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Analysis Of the Influence of Quality Management System (QMS) On Quality Cost of Road Projects in Palu City

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Abstract
The high level of competition makes contractors continue to provide the best quality and performance. The implementation of ISO 9001:2015-primarily based great management gadget (QMS) in construction services is an alternative that may advantage contractors in dealing with opposition and enhancing the excellent of production work. through improving first-class, the first-rate charges incurred also increase. This take a look at objectives to decide the effect of the implementation of ISO 9001:2015-primarily based QMS on the fine costs of construction initiatives and limitations inside the implementation of ISO 9001:2015-based QMS. facts analysis of 48 contractor respondents using the Structural Equation Modeling - Partial Least square (SEM-PLS) method with the SmartPLS application. The improvement variable has the most powerful affect observed by way of operations, performance evaluation, and management. in the meantime, the aid and making plans variables do no longer have a enormous effect on mission best charges. This study also obtained three main limitations within the implementation of ISO 9001:2015-primarily based QMS. The most dominant barriers are the shortage of direction or socialization regarding ISO 9001:2015-based totally SMM, the enterprise's lack of knowledge of ISO 9001:2015-based SMM, and the dearth of communique and cooperation in enforcing ISO 9001:2015-based totally SMM

Keywords: *Cost, Quality, Obstacles, Road Construction*

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I. INTRODUCTION

Along with the increasing development, contractors as construction service providers continue to grow and develop[1], [2]. The high level of competition in the field of construction services, makes contractors compete in providing the best quality and performance in winning the competition and achieving customer satisfaction[3]. Quality is one important aspect that must be considered besides cost and time. The better the quality produced, the greater the success of a construction project[4], [5]. One system that can be applied to improve the quality of a construction is by implementing a Quality Management System[6], [7].

The nice control gadget continues to be evolved in order that it is able to be used as a guide for a creation service company (contractor) in maintaining the quality of work and avoiding non-conformities. The ISO 9001-based Quality Management System is an International Standard to be applied in various fields including the construction services secto[8], [9].

The implementation of the ISO 9001:2015-based nice management gadget in construction offerings is an alternative which can gain contractors in dealing with competition.. The implementation of the ISO-based Quality Management System will be a benchmark in considering the selection of a company that is worthy of winning work/tenders for both local and foreign projects[10].

Along with the increase in quality carried out by construction companies, it is often followed by an increase in quality costs. One of the company's efforts to provide great service is by way of imposing a great control machine continuously and responsibly. The quality management system is the best and most practical way to ensure customer satisfaction[11].

A construction project is a series of implementation activities that have a certain time, target, and resources, starting from planning, implementation and maintenance activities. The series of activities is a process of processing project resources into a type of construction[12]. These resources have been arranged in a project organization to complete based on the agreed time, cost and quality[13]. A construction project is something that takes a long time, is complicated and involves many parties[5]. The success of the construction work manner is fairly depending on the interrelationships between the parties concerned in the production project. In its

implementation, there are quite a few obstacles in meeting construction quality, implementation costs, and completion time[14].

Quality in the construction industry is one of the dominant factors in increasing a company's competitiveness[15]. The implementation of a total quality management system through a quality improvement plan outlined in Strategic Quality Management (SQM) is one of the company's internal understandings in an effort to increase the company's competitiveness[16]. Meanwhile, ISO defines quality as something that is more than just a product, but also includes broader things, such as processes, organizations, responsibilities, work instructions and resources. Whether a quality is good or not depends on the user or project owner.'Another definition, quality is usually interpreted by each service user, this makes the definition of quality can change at any time, quality is directly related to the assessment of service users. Service user satisfaction is one form of quality that is appropriate. Quality targets can be achieved or met when all aspects of the organization work together to make it happen[17]

To achieve the goals as in the definition of quality, quality management is needed. With the management of this project quality, it is hoped that no work will have to be repeated because there is damage or failed work, so that it does not cause losses. The definition of quality varies greatly, depending on the perspective you want to see. To achieve certain quality targets, cooperation and good communication are needed from all levels of work. In maintaining quality, it is very closely related to the quality costs that will be incurred.[6], [18]

