EasyChair Preprint

№ 1320

Analysis Of Quality Improvement Of Finishing Work In The Development Of Puncak CBD Surabaya Apartment

Safira Damayanti and I Putu Artama Wiguna

July 21, 2019

Analysis Of Quality Improvement Of Finishing Work In The Development Of Puncak CBD Surabaya Apartment

Safira Rizki Damayanti[1], I Putu Artama Wiguna[2]

The quality is one of the important factors in the success of construction project. In fact, the cost of construction is vain until 6-15% because reworking and process of work are late. Wika Building Contractor has standard of quality, name is QPASS (*Quality Performance Assessment Support System*) for all projects. Puncak CBD Surabaya Apartment,is one of Wika Building Project that having lower quality standard value in 2018. In this study, the six sigma method with the DMAIC (*Define, Measure, Analyze, Improve, Control*) approach was used to improve low quality values. Starting with identify works with defect largest based on QPASS monthly report, then calculate the dominant defect using a level of sigma. The research results show the wall work having highest total number of defects. The wall work defect with sigma value under 3 level are joint of wall is not perpendicular, cracked plaster seen from 1.5 m distance and flaking paint. At the improve phase, determined the best action plan for handle cause factor of the three such defects. The best action was determined are do thickening and adjust the angle of wall for defect "Joint of wall is not perpendicular", giving direction for workers about correct plaster mixture for defect "Cracked plaster seen from 1.5 m distance", and cleaning of wall before painting for defect " Flaking paint".

Keywords: Quality, Six Sigma, DMAIC, Qpass, Defect of Finishing Work

I. INTRODUCTION

Quality is one of the important factors in the success of a construction project. Design and construction are two important phases of the project construction life cycle [1]. According to a study, management of commitment and leadership in construction organization, can affect the quality of construction [2]. In construction work types of work that often defect so need to do rework. The defect is a group of finishing and complementary work, for example such as errors in ceramic installation, ceilings, door leaf, and piping, because lack of supervision [3]. In general, every construction company, especially contractors, is responsible for facilities, methods, techniques, sequences and construction procedures, as well as preventive measures and safety program during the construction process [4]. Wika Building Contractor is a state-owned contractor that manage the quality management for maintain the value of quality work that is being done.

In 1989, Singapore has introduced a Construction Quality Assessment System, named (CONQUAS) to evaluate the quality performance of building contractors using numerical scores [5]. Wika Building Contractor currently have standard quality assessment system every month using a numerical score, named QPASS (Quality Assasment System System). From the QPASS score, the quality of work produced every month will be known to be good or bad. The one of project of Wika Building Contractor named Puncak CBD Surabaya Apartment, having lower quality standard value seen from the QPASS score in 2018. Score of Qpass in 2018, is below the quality standard value of 85%, especially in finishing work. This project having lower quality in 2018 because defect of work is high and the consequently the work must be repair again. Construction defects are the process of managing the wrong structure of the method, and the lack of communication between planners and consultants [6]. This study purpose to improve the quality of work by identifying the causes of defect that makes the quality of finishing work in the Puncak CBD Surabaya Apartment project is lower. In this study, the methode that can be done to improve the quality is by using six sigma method with the DMAIC *(Define, Measure, Analyze, Improve, Control)* approach. Construction projects in Indonesia have implemented quality management. It can be seen from the results of the calculation analysis which shows the tendency that the respondents have involved the 6-sigma method approach factors in quality management [7]. In the improve phase, determined the best action plan for handle cause factor of defects that makes quality of finishing work is lower.

[1] *Safira Rizki Damayanti Departemen Of Magister Management Technic, ITS, Surabaya, Postal Code, Sidoarjo. E-mail: safiradamayanti17@yahoo.com*

[2] *I Putu Artama Wiguna, Departemen Of Magister Management Technic, ITS, Surabaya, Postal Code, Surabaya, E-mail: artama.wiguna@gmail.com*

II. METHOD

In this study, data was collected based on the results of the assessment and the number of defects from the QPASS data. The way to analyze this research is to use the DMAIC approach. The DMAIC methodology is divided into five stages, namely Define, Measure, Analysis, Improve, Control [8]. Following the analysis phase with the DMAIC approach are :

A. Define

At this stage determined a Critical to Quality (CTQ) of Finishing work in Puncak CBD Surabaya Apartement. In finishing work there is a defect that makes the value of quality from the results of QPASS is lower. At this stage the percentage of defects will be calculated from each finishing work. The work with the highest defect percentage, that will be made Critical to Quality or will be analyzed further to find the best action for handle the defect of works**.**

B. Measure

After the dominant defect is known, then measure the control limit and sigma level from the dominant defects, between :

- Measurement of process stability, is used to determine the control limits of the lower control of the defect data that has been determined. The measurement uses Statistical Process Control (SPC) tools with C-Chart control maps.
- Displays the percentage of defects with the pareto diagram.
- Measurement of process capability with calculation of DPMO (Defect Per Million Opportunities) to find out the number of defects that appear in one million times the process.

$$DPMO = \frac{Total\ Defect}{Total\ Product}\ x\ 1.000.000$$

- Calculation of Sigma Level, if the DPMO value generated is between the upper and lower DPMO values, then do more accurate calculations. The formula is :

$$Y = Y1 + \frac{(X - X1)}{(X2 - X1)}\ x\ (Y2 - Y1)$$

In this measurement, work with defect is below the average sigma level, will be analyzed further.

