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APPLICATION OF QUALITY PLANNING TO OPTIMIZE PRODUCT AND CONSTRUCTION PROJECT QUALITY

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A country is called developed when the capacity and progress of science and technology have created products that always meet the requirements and increasing needs of people, ensuring stability and development of the nation in particular and the movement of the world in general. In Vietnam, the quality of goods is still modest. This exists not only from a macro perspective but also from a micro perspective and the transition from macro to micro because of a lack of orientation, or can be called the lack of "Product quality planning" in terms of space. This paper will discuss the concepts of quality, expand the concept of quality with the aim of achieving good quality, meeting increasing requirements, need to perform the "quality planning" work under the space degree. The paper uses a mathematical tool based on the Cartesian coordinate system to determine the optimal value of product quality in order to demonstrate quantitatively according to the spatial frameworks when the quality is desired to achieve the required perfection through the magnitude of the "quality demand." In a similar way, in order to get the construction project achieve the maximum quality, there must be adjustment solutions in 3 aspects. However, at present, in Vietnam in particular and the world in general, there have not been many in-depth studies on the formation of quality and the factors affecting the quality, especially the industrial construction projects. Through the success or failure of investment projects in the form of public private partnerships (PPP) of countries around the world, including developed countries, the author thinks that in order for the project to be successful, it is necessary to apply construction product quality planning.

Key words: Product quality, quality planning, quality demand, satisfaction level, optimal values

INTRODUCTION

The advance of science and technology has made products to meet the requirements, the increasing needs of people, ensuring the stability and development of the nation in particular and the movement of the world in general [19]. They must prove that the quality of their products is becoming higher and higher, more convenient to use at lower costs. The UK is the first country to set standards for quality and they have succeeded [18]. Japan is an Asian country, from the 1960s, they were aware and interested in product quality and identified it as a national priority. Their success created a quality product system in all fields of security, defense, consumption, etc. with great leaps and bounds and was dubbed the "Asian Dragon", the real product system. Their quality products are mostly accepted by countries around the world [20]. This proves that Japan has a consensus by the quality-oriented work expressed by the legal system, the implementation of the ministries and branches by the system of sub-law documents and the legal corridor for the manufacturing industry, and finally the human consciousness and the production facilities of the product.

In a competitive market, the only way for successful organizations is to make customers happy with their products [1,18,31]. Of course, how to identify and measure whether customers are satisfied or not. After buying the product they need to evaluate whether the product is of sufficient quality or not. If guaranteed, the customer may be willing to return to the company in the future, but if not satisfied, it is likely that the customer will turn to a competitor [4]. The challenge for organizations is to identify what creates high quality products according to customers. [17] It is argued that customers who endorse high quality customer satisfaction tend to be loyal to the company [24].

The term “planning” has been around in Vietnam since 1961 [20]. At first it was used to refer to the concept of setting up the ground for the development and construction of urban areas, often called urban planning. The term planning was gradually used in other fields of knowledge, this term has been used relatively popular such as industrial cluster planning, coal industry planning, fishery industry planning, national power network planning, etc. [20] All of the above terms are related to the term "planning".

The term “planning” can be understood as giving a roadmap to implement an idea or a job that needs investing a lot of resources and there is an organic relationship between them, forming a closed chain and each link in a sequence that does not perform well will give different results [19].

According to Professor Margaret Roberts, planning is a process of making decisions and activities of providing resources, so planning is also political on the other hand in the context of global economic fluctuations, with economic development steps [19,20]. However, due to the great leaps, planning is always dynamic. Therefore, the

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planning term includes the following steps:

Step 1: Set goals - Set directions - Identify resources - Make action decisions (macro)

Step 2: Develop requirements - Standards - action programs, the system of legal documents, implementation models, guiding documents, institutional measures, inspection measures, management measures (mesenchymal) [26].

Step 3: Includes prepare the implementation process; Development of implementation plan; Organize, perform; Review, research, learn from experience, adjust (micro).