Quality cost is the expenses incurred in dealing with pleasant problems, each that allows you to enhance high-quality and fees springing up from terrible exceptional. In other words, fine expenses are all fees incurred in maintaining first-class or first-rate targets. pleasant costs, in preferred, can be described as expenses incurred to make sure that the general excellent of the products or services produced is according with the needs of the project proprietor. A high-quality management machine is a set of documented techniques and popular practices for device management that objectives to ensure the conformity of a manner and product (goods/services) to sure desires and necessities. A first-rate control gadget is a coordinated activity to direct and manage an organisation with regards to nice. A satisfactory management device also method a device that guarantees the fulfillment of planned first-class goals and objectives. [19].

A program that can be carried out by way of a creation service employer so as to manage sports inside the operational degree of improvement (creation) is a excellent control device. A pleasant management system in fashionable is a sequence of ongoing activities (cycles) of an enterprise to reap desires such as assembly consumer or market goals, preventing pollution, preventing injuries according with enterprise polic. The exceptional control machine affords an outline of the employer in imposing high-quality management practices continuously to meet client or marketplace desires[8], [9]

ISO is a global norm frame created in order to enhance the workforce and products in trade international. ISO is a international affiliation answerable for the training of latest principles or updates to current ISO guidelines. ISO 9001:2015 is a satisfactory control wellknown that contains the requirements that should be met through a agency / agency in forming a first-class control machine. chargeable for the practise of new standards or updates to present ISO guidelines. The ISO hints which have been formalized can be reviewed once more inside five to 6 years so that the present standards continue to be relevant to the modern situations of the business global in all fields [20]

ISO 900:2015 is one of the internationally identified pleasant management widespread frameworks. ISO 9001 has gone through development and revision considering the fact that 1980, 1987, 1994, 2000, 2008, and 2015 by way of adjusting the desires of high-quality control at the time. The ISO 9001:2015 exceptional management fashionable can't simplest be applied to the economic international that produces merchandise, however also can be implemented to the sphere that produces services in this case, creation company offerings (contractors). with the aid of relating to ISO 9001:2015, companies can evaluate the offerings supplied and provide consistency within the high-quality of the services produced. There are several modifications in ISO model 9001:2015 with ISO 9001:2008,[19], [21]

II. METHODOLOGY

The kind of research used is quantitative research. which is analyzed descriptively. The descriptive approach is a method in researching the fame of a set of people, an item, a fixed of situations, a gadget of thought, or a category of occasions inside the gift. Descriptive research targets to create a description, photograph or portray systematically, factually and appropriately regarding the records, characteristics and relationships between the phenomena being investigated.

Quantitative research is research that is required to apply many numbers, beginning from data collection, interpretation of facts, and the advent of the consequences. The motive for using quantitative descriptive research is due to the fact this studies is required to provide an explanation for numerous phenomena or pix definitely and descriptively which may be very useful for obtaining variations in issues associated with the sphere of education

and human conduct and researchers need to obtain extensive information from a populace, but now not in depth, if the population is just too massive, then the have a look at can use samples taken from the populace. Researchers need to get correct records, primarily based on empirical and measurable phenomena. based on the information above, this kind of studies is used to describe the affect of ISO 9001: 2015 quality management on the high-quality cost of street projects within the metropolis of Palu. This research is located in the tender for a road construction project in Palu City, Central Sulawesi Province, which is within the scope of the Electronic Procurement Service (LPSE). The sample that will be the subject of the research is the winning Service Provider (contractor) of the tender in LPSE in the period 2022-2024 with a work budget value of more than 500 million Rupiah.