C. Analyze

In the analysis phase determine the causal relationship of the dominant defect that has been determined from the measure stage with brainstorming and quisioner. In this stage, we will determine the most important causes of defects, quality problems, customer input, cycle time, etc [9].

D. Improve

During the improve phase, the project team plans optimization process through design of experiment [10]. In this research, the improvement that will be done by focus groups discuss and distributing questionnaires to experts and foremen. The purpose is to find the best action to deal the dominant defect.

III. RESULTS AND DISCUSSION

A. Definition Phase (Determination of Critical to Quality (CTQ) Finishing work)

In this study the object study consisted of 5 finishing work, namely wall work, floor work, door work, window work, and ceiling work. From the percentage of defects every work, the highest percentage will be a Critical to Quality or will be analyzed further. The following is the calculation of the total number of defects in finishing work on monthly reports from January to October 2018

Table 1.
Percentage defects finishing Work

Month	Number Of Deffect					Total of Defect
	Floor Work	Wall Work	Celling Work	Doors Work	Windows Work	
Jan	7	33	7	11	6	64
Feb	11	26	1	22	6	66
Mar	19	78	6	20	7	130
Apr	28	67	6	25	8	134
May	12	38	11	10	19	90
Jun	19	61	12	20	11	123
Jul	19	65	18	14	20	136
Augts	30	88	17	15	7	157

[1] *Safira Rizki Damayanti Departemen Of Magister Management Technic, ITS, Surabaya, 60264, Surabaya. E-mail: safiradamayanti17@yahoo.com*
[2] *I Putu Artama Wiguna, Departemen Of Magister Management Technic, ITS, Surabaya, 60264, Surabaya, E-mail: artama.wiguna@gmail.com*

Sep	21	75	16	13	9	134
Oct	22	49	14	9	6	100
Tot.	188	580	108	159	99	1134
%	16.58%	51.15%	9.52%	14.02%	8.73%	

In table 1, it can be seen that the five types of finishing work, the highest defects number of finishing work is wall work with a percentage of 51.15%. So this wall work becomes a critical to quality and will be analyzed further to find out the causes.

B. Measurement Phase (Measurement of Work defect Count)

1. Determination Of Control Limits

Measurement of defect control limits of finishing work is done by using C-Chart control maps. C-Chart control maps is use to wall work that having a highest defect as much 580 defect (Table 1). The following is the calculation of the upper control limit and control limit under wall work defects :

- Determining the Central Line (CL) value
  The Central Line from wall work is :
  Central Line = 580/10 = 58
- Set the upper control limit (UCL)
  Upper Limit Control (UCL) of wall work is :
  $UCL = C + 3\sqrt{C}$
  $UCL = 58 + 3\sqrt{58}$
  $UCL = 58 + 22.85$
  $UCL = 80.85$
- Set the lower control limit (LCL)
  Lower Control Limit of wall work is :
  $LCL = C + 3\sqrt{C}$
  $LCL = 58 - 3\sqrt{58}$
  $LCL = 58 - 22.85$
  $LCL = 35.15$

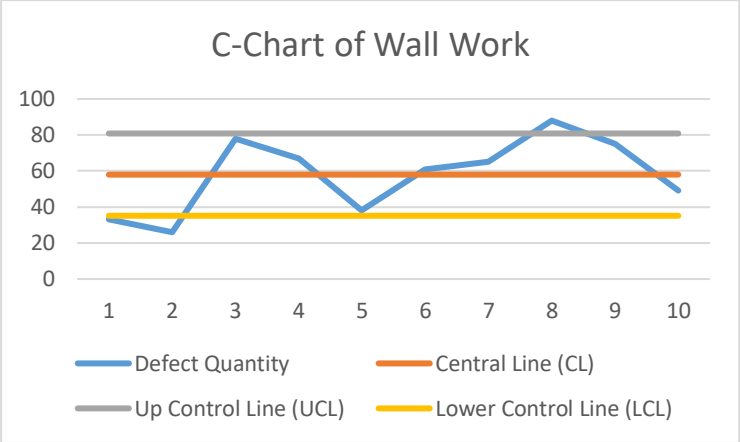

Figure 1. C- Chart of Wall Work

Based on Figure 1, illustrates that there are some defects that are still outside the tolerance limit of C control map. Defect in month 1 (January), 2 (February) are below the lower control limit, that means in January and February there are many repair or rework processes to minimize defects. Whereas defects in the month of 8 (August), still above in upper control limit, that mean in August there are many failed finishing work. So it can be assessed that the wall work on the Puncak CBD Surabaya Apartement Project is still have unstable conditions, because there are three points outside of control limit in the last 10 months.

