times in previous researches. (Source: Researcher)

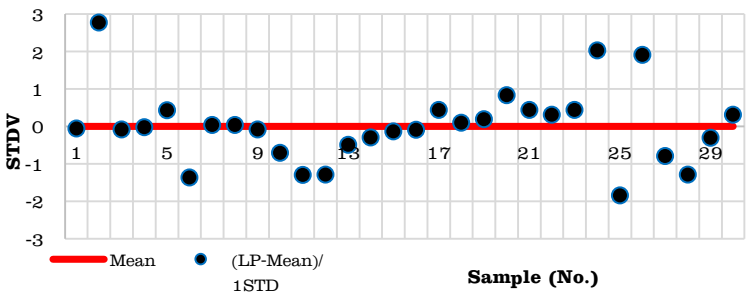

Fig. 2: Sensitivity of collected data through Statistical Process Control for gypsum plastering in National style. (Source: Researcher)

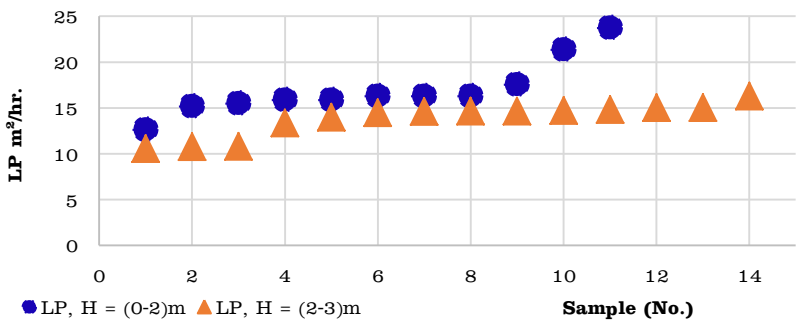

Fig. 3: Effects of Height on LP for gypsum plastering works. (Source: Researcher)

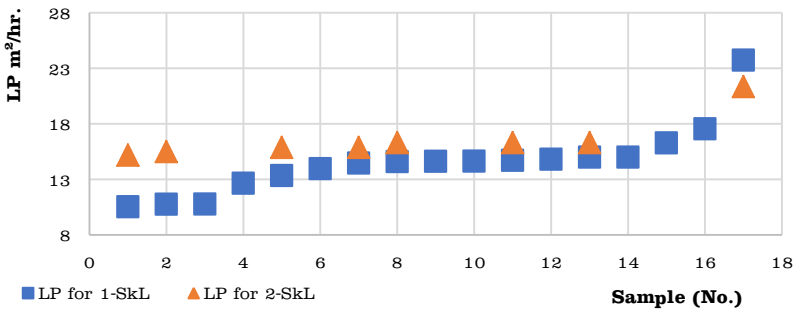

Fig. 4: Effects of Number of Skilled Laborers on LP for gypsum plastering in national style. (Source: Researcher)

Fig. 5: Effects of Number of Crew Size on LP for (GP1_Iq). (Source: Researcher)

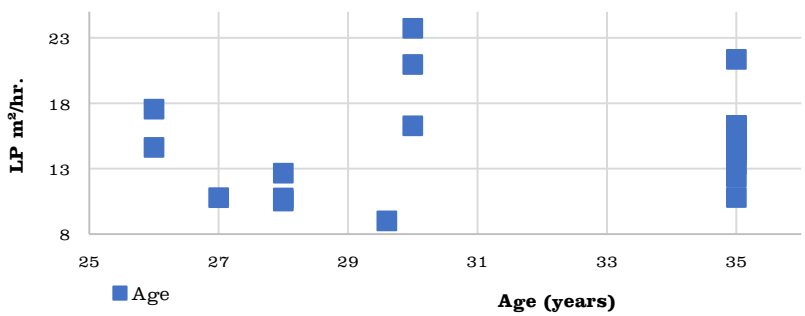

Fig. 6: Effects of Age on LP. (Source: Researcher)

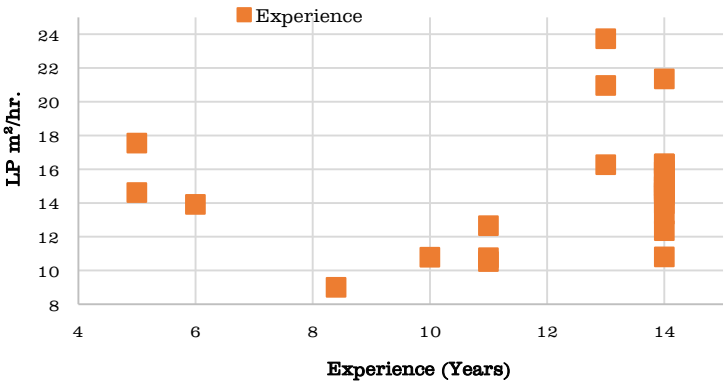

Fig. 7: Effects of years of Experience on LP. (Source: Researcher)

Parameters:
Number of data= 24 with the ranges
H = (0-2 and 2-3)m
SL = 1-2 No.
Cz = 2-4 No.
Age = (26-35)years
Experience =(5-14)years
Country = Iraq and Iran

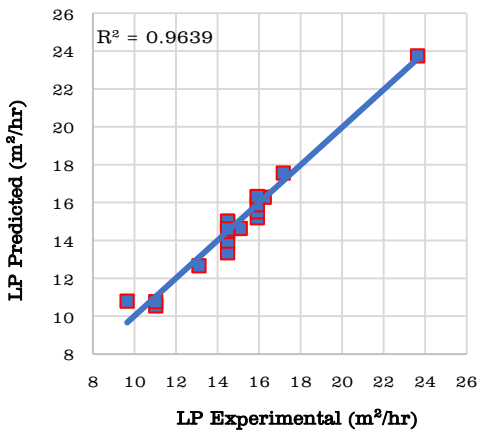

Fig. 8: Comparison between Experimental and Predicted LP's. (Source: Researcher)