MATERIALS AND METHOD

Product quality

According to philosophical viewpoint, quality is the basic definition of the object, whereby it is one and not the other, so that it is different from other objects. Through this interpretation, it is possible to understand that the quality cannot be attributed to specific properties, but it is closely associated with the object as a unified whole, covering the whole object, inseparably [14,16].

The International Organization for Standardization of ISO, the term standard ISO 8402, has introduced a term that is widely accepted by countries [3,12].

"Quality is all the characteristics of an entity, giving that entity the ability to satisfy a stated or potential need."

The characteristics of the product are usually determined by the criteria, economic - technical - aesthetic parameters that can be measured, calculated and assessed. Product quality is a measure of use value, the same value of use, products can have different levels of usefulness, different levels of quality [7,9].

The concept of quality as above is highly generalized, this concept has dominated and fundamentally changed theories of quality management. It also changed the way people perceive the process of how to create quality [6,29,30,32].

According to expert K Ishi Kawa, quality is the ability to satisfy market demand with the lowest cost [7].

According to the manufacturer, the quality of products/services must meet the set technical standards [12].

According to the trader, quality is sold out and has regular customers.

According to consumers, quality is the fulfillment of their desires in all aspects including [12]:

– Technical features or usefulness of it.
– Reasonable cost (worth the cost they spend).
– Convenient with their terms of use.

Quality is formed on the basis of customer and manufacturer relationships or we can say the agreement between customers and manufacturers (Figure 1). Manufacturers must find customer requirements to agree on what needs to be done to meet customer requirements [2,13,24].

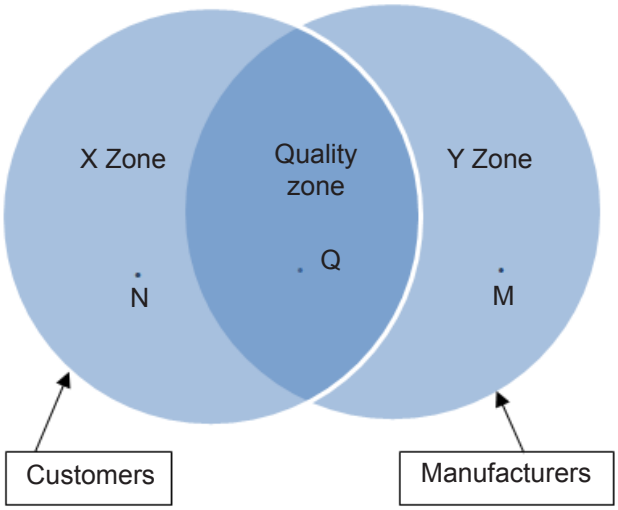

Figure 1: Quality model in narrow sense

In Fig. 1, N-circle is a set of characteristics that a customer requires for a product. The M-circle is a collection of properties created by the manufacturer in the product. The area of intersection Q between the two circles is the feature area of the product that meets customer requirements called the "Quality Zone". Zone X is the area where customers need some features that the product does not meet is called "Quality zone below required". The Y zone is an area of a product that customers don't need to call it "another quality zone required". In order for the Q region to grow larger and reach the perfect level or ideal level when circle M covers circle N. It is very difficult to achieve this, meaning to understand the requirements and tastes of the groups. Customers to meet those requirements, but the reality to satisfy all customer groups is unimaginable, because it depends on regional characteristics, income, age, etc. That is reflected in the Y region (Fig. 1) [17].

Quality in the narrow sense: The quality presented above can be called quality in the narrow sense, which means it is limited only within the framework of the manufacturer and the product only meets the specific needs in the geographical region or consumer group. It is not widely used, typical for manufacturing industry [10,15].

Quality in the broad sense (general quality): When human demand is higher and higher, the demand for quality goes beyond the price and quality factor, which will bring existence and development to manufacturers, even the nation's manufacturing industry [21].

The expanded quality view now must also satisfy other social requirements [5,22] such as: legal requirements, environment, social security, economic balance, anti-inflation, oversupply crisis, unemployment, etc., which means: "Quality products are understood as in addition to ensuring functions, durability, longevity, usability on the basis of satisfying the requirements of the user, it is necessary to meet other requirements of the society such as legal, environmental, social security and balance conditions of the economy and productivity means to have a consensus from macro to micro, according to a certain schedule" [21,23].