2. Grouping of Wall Work Defects

Wall work defect data is obtained from data QPASS monthly, this data is contains a total defect of wall work every month. In the Puncak CBD Surabaya Apartemen project there are 15 sample unit for assessed with quality standard of QPASS. For 15 sample unit, the total wall area is :

- Total of wall area without partition wall :
  51,245 m² x 15 sample = 768,675 m²
- Total all of wall (brick wall, partition wall and precast)
  63,71 m² x 15 sample = 955,65 m²
- Total of ceramic wall
  10.8 m² x 15 sample = 162 m²
- Total of wall area that have a “Reveal”
  43.84 m² x 15 sample = 657.525 m²

[1] *Safira Rizki Damayanti Departemen Of Magister Management Technic, ITS, Surabaya, 60264, Surabaya. E-mail: safiradamayanti17@yahoo.com*
[2] *I Putu Artama Wiguna, Departemen Of Magister Management Technic, ITS, Surabaya, 60264, Surabaya, E-mail: artama.wiguna@gmail.com*

The following is a calculation of the percentage of wall work defects :

Table 2.
Defect Percentage Table

No	Types of Wall Work Defects	Total Defect	Total Amount Of Unit Area Sample	Defect Precentage
1	Joint of wall is not perpendicular	105	955.65 m²	10.99%
2	The surface of wall is not flat	39	955.65 m²	4.08%
3	The angle of wall is not sharp and straight	52	955.65 m²	5.44%
4	Cracked plaster seen from 1.5 m distance	91	768.675 m²	11.84%
5	Width of "Reveal" is not uniform	22	657.525 m²	3.35%
6	The "Reveal" is bumpy more than 3 mm	38	657.525 m²	5.78%
7	There are pore on the wall	23	768.675 m²	2.99%
8	The color of paint is not uniform	49	955.65 m²	5.13%
9	Flaking Paint	88	955.65 m²	9.21%
10	The color of paint is faded	32	955.65 m²	3.35%
11	The color and texture of ceramic walls is not uniform	9	162 m²	5.56%
12	The size of the ceramic wall is not consistent	7	162 m²	4.32%
13	Ceramic walls is broken	9	162 m²	5.56%
14	Nad is not straight	8	162 m²	4.94%
15	Cement for ceramic wall is less	8	162 m²	4.94%

3. Defective Percentage With Pareto Diagram

In this pareto diagram show about a graphic percentage of each type of defect and the cumulative percentage. Here's a picture of the Pareto diagram for wall work :

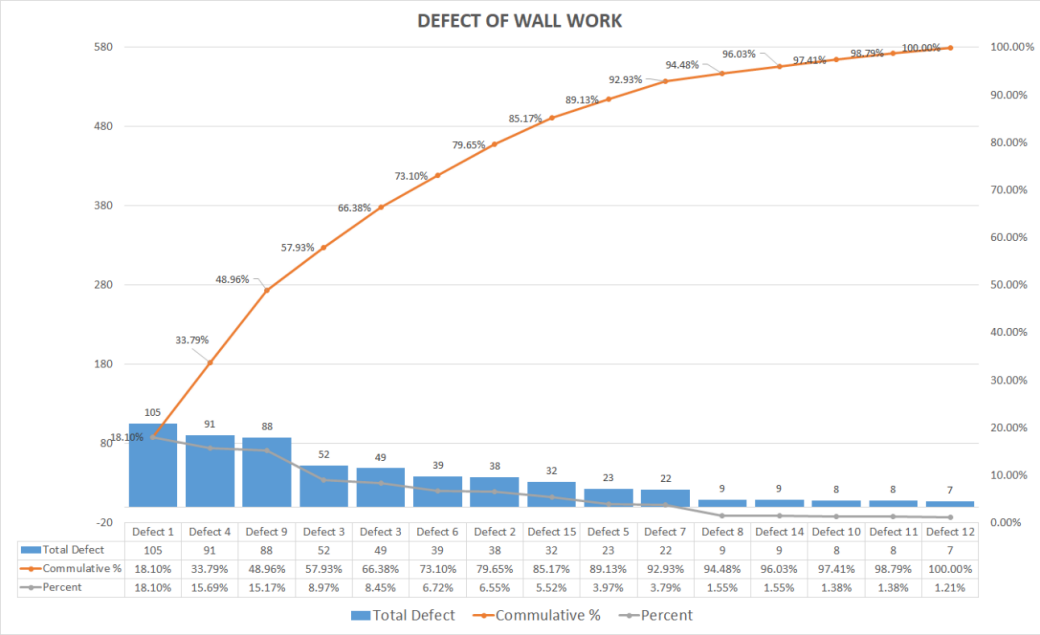

Figure 2. Pareto Diagram of Wall Work

[1] *Safira Rizki Damayanti Departemen Of Magister Management Technic, ITS, Surabaya, 60264, Surabaya. E-mail: safiradamayanti17@yahoo.com*
[2] *I Putu Artama Wiguna, Departemen Of Magister Management Technic, ITS, Surabaya, 60264, Surabaya, E-mail: artama.wiguna@gmail.com*

In Figure 2, it can be seen that from the 15 wall work defects, the highest defect occurred in defect 1 of 18.10%, namely "Joint of wall is not perpendicular", this is important to note because the walls have important role in the aesthetics and beauty of the room.