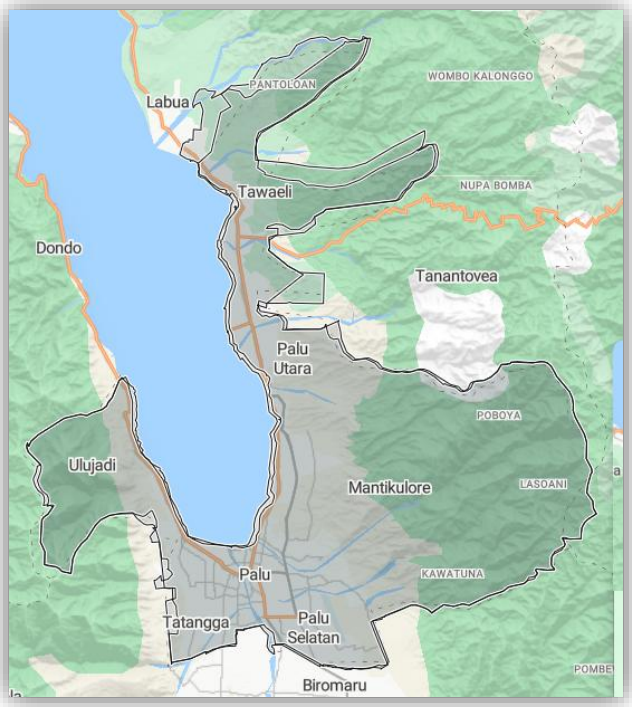

Figure 1, Location of Research Study Area

Population the whole organization of respondents who may be the object of studies. A pattern is part of the populace that is cautiously selected to represent the populace. The pattern of this look at is the quantity of avenue creation service providers (contractors) within the duration 2022-2024 and the price range price of the paintings is above 500 million Rupiah. The quantity of respondents turned into obtained from the calculation of the full range of avenue contractors involved inside the production of the valuable of the Central Sulawesi Province road.

The quantity of populations can be decreased to the variety of samples. The variety of samples is decided using the Yamane formula,

$$n = \frac{N}{1 + Nd^2}$$

with the understanding:

n = Number of samples

N = Number of populations

d = Expected level of significance

This sampling was carried out as an efficient step, without ignoring the representation of the various characteristics in the population. The sample size was obtained by substituting the N value according to the population of 48,. and a significance level of five%. The wide variety of samples primarily based at the calculation become acquired as 42 respondents as shown in Appendix 1. Respondents had been asked to provide the extent of implementation of the SMM inside the implementation of avenue tasks and its effect on excellent prices The questionnaire format has been adjusted to the objectives of this study.

Research variables are anything in any form that is determined in the research to be studied so that information about it is obtained. variables in this study include: Independent variables (X) or loose variables are variables that have an impact on or cause changes within the dependent variable, the variables on this observe are

ISO 9001: 2015 and based variables (Y) or bound variables are variables that are prompted or resulting from adjustments inside the impartial variable, the structured variable in this take a look at is high-quality fee (Y).