Product quality planning

Combining the words "Planning" and "product quality" to give the concept of product quality under the perspective of "product quality planning" is understood as follows:

“In order for a product to have good quality that is accepted by society and consumers, the process of product formation must combine synchronously groups of elements according to spatial scale and the process of forming quality called "Product quality planning" [21].

The group of factors mentioned above can be considered as function variables f (x, y, z). But in order to achieve the desired quality for the desired result, it is necessary to take measures to adjust the function of variables, because these variables are influenced by objective and subjective conditions. For variables that meet the requirements, it is necessary to plan an itinerary for quality formation as a basis for orientation for action [21,25].

According to professor Margaret Roberts [20], planning is a decision-making process and resource supply activities so product quality planning is similar, must have an orientation throughout the macro level to intermediate steps in drafting standards, procedures, implementation itinerary followed by the micro level (design, manufacturing, testing, adjusting, manufacturing, distributing products) [21].

Macro level: Including conditions and opportunities (the development of science and technology, the needs of society, the conditions allowed by law, etc.).

The support of the government manifests itself through orientation, through goals, decisions, guidelines and timing of implementation.

Table 1: Spatial framework of quality constituent factors

Elements / Degree	Groups of elements
Macro	- Identify the conditions and opportunities - Determine goals to be implemented - Make decisions
Meso	- Define policies - Develop institutions and mechanisms - Build the implementation program
Micro	- Planning for the project and designing - Implement manufacturing project products - Use - evaluate - improve research

Intermediate level: Ministries, branches and local authorities implement through sub-law document system (Decree - Circular - Technical standards - Management model - Decision - Implementation guidance - Testing supervising to adjust the implementation process towards the set target).

Micro space: Including the direct implementation processes such as: Organization of production, design, manufacturing, quality control, evaluation, adjustment, improvement, product supply, warranty, care customer care. [11]

The relationship between quality demand and spatial scale and quality demand value

Based on the group of quality constituents (Table 1) or it can be said that the factors affecting the quality are determined by three spatial scales, the problem now is to consider the extended quality perspective, the variability of all three spatial scales and the degree of influence through the variation of quality demand and the influence of 3 spatial degrees to the maximum possible value of quality demand [21].

If the three spatial frames of the product quality plan are expressed on the same coordinate system to be perpendicular, the product quality is represented by the inscribed sphere in the quadrilateral top of the quadrilateral whose sides are denoted as spatial scale - called quality demand, the remaining volume of the quadrilateral pyramid can be considered as an area of product characteristics that customers do not need (Fig. 2) or can be said as zero. Uniformity in quality viewpoint due to reasons of regional characteristics, cultural practices, usage requirements, purchasing power, age, etc. and finally, the loss of quality due to three angles of unbalanced space [2].

Calling R the radius and V the magnitude (volume) of quality demand. H is the center of inscribed circle of Oxyz axis. From our mathematical formulas, we will study the relationship between the quality demand and the magnitude of the three frames X, Y, Z.

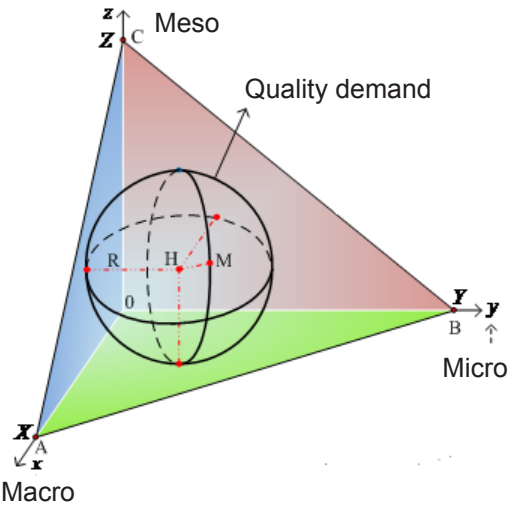

Figure 2: Planning model of product quality in three frames of X> 0, Y> 0, Z> 0

CALCULATION AND RESULTS

Calculation of R, V values

The quality sphere is in contact with three planes Oxy, Oxz, Oyz so the center of the sphere has coordinates H(R,R,R). Therefore this sphere has the equation (1).