4. Measurement of Sigma Levels

For each type of wall work defect, the sigma and DPMO values will be measured. The purpose is to determine the defects that values under level 3 sigma. Defects with values under the sigma level will be further analyzed. The measurement of the sigma and DPMO values is based on the total number of defects and the total area of the sample unit. Following is the calculation of the sigma value and DPMO value of each wall work defect :

Table 3.
Sigma and DPMO Value Table

No	Types of Defect	Total defect	Total Area of Sample Unit	Defect Precentage	DPMO	Sigma Value
1	Joint of wall is not perpendicular	105	955.65 m²	10.99%	109872.86	2.77
2	Surface of wall is not flat	39	955.65 m²	4.08%	33485.06	3.37
3	The angle of wall is not sharp and straight	52	955.65 m²	5.44%	54413.23	3.20
4	Cracked plaster seen from 1.5 m distance	91	768.675 m²	11.84%	118385.53	2.62
5	Width of “Reveal” is not uniform	22	657.525 m²	3.35%	33458.80	3.37
6	The “Reveal” is bumpy more than 3 mm	38	657.525 m²	5.78%	57792.48	3.02
7	There are pore on the wall	23	768.675 m²	2.99%	29921.62	3.32
8	The color of paint is not uniform	49	955.65 m²	5.13%	51274	3.17
9	Flaking Paint	88	955.65 m²	9.21%	92083.92	2.87
10	The color of paint is faded	32	955.65 m²	3.35%	33485.06	3.37
11	The color and texture of ceramic walls is not uniform	9	162 m²	5.56%	55555.56	3.01
12	The size of the ceramic wall is not consistent	7	162 m²	4.32%	43209.88	3.29
13	Ceramic walls is broken	9	162 m²	5.56%	55555.56	3.01
14	Nad is not straight	8	162 m²	4.94%	49382.72	3.15
15	Cement for ceramic wall is less	8	162 m²	4.94%	49382.72	3.15
Total Defect of Wall Work		**580**				

In many types of defects the lowest sigma level is in defects :

- “Joint of Wall is not Perpendicular”, with sigma value 2.77
- "Cracked Plaster seen from 1.5 m Distance”, with sigma value 2.62
- "Flaking Paint", with sigma value 2.87

This concludes that the quality in plaster and paint work is still have low quality.

C. Analysis Phase (Identification Of Causes Of Defective Wall Work Factors)

In the analysis phase, the causative factor of wall work defects that below under sigma level will be searched. The causative factor is founded by brainstorming and distributing questionnaires.

The causative factor that have been collected will be used as questionnaire variables to determine the causative main factor of defect that have a low sigma

[1] *Safira Rizki Damayanti Departemen Of Magister Management Technic, ITS, Surabaya, 60264, Surabaya. E-mail: safiradamayanti17@yahoo.com*
[2] *I Putu Artama Wiguna, Departemen Of Magister Management Technic, ITS, Surabaya, 60264, Surabaya, E-mail: artama.wiguna@gmail.com*

value. The following are some of causative factor from the resul of brainstorming :

1. Causative Factor of "Joint of wall is not perpendicular"
   - Work is not done well
   - The field inspector doesn't expert
   - The experience of manpower is less
   - The thickness of plaster is not flat, so it looks bumpy at the joint of the wall.
   - Buy materials with low prices and low quality.
   - The opnam costs have minimal price, so that it affects the implementation of manpower in the field
   - The neatness of the joint of wall is not noticed
   - The wall polishing is less so it still looks bumpy
   - Do not use an triangle ruler when measured the joint of wall

2. Causative Factor of "Cracked Plaster seen from 1.5 m Distance"
   - Work is not done well
   - The field inspector doesn't expert
   - The experience of manpower is less
   - Sand with high levels of sludge and organic matter
   - Too much / little cement
   - The wall is too dry
   - Buy materials at low prices and low quality
   - The brick have expanded so it is easily cracked especially in weak connection areas such as the corners of the window
   - The adhesive of the joint of brick is less, so it easy to crack
   - The plaster and aci are made too much water so when drying, a shrinkage process will occur
   - The difference thickness of the plaster can makes different shrinkage and drying so the result will be cracks
   - The opnam costs have minimal price, so that it affects the implementation of manpower in the field
   - There are any stage of work that missed

3. Factors Cause of Flaking Paint Defects
   - Work is not done well
   - The field inspector doesn't expert
   - The experience of manpower is less
   - There are any stage of work that missed
   - Low paint quality
   - Mismatch of base paint and final paint
   - Buy materials at low prices and low quality
   - Painting on wall surfaces that contain a dust, dirt, or oil so the paint cannot stick perfectly
   - The putty or wall plamir are low quality.
   - Not using primary paint / primary alkali
   - When repainting, the old layer of paint is not scraped first
   - The opnam costs have minimal price, so that it affects the implementation of manpower in the field