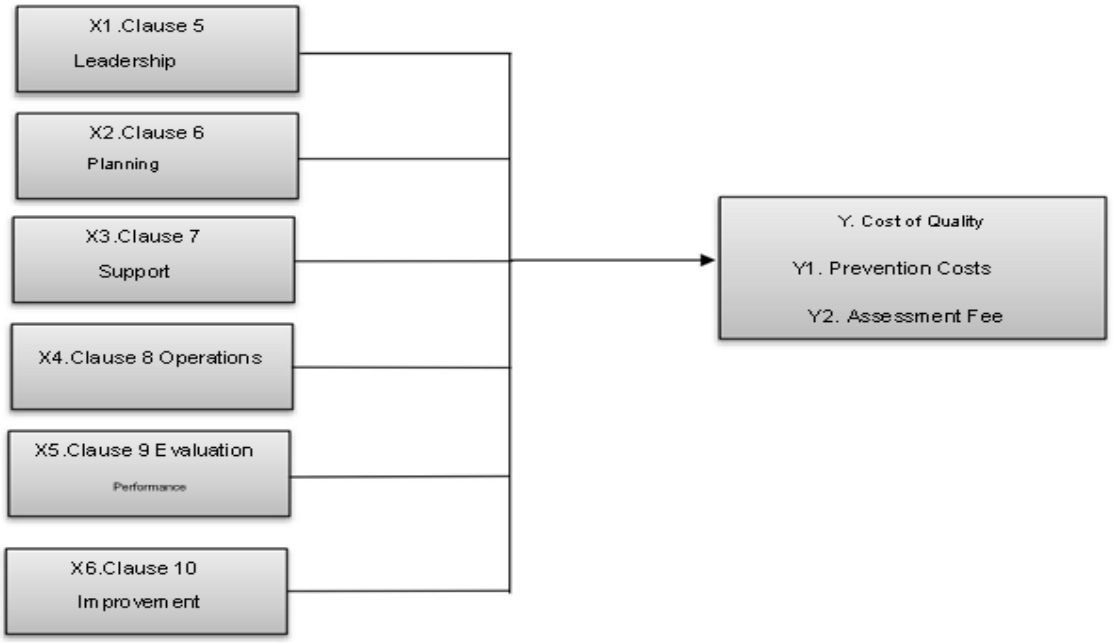

Figure 2. Research Variable Chart

Measurement uses the following criteria option measurement of variables within the questionnaire makes use of a Likert scale which is a method of measuring attitudes through mentioning agreement or confrontation with a specific subject or object. dimension uses the following criteria alternatives:

Table 1. Likert Measurement Scale

Measurement	Scale Value	Value Clarification
1	Strongly Disagree	Respondent Strongly disagrees with the declaration, in line with the state of affairs felt via the respondent within the corporation he works
2	Disagree	Respondent disagrees with the statement, according to the situation felt by the respondent in the company he works
3	Quite Agree	Respondent disagrees with the announcement, in line with the state of affairs felt by means of the respondent within the enterprise he works
4	Agree	Respondent has the same opinion with the statement, in keeping with the situation felt through the respondent inside the corporation he works
5	Agree	Respondent Strongly is of the same opinion with the assertion, consistent with the situation felt by means of the respondent inside the agency he works

SEM – PLS is an alternative to the use of SEM evaluation in which the statistics is not generally dispensed, so, PLS-primarily based SEM is likewise referred to as a smooth modeling method whose necessities aren't as stringent as those in SEM, as an instance in phrases of size scale, pattern length and residual distribution. statistics analysis became executed using the Partial Least square (PLS) technique the usage of SmartPLS software model 4[22]. SEM has a high stage of flexibleness in studies that connects principle and facts, and is capable of carry out route analysis with latent variables so that it's miles regularly utilized by researchers. in this method, information additionally does now not ought to be multivariate usually allotted (indicators with specific, ordinal, c programming language to ratio scales may be used inside the identical version), the sample does not ought to be massive.[23]

Dimension in SEM – PLS does not use international version standards like in SEM which is primarily based on covariance. Measurements completed in SEM – PLS include: evaluation of the outer version (Outer version) or additionally known as the dimension model, which connects all show up variables or signs with their latent variables. And evaluation of the inner version (internal version) or structural model, which is wherein all latent variables are connected to each different based on principle [22].

The effects of the look at are said to be dependable if there are similarities in information at special instances. A reliable device is an tool that, while used several times to degree the equal object, will nevertheless have the same results. A questionnaire is considered dependable if someone's solution to the question is steady or solid over the years or with tolerance for small differences between several measurements. Reliability testing on

this study become executed using the calculation of the Cronbach's Alpha value of each variable examined. A variable is stated to be dependable if it has a Cronbach's Alpha> 0.60.