After that, the causative factor of the results brainstorming were used as questionnaire variables. Data from the questionnaire were analyzed to look for the main causes. Questionnaire results data with high mean values and standard deviations below the average will be the main causative factors. The following data on the results of the questionnaire cause :

- Main Causative Factor of Joint of wall is not 90 degrees

Table 4.
Variabel Score of Causative Factor defect of "Joint of Wall is not Perpendicular"

	Score Item From 15 Respondent															Total Score	Mean	Standard Deviation
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15			
Question 1	4	2	1	4	4	4	4	4	4	4	4	2	2	2	2	47	3.133	1.125
Question 2	2	2	2	5	3	1	4	4	4	4	2	2	2	2	2	41	2.733	1.163
Question 3	2	2	2	5	4	2	2	4	4	2	2	2	2	2	2	39	2.600	1.056
Question 4	4	2	1	4	4	2	2	4	4	4	4	4	4	3	4	50	3.333	1.047
Question 5	1	2	1	4	4	4	2	4	2	4	4	4	4	3	4	47	3.133	1.187
Question 6	2	2	2	5	4	2	5	4	5	4	4	4	5	4	2	54	3.600	1.242
Question 7	5	4	4	5	4	3	4	3	4	5	4	4	5	4	4	62	4.133	0.640
Question 8	2	2	2	2	4	2	2	2	2	2	2	2	2	2	2	32	2.133	0.516
Question 9	4	4	1	4	4	4	4	4	4	4	2	2	2	2	2	47	3.133	1.125

[1] *Safira Rizki Damayanti Departemen Of Magister Management Technic, ITS, Surabaya, 60264, Surabaya. E-mail: safiradamayanti17@yahoo.com*
[2] *I Putu Artama Wiguna, Departemen Of Magister Management Technic, ITS, Surabaya, 60264, Surabaya, E-mail: artama.wiguna@gmail.com*

Table 5.
Questionnaire Variable Validity Test defect of "Joint of Wall is not Perpendicular"

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Result
P1	24.80	24.600	.632	.750	Valid
P2	25.20	23.743	.691	.740	Valid
P3	25.33	24.810	.666	.746	Valid
P4	24.60	25.829	.564	.761	Valid
P5	24.80	27.886	.289	.802	Not Valid
P6	24.33	24.238	.584	.757	Valid
P7	23.80	31.600	.127	.806	Not Valid
P8	25.80	31.171	.258	.796	Not Valid
P9	24.80	26.314	.463	.776	Not Valid

Table 6.
Questionnaire Variable Reliability Test defect of "Joint of Wall is not Perpendicular"

		N	%
Cases	Valid	15	100.0
	Excluded(a)	0	.0
	Total	15	100.0

From table 5, the variabel of P5,P7,P8,P9 are "Invalid", because the value of *Corrected Item – Total Correlation* or r count are smaller than r table. While the variabel of P1,P2,P3,P4,P6 are"Valid" because the value of *Corrected Item – Total Correlation* or r count more biggest than r table. The variabels are valid used for further analysis.

Table 7.
Mean and Standard Deviation Variables Questionnaires

Code	Causative Factor Variabel	Mean	Standard Deviasi	Ranking
P6	The opnam costs have minimal price, so that it affects the implementation of manpower in the field	3.600	1.242	1
P4	The thickness of plaster is not flat, so it looks bumpy at the joint of the wall	3.333	1.047	2
P1	Work is not done well	3.133	1.125	3
P2	The field inspector doesn't expert	2.733	1.163	4
P3	The experience of manpower is less	2.600	1.056	5

Based on table 7, The main causative factor of "joint of wall is not perpendicular" is in question 4 " The thickness of plaster is not flat, so it looks bumpy at the joint of the wall " with a high mean value and a small standard deviation below the average.

[1] *Safira Rizki Damayanti Departemen Of Magister Management Technic, ITS, Surabaya, 60264, Surabaya. E-mail: safiradamayanti17@yahoo.com*
[2] *I Putu Artama Wiguna, Departemen Of Magister Management Technic, ITS, Surabaya, 60264, Surabaya, E-mail: artama.wiguna@gmail.com*

- Main Causative Factor of Cracked Plaster seen from 1.5 m distance

Table 8.
Variabel Score of Causative Factor defect of "Cracked Plaster seen from 1.5 m Distance"