Within the Outer version, this look at uses a reflective version size which is classified the usage of reliability and validity. in the meantime, the values used as measurements may be seen in the following table:

Table 2. Outer model measurement criteria

Criteria	Description
Composite Reliability	inner consistency size with a value> 0.6 interpreted the same as the cronbach alpha value
AVE	The common extract variance with a value > 0.6 used as a determinant of convergent validity
Fornell - Larcker	Used to ensure discriminant validity, then the AVE for every latent variable need to be higher than R2 with all other latent variables. thus each indicator block than with different latent variables representing one exclusive indicator block
Move Loading	Used to check discriminant validity. If an indicator has a better correlation with other latent variables than with its very own latent variable, then the model fit have to be reconsidered

Testing on the internal version is done to test the connection among latent variables. This measurement describes the relationship among latent variables based on major theory. The internal version is tested via searching on the R square value and route coefficient to obtain statistics on how a lot the endogenous latent variable is motivated by means of the exogenous latent variable, as well as the importance check to test the importance price of the relationship among variables. Structural model measurement is a version that connects latent variables. Structural version size may be seen inside table:

Table 3. Inner Model Measurement Criteria

Kriteria	Deskripsi
R^2 Endogenous latent variable	The R^2 value of 0,67 is labeled as widespread
0	The R^2 value of 0,33 is categorized as slight
	The R^2 value of 0,19 is categorized as vulnerable
	The R^2 value of >0,7 is categorized as robust
Measure of influence f^2	The f^2 value of 0,02 is categorized as a vulnerable have an effect on of the latent predictor variable (exogenous latent variable).
	The f^2 value of 0,15 as a enough have an effect on of the predictor latent variable (exogenous latent variable)
	The f^2 value of 0,35 as sufficient have an impact on of the predictor latent variable (exogenous latent variable)..
Relevance of prediction Q^2 dan q^2	Value $Q^2 > 0$ shows evidence that the observed values have been well reconstructed. Thus, the model has predictive relevance. While the value $q^2<0$ shows no predictive relevance
	The q^2 used to see the relative impact of the structural model on remark measurements for endogenous latent variables.
VIF	If the VIF value of an impartial variable is less than or same to ten, it's far considered that there is no severe multicollinearity. which means the correlation among unbiased variables is still within suited limits, in order that the have an effect on of the impartial variable can be separated properly from other variables.
SRMR *(Standardized Root Mean Square Residual*)	This value is a measure of version in shape, specifically the difference among the facts correlation matrix and the estimated version correlation matrix. This check appears on the SRMR cost if it's far less than zero.10 then the model used is healthy.
Chi-square	The smaller the chi-rectangular value, the higher the model and the significance value is extra than the cut offvalue (p>0.05).

III. RESULT AND DISCUSSION'

Outer model analysis or dimension version shows how the relationship between latent variables and their signs. This analysis is to ensure that the measurements used are worth of being used as measurements or are legitimate and dependable. assessment of the measurement version via confirmatory component evaluation is by the use of the MTMM (MultiTrait-MultiMethod) approach with the aid of testing convergent validity and discriminant validity. whilst the reliability check is carried out in ways, specifically Cronbach's Alpha and Composite Reliability Convergent validity is an indicator that is assessed based at the correlation among object score/thing rating with assemble rating, which may be seen from the standardized loading aspect which describes the significance of the correlation of every size object (indicator) with the construct. man or woman reflective measures are said to be high in the event that they correlate extra than 0.70 with the assemble to be measured. An outer loading cost of zero.50-0.60is still acceptable.

Table 4. Outer Loading Value

Laten Variables	Indicator	Outer Loading	Critical Point	Conclusion
Leadership (X1)	X11	0.900	0.600	Valid
	X12	0.907	0.600	Valid
Planning (X2)	X21	0.910	0.600	Valid
	X22	0.932	0.600	Valid
Support (X3)	X31	0.896	0.600	Valid
	X32	0.901	0.600	Valid
Operation (X4)	X41	0.906	0.600	Valid
	X42	0.921	0.600	Valid
Performance Evaluation (X5)	X51	0.884	0.600	Valid
	X52	0.887	0.600	Valid
Improvement (X6)	X61	0.904	0.600	Valid
	X62	0.908	0.600	Valid
Cost of Quality (Y)	Y1	0.870	0.600	Valid
	Y2	0.912	0.600	Valid
	Y3	0.902	0.600	Valid

It can be seen that all data are above 0.7. With the highest loading factor value of 0.932, which is an indicator of planning and the lowest value of 0.870 is one of the indicators of quality costs. So that the assumption of convergent validity on all question items passes. The consequences of outer loading can also be seen inside the following figure

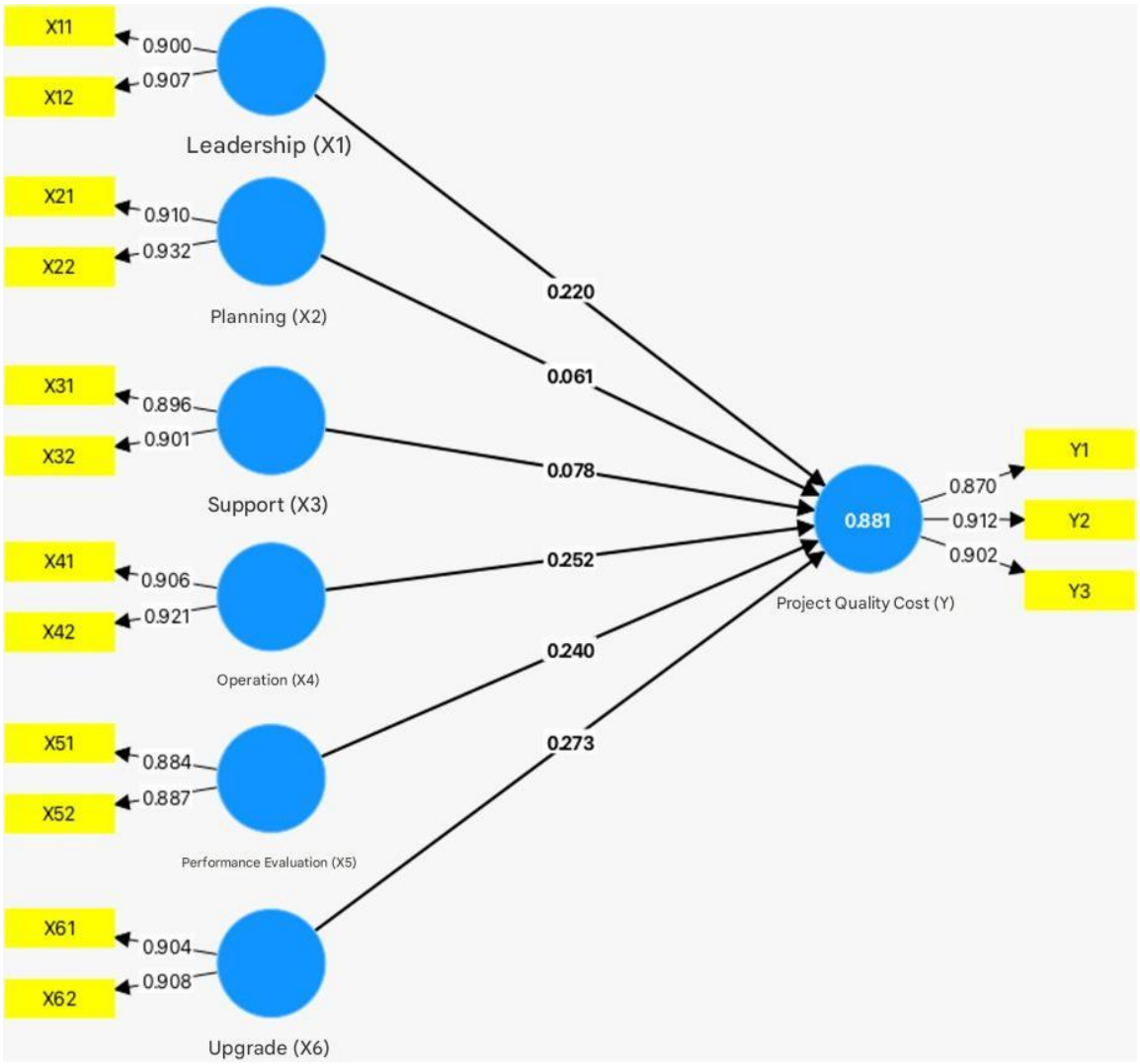

Figure 3 ,PLS (Outer Loading) Model

In. in addition to looking on the outer loading or loading aspect cost to evaluate convergent validity. Convergent validity can also be evaluated by way of considering the outer loading of the indicator and the average variance extracted (AVE). The version is said to have pretty precise convergent validity if the AVE (rectangular of common Variance Extracted) cost is greater than 0.50. This shows that on average the assemble explains extra than 1/2 of the variance of its indicators. The ensuing AVE price may be visible in desk 5. - An AVE price ≥ 0.five suggests that the construct has precise convergent validity. this means that at least 50% of the variance of the signs can be explained via the assemble being measured.An AVE price <0.5 indicates that the convergent validity is low, so the indicators might not be proper sufficient to represent the assemble.

primarily based on the desk above, it could be concluded that every one constructs every have an AVE price higher than 0.5 so it is concluded that all constructs have exact convergent validity. This trying out level is carried out to give an explanation for how some distance the difference among a hallmark (manifest) of a construct and different constructs. In discriminant validity trying out, there are 2 ways, namely by using searching at the go loading value or comparing the square root of the common variance extracted (AVE) for every assemble with the correlation cost among the construct and the version.. Research

Tabel 5. Average variance extracted (AVE) Value

Laten Variabel	AVE Value	Description
Project Quality Cost (Y)	0.801	Good