	Score Item From 15 Respondent															Total Score	Mean	Standard Deviation
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15			
Question 1	4	4	1	4	4	4	4	4	3	4	4	2	2	2	2	48	3.200	1.082
Question 2	4	2	1	4	4	4	4	4	3	4	4	2	2	2	2	46	3.067	1.100
Question 3	2	2	2	5	3	1	4	4	3	4	2	2	2	2	2	40	2.667	1.113
Question 4	2	2	2	5	4	2	2	4	3	2	2	2	2	2	2	38	2.533	0.990
Question 5	2	2	2	2	4	2	2	2	1	2	2	2	2	2	2	31	2.067	0.594
Question 6	5	4	4	5	4	3	4	3	3	5	4	4	5	4	4	61	4.067	0.704
Question 7	4	2	1	4	4	2	2	4	3	4	4	4	4	3	4	49	3.267	1.033
Question 8	4	4	1	4	4	4	4	4	3	4	2	2	2	2	2	46	3.067	1.100
Question 9	4	3	4	3	2	3	2	2	1	3	4	3	3	3	2	42	2.800	0.862
Question 10	2	2	2	4	4	2	2	4	3	4	2	2	2	2	2	39	2.600	0.910
Question 11	1	2	1	1	2	1	4	2	1	2	2	2	2	2	2	27	1.800	0.775
Question 12	2	2	1	4	2	2	2	1	3	3	2	2	2	2	2	32	2.133	0.743
Question 13	2	2	1	4	2	2	2	1	3	3	2	3	3	3	2	35	2.333	0.816

Table 9.
Questionnaire Variable Validity Test defect of "Cracked Plaster seen from 1.5 m Distance"

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Result
P1	32.40	32.543	.657	.758	Valid
P2	32.53	31.838	.708	.752	Valid
P3	32.93	32.067	.676	.755	Valid
P4	33.07	34.352	.559	.769	Valid
P5	33.53	39.695	.238	.795	Not Valid
P6	31.53	38.838	.284	.793	Not Valid
P7	32.33	35.381	.438	.781	Not Valid
P8	32.53	32.695	.630	.760	Valid
P9	32.80	44.314	-.281	.836	Not Valid
P10	33.00	33.714	.689	.758	Valid
P11	33.80	41.314	-.009	.813	Not Valid
P12	33.47	36.410	.543	.774	Valid
P13	33.27	38.067	.307	.792	Not Valid

Table 10.
Questionnaire Variable Reliability Test defect of "Cracked Plaster seen from 1.5 m Distance"

		N	%
Cases	Valid	15	100.0
	Excluded(a)	0	.0
	Total	15	100.0

[1] *Safira Rizki Damayanti Departemen Of Magister Management Technic, ITS, Surabaya, 60264, Surabaya. E-mail: safiradamayanti17@yahoo.com*
[2] *I Putu Artama Wiguna, Departemen Of Magister Management Technic, ITS, Surabaya, 60264, Surabaya, E-mail: artama.wiguna@gmail.com*

From table 9, the variabel of P5,P6,P7,P9,P11,P13 are "Invalid", because the value of *Corrected Item – Total Correlation* or r count are smaller than r table. While the variabel of P1,P2,P3,P4,P8,P10,P12 are"Valid" because the value of *Corrected Item – Total Correlation* or r count more biggest than r table. The variabels are valid used for further analysis

Table 11.
Mean and Standard Deviation Variables Questionnaires

Code	Causative Factor Variabel	Mean	Standard Deviasi	Ranking
P1	Work is not done well	3.200	1.082	1
P2	The field inspector doesn't expert	3.067	1.100	2
P8	The brick have expanded so it is easily cracked especially in weak connection areas such as the corners of the window	3.067	1.100	3
P3	The experience of manpower is less	2.667	1.113	4
P10	The plaster and aci were made too much water so when drying, a shrinkage process will occur	2.600	0.910	5
P4	Sand with high levels of sludge and organic matter	2.533	0.990	6
P12	The opnam costs have minimal price, so that it affects the implementation of manpower in the field	2.133	0.743	7

Based on table 11, the main causative factor of Cracked Plaster seen from 1.5 m distance is in question 10 " The plaster and aci were made too much water so when drying, a shrinkage process will occur " with a high mean value and a small standard deviation below the average

- Main Causative Factor of Flaking Paint

Table 12.
Variabel Score of Causative Factor defect of "Flaking Paint"

	Score Item From 15 Respondent															Total Score	Mean	Standard Deviation
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15			
Question 1	2	2	1	4	2	1	2	1	4	3	3	2	2	2	2	33	2.200	0.941
Question 2	2	2	1	4	2	1	2	1	4	3	3	3	3	3	2	36	2.400	0.986
Question 3	4	2	1	4	4	3	4	4	4	4	5	2	2	2	2	47	3.133	1.187
Question 4	2	2	2	5	4	1	2	4	4	2	3	2	2	2	2	39	2.600	1.121
Question 5	2	2	2	2	4	1	2	2	2	2	3	2	2	2	2	32	2.133	0.640
Question 6	1	2	1	2	4	3	2	4	2	3	4	4	4	3	4	43	2.867	1.125
Question 7	4	4	2	5	4	1	5	4	5	4	5	4	5	4	2	58	3.867	1.246
Question 8	5	4	4	5	4	2	4	3	4	5	5	4	5	4	4	62	4.133	0.834
Question 9	4	2	1	4	4	1	2	4	4	4	5	4	4	3	4	50	3.333	1.234
Question 10	4	4	1	4	4	3	4	4	4	4	3	2	2	2	2	47	3.133	1.060
Question 11	4	3	4	3	2	2	2	2	2	3	5	3	3	3	2	43	2.867	0.915
Question 12	2	4	1	2	2	3	2	4	4	4	5	2	2	2	2	41	2.733	1.163