DSupport (X3)	0.807	Good
Performance Evaluation (X5)	Good	Good
Leadership (X1)	0.817	Good

Operation (X4)	0.834	Good
Improvement (X6)	0.821	Good
Planning (X2)	0.849	Good

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SRMR is Standardized Root mean square Residual. In Yamin (2022), this value is a measure of version in shape, particularly the distinction between the facts correlation matrix and the estimated version correlation matrix. This take a look at seems at the SRMR value if it is less than 0.10 then the model used is fit.

Table 6. SRMR Test Value

	Saturated model	**Estimated model**
SRMR	0.074	0.074

It can be seen that the SRMR price of 0.074 <0.10. So the model on this look at is healthy.The F-rectangular (f^2) check in PLS-SEM (Partial Least Squares Structural Equation Modeling) is used to degree the neighborhood impact length or the impact of modifications inside the R^2 fee whilst an unbiased variable is removed from the model. This enables become aware of how a whole lot influence the impartial variable has at the established variable in the structural version.

The F-rectangular (f^2) test indicates the neighborhood effect length to see how a good deal an unbiased variable contributes to the established variable within the structural model. particularly, this check suggests how a whole lot trade in R^2 (coefficient of willpower) takes place when one predictor variable is removed from the version. If the f^2 fee is high, it manner that the impartial variable has a sizeable effect at the structured variable. Conversely, a small f^2 price suggests that the variable has a small impact. The f^2 effects are interpreted based on the subsequent standards (Cohen, 1988):

- $f^2 \geq 0.02$: Small size effect
- $f^2 \geq 0.15$: Medium size effect
- $f^2 \geq 0.35$: Large size effect

Table 7. f^2 Test Value f^2

	Project Quality Cost (Y)
Project Quality Cost (Y)	
Support (X3)	0.019
Performance Evaluation (X5)	0.206
Leadership (X1)	0.140
Operation (X4)	0.241
Improvement (X6)	0.263
Plannin (X2)	0.012