[1] *Safira Rizki Damayanti Departemen Of Magister Management Technic, ITS, Surabaya, 60264, Surabaya. E-mail: safiradamayanti17@yahoo.com*
[2] *I Putu Artama Wiguna, Departemen Of Magister Management Technic, ITS, Surabaya, 60264, Surabaya, E-mail: artama.wiguna@gmail.com*

Table 13.
Questionnaire Variable Validity Test defect of "Flaking Paint"

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Result
P1	33.20	47.886	.717	.815	Valid
P2	33.00	48.571	.624	.821	Valid
P3	32.27	46.067	.660	.816	Valid
P4	32.80	47.886	.578	.824	Valid
P5	33.27	53.352	.466	.835	Not Valid
P6	32.53	55.124	.103	.860	Not Valid
P7	31.53	44.267	.742	.808	Valid
P8	31.27	51.067	.533	.829	Valid
P9	32.07	43.924	.774	.805	Valid
P10	32.27	50.352	.441	.834	Not Valid
P11	32.53	55.981	.095	.855	Not Valid
P12	32.67	49.952	.414	.837	Not Valid

Table 14.
Questionnaire Variable Reliability Test defect of "Flaking Paint"

		N	%
Cases	Valid	15	100.0
	Excluded(a)	0	.0
	Total	15	100.0

From table 13, the variabel of P5,P6,P10,P11,P12 are "Invalid", because the value of *Corrected Item – Total Correlation* or r count are smaller than r table. While the variabel of P1,P2,P3,P4,P7,P8,P9 are"Valid" because the value of *Corrected Item – Total Correlation* or r count more biggest than r table. The variabels are valid used for further analysis

Table 15.
Mean and Standard Deviation Variables Questionnaires

Code	Causative Factor Variabel	Mean	Standard Deviasi	Ranking
P8	Painting on wall surfaces that contain a dust, dirt, or oil so the paint cannot stick perfectly	4.133	0.834	1
P7	Buy materials at low prices and low quality	3.867	1.246	2
P9	The putty or wall plamir are low quality	3.333	1.234	3
P3	The experience of manpower is less	3.133	1.187	4
P4	There are any stage of work that missed	2.600	1.121	5
P2	The field inspector doesn't expert	2.400	0.986	6
P1	Work is not done well	2.200	0.941	7

[1] *Safira Rizki Damayanti Departemen Of Magister Management Technic, ITS, Surabaya, 60264, Surabaya. E-mail: safiradamayanti17@yahoo.com*
[2] *I Putu Artama Wiguna, Departemen Of Magister Management Technic, ITS, Surabaya, 60264, Surabaya, E-mail: artama.wiguna@gmail.com*

Based on table 15, the main cause of flaking paint defects is question 8 " Painting on wall surfaces that contain a dust, dirt, or oil so the paint cannot stick perfectly " with a high mean value and a small standard deviation below

D. Improvement Phase (Determination of best action against key cause factors)

Determination of the best actions for the causative factort is done by Focus Group Discuss (FGD) and questionnaires. The best proposed actions from the Focus Group Discuss will be used as questionnaire variables to find the best action. The following are the results of the best action questionnaire analysis

1. The Best Actions for defect of "Joint of wall is not Perpendicular"

Table 16.
Weight Value Recommended from Respondennt for defect "Joint of wall is not Perpendicular"

Causative Factor of Joint of Wall is not Perpendicular	Mean	Recommendations from Respondents	Mean	Weight
The thickness of plaster is not flat, so it looks bumpy at the joint of the wall	3.333	Do a checklists about neatness angle of wall	4.000	13.332
		Direct the manpower about how to neat scrub the angle of wall	2.800	9.332
		Minimize a not straight plaster	2.800	9.332
		Monitoring the plaster work process	4.200	13.999
		Do thickening on the walls when the joint of wall is not perpendicular	4.600	15.332

Based on table 16 the recommendations chosen with the highest weighting value are " Do thickening on the walls when the joint of wall is not perpendicular "

2. The Best Actions for defect of "Cracked Plaster seen from 1.5 m Distance"

Table 17.
Weight Value Recommended from Respondent for defect "Cracked Plaster seen from 1.5 m Distance"

Causative Factor of Cracked Plaster Seen From 1.5 m Distance	Mean	Recommendations from Respondents	Mean	Weight
The plaster and aci were made too much water so when drying, a shrinkage process will occur	2.600	Directing manpower about the proportion of cement, sand and water (ratio 1: 3 - 1: 5)	4.400	11.440
		The plaster mixture is stirred until blended and the mixture is completely homogeneous	4.000	10.400
		Monitoring manpower when they mix the plaster before applying	4.400	11.440
		Apply the plaster mixture soon, so that the mixture does not settle and secrete water	4.000	10.400

Based on table 17 the recommendations chosen with the highest weighting value are " Directing manpower about the proportion of cement, sand and water (ratio 1: 3 - 1: 5) and Monitoring manpower when they mix the plaster before applying"

[1] *Safira Rizki Damayanti Departemen Of Magister Management Technic, ITS, Surabaya, 60264, Surabaya. E-mail: safiradamayanti17@yahoo.com*
[2] *I Putu Artama Wiguna, Departemen Of Magister Management Technic, ITS, Surabaya, 60264, Surabaya, E-mail: artama.wiguna@gmail.com*

3. The Best Actions for defect "Flaking Paint"

Table 18
Weight Value Recommended from Respondennt for defect "Flaking Paint"

Causative Factor of Flaking Paint	Mean	Recommendations from Respondents	Mean	Weight
Painting on wall surfaces that contain a dust, dirt, or oil so the paint cannot stick perfectly	4.133	Check the cleanliness of material especially on paint rollers and brushes	4.000	16.532
		Check the surface of the wall before painting (damp / dry walls)	3.400	14.052
		Clean the wall before painting	4.600	19.012
		Check the compound in the repair area is completely dry and has been rubbed	3.600	14.879
		Clean the floor of the unit to be painted for minimize a dust	4.600	19.012
		Direct manpower especially paint workers to clean paint tools before they are used to painting	4.000	16.532

Based on table 18 recommendations chosen with the highest weighting value are "Clean the wall before painting and Clean the floor of the unit to be painted for minimize a dust"

IV. CONCLUSION

Quality is one of the important factors in finishing work. In the finishing work, it is necessary to pay attention the stages of work so that the quality value can be maintained. In this study, it is proven that the implications of the problems in this study are simple and doesn't needs a lot of time, but if they are not done the impact is to large.

The research results show the wall work having highest total number of defects. The wall work defect with sigma value under 3 level are joint of wall is not perpendicular, cracked plaster seen from 1.5 m distance and flaking paint. At the improve phase, determined the best action plan for handle cause factor of the three such defect. The best action was determined are do thickening and adjust the angle of wall for defect "Joint of wall is not perpendicular", giving direction for workers about correct plaster mixture for defect "Cracked plaster seen from 1.5 m distance", and cleaning of wall before painting for defect " Flaking paint".

REFERENCES

[1] Ashokkumar, D. (2014). International Journal of innovative Research in Science Engineering and Technology. *Study of quality management in construction industry.* , 36-43.

[2] Gunaydin, H. M. (1995). *TQM in the Construction Industry (Master Thesis).* Chicago.

[3] Herdianto Ardhan, et al. (2015). EVALUASI PENGERJAAN ULANG (REWORK) PADA PROYEK KONSTRUKSI GEDUNG DI SEMARANG. *Jurnal Karya Teknik Sipil*, 93-106.

[4] Ledbetter, W. B. (1990). *The quality performance management system: a blue print for implementation,* . Austin.

[5] Kaming Peter F, Natassasanti. (2018). Asesmen Kualitas Komponen Arsitektural TIGA Gedung Perkantoran di Yogyakarta dengan Prinsip - Prinsip CONQUAS dan Six Sigma.ISBN, 978-602

[6] Kristanto, W. (2018). Defect Analysis of Building Construction Works Building in Surabaya with Six Sigma Methode. *International Journal of Innovative Science and Reaserch Technology*

[7] Latief Yusuf, et al. (2009). PENERAPAN PENDEKATAN METODE SIX SIGMA DALAM PENJAGAAN KUALITAS PADA PROYEK KONSTRUKSI. *Makara, Teknologi*, 67-72

[8] Heizer & Render (2015). Operation Management: Sustainability and Supply Chain Management. Jakarta: Salemba Empat

[9] Gaspersz, V. (2002). Total Quality Management. Jakarta : PT. Gramedia Pustaka Utama

[1] *Safira Rizki Damayanti Departemen Of Magister Management Technic, ITS, Surabaya, 60264, Surabaya. E-mail: safiradamayanti17@yahoo.com*
[2] *I Putu Artama Wiguna, Departemen Of Magister Management Technic, ITS, Surabaya, 60264, Surabaya, E-mail: artama.wiguna@gmail.com*

[10] Hartoyo Ferdian, et al. (2012.). Penerapan Metode DMAIC dalam Peningkatan Acceptance Rate Untuk Ukuran Panjang Produk Bushing. *ComTech Vol.3,* 938 -995.

.

[1] *Safira Rizki Damayanti Departemen Of Magister Management Technic, ITS, Surabaya, 60264, Surabaya. E-mail: safiradamayanti17@yahoo.com*
[2] *I Putu Artama Wiguna, Departemen Of Magister Management Technic, ITS, Surabaya, 60264, Surabaya, E-mail: artama.wiguna@gmail.com*