Based on the f-square value results in table 4.14, it can be seen that the variable that has the greatest influence on Project Quality Cost (Y) is Improvement (X6) with an f-square value of 0.263, followed by Operation (X4) of 0.241, and Performance Evaluation (X5) of 0.206, all three of which are included in the category of medium to large effects according to Cohen's interpretation. Meanwhile, Leadership (X1) has a moderate effect of 0.140, and the other two variables, namely Support (X3) and Planning (X2), have a very small effect with f-square values of 0.019 and 0.012, respectively, which are classified as weak effects. This shows that the contribution of Improvement, Operation, and Performance Evaluation to changes in Project Quality Costs is more significant than other variables. The Goodness of Fit test aims to test the overall fit of the model, both for the outer model and the inner model and whether there is a match with the observed values with the expected values in the model. The Goodness of Fit test value can be seen in the following table:

Tabel 8. Goodness of Fit Test Value

	Saturated model	**Estimated model**
Chi-square	219.077	219.077
NFI	0.639	0.639

The interpretation of the GoF index price is zero.1 (low GoF), zero.25 (medium GoF) and 0.36 (excessive GoF). The calculation consequences display that the GoF price of the model is zero.639 inside the NFI table and is protected within the high GoF category. Empirical statistics is capable of explain the dimension version and the measurement model with a excessive level of suit.The Q^2 size is examined using blindfolding trying out and a version can be stated to meet the predictive relevance criteria if the coefficient of Q^2 is better than 0. A Q^2 cost more than 0 shows that the version has predictive relevance for a selected endogenous construct, conversely a cost of 0 and under shows a loss of predictive relevance.

Dimension, the relative length of predictive relevance, namely the values 0.02; zero.15; and 0.35 imply that the unbiased variable construct has predictive relevance. primarily based at the effects of the path coefficient analysis, the variables that have a sizable influence on mission first-class value (Y) are overall performance evaluation (X5), leadership (X1), Operation (X4), and development (X6), indicated with the aid of a p price <0.05 and a t value> 1.96. specifically, improvement (X6) has the most powerful impact (O = zero.273; p = zero.001), followed by way of Operation (X4) (O = 0.252; p = zero.008), overall performance assessment (X5) (O = zero.240; p = zero.004), and management (X1) (O = 0.220; p = 0.044). meanwhile, the help (X3) and making plans (X2) variables do no longer have a full-size impact on challenge first-class charges because the p values are 0.505 and 0.468, respectively, which exceed the significance limit of zero.05. This suggests that the elements of development, operations, performance evaluation, and leadership play a greater essential position in suppressing or handling project high-quality fees in comparison to support and planning.Based at the recapitulation of the results of the respondent questionnaire, there are three primary limitations in the implementation of the ISO 9001:2015 first-class management device on the Road project in Palu City.

IV. CONCLUSION

The effects of the identification of literature research and former research, it became acquired that the Implementation of the ISO 9001: 2015 fine control system has a tremendous impact on the pleasant prices of a production assignment. There are 6 elements or 6 clauses inside the ISO 9001: 2015-primarily based quality control gadget that affect the nice expenses of road paintings in Palu city, specifically management, planning, aid, Operations, performance assessment and improvement. records evaluation the use of smartPLS model four software program with the SEM-PLS method and the usage of outer version and inner version trying out obtained the variable development (X6) has the strongest influence followed by way of Operations (X4), overall performance assessment (X5) and leadership (X1) in the meantime, the aid (X3) and making plans (X2) variables do now not have a extensive impact on task high-quality costs. This shows that the factors of improvement, operations, performance evaluation, and leadership play a greater crucial role in reducing or managing challenge first-rate expenses compared to help and planning. 3 essential obstacles within the implementation of the ISO 9001: 2015 pleasant control gadget implementation on the road mission in Palu town. The most dominant impediment is the shortage of route or socialization regarding the ISO 9001:2015 nice control gadget, second is the employer's lack of know-how of the ISO 9001:2015-primarily based nice control gadget, and third is the dearth of communication and cooperation in enforcing the ISO 9001:201quality management system

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