$$(x-R)^2+(y-R)^2+(z-R)^2=R^2 \quad (1)$$

The plane (ABC) has the equation:

$$\frac{x}{X}+\frac{y}{Y}+\frac{z}{Z}-1=0 \quad (2)$$

Since the sphere is in contact with the plane (ABC), we have the distance from point H to the plane (ABC) to be equal to the radius R, that is:

$$d\left(H,(ABC)\right) = R \quad (3)$$

From (3), infer:

$$\frac{\left|\frac{R}{X}+\frac{R}{Y}+\frac{R}{Z}-1\right|}{\sqrt{\frac{1}{X^2}+\frac{1}{Y^2}+\frac{1}{Z^2}}}=R \quad (4)$$

To eliminate absolute values and R from (4), we construct a line through the center H(R,R,R) and perpendicular to the plane Oxy. This line intersects the plane (ABC) at the point K(R,R,Z_K). Substituting the entry point K(R,R,Z_K) coordinates (2), calculate:

$$z_K=Z\left(1-\frac{R}{X}-\frac{R}{Y}\right) \quad (5)$$

The center H is below the plane (ABC) so we have:

$$Z_H < Z_K,\ where\ Z_H=R \quad (6)$$

From (5) and (6), infer:

$$\frac{R}{X}+\frac{R}{Y}+\frac{R}{Z}-1<0 \quad (7)$$

From (4) and (7), infer:

$$1-R\left(\frac{1}{X}+\frac{1}{Y}+\frac{1}{Z}\right)=R\sqrt{\frac{1}{X^2}+\frac{1}{Y^2}+\frac{1}{Z^2}} \quad (8)$$

From (8) we have the formula for calculating the quality sphere:

$$R=\frac{1}{\frac{1}{X}+\frac{1}{Y}+\frac{1}{Z}+\sqrt{\frac{1}{X^2}+\frac{1}{Y^2}+\frac{1}{Z^2}}} \quad (9)$$

Quality bridge magnitude:

$$V=\frac{4}{3}\pi R^3=\frac{4}{3}\pi\frac{1}{\left(\frac{1}{X}+\frac{1}{Y}+\frac{1}{Z}+\sqrt{\frac{1}{X^2}+\frac{1}{Y^2}+\frac{1}{Z^2}}\right)^3} \quad (10)$$

(X, Y, Z are magnitude 3 space frames)

Analyze the variation of quality demand according to degree frames

According to the formula (10), the magnitude depends on the three frames of X, Y, Z. Therefore we consider it as a function of three variables X, Y, Z and study its variation according to these variables. We consider the following cases:

a) V function increases with each variable X, Y, Z
Consider arbitrary and fixed.
We have:

$$\frac{1}{X_1}+\frac{1}{Y}+\frac{1}{Z}+\sqrt{\frac{1}{X_1^2}+\frac{1}{Y^2}+\frac{1}{Z^2}}>\frac{1}{X_2}+\frac{1}{Y}+\frac{1}{Z}+\sqrt{\frac{1}{X_2^2}+\frac{1}{Y^2}+\frac{1}{Z^2}} \quad (11)$$

From (10), infer:

$$V(X_1,\ Y,Z) < V(X_2,Y,Z) \quad (12)$$

So the function V increases with the variable of X. Similar conclusions for variables of Y and Z.

b) If there is at least one frame of weakness
A mathematically weak framework can consider its magnitude to 0.
Suppose X → 0, so 1/X →+∞, from (10) infer V → 0
Suppose X → 0, Z → 0, so 1/X →+∞, 1/Z →+∞, from (10) infer V → 0

c) The degree frames are limited
Provided that the frames are limited, we will consider when the demand for quality reaches its maximum value in each of the following cases.
Suppose (X+Y+Z) ≤ m, with m is a positive constant.
Cauchy inequality: $a+b+c\geq 3.\sqrt[3]{abc}$ in which a, b, c are three arbitrary non-negative real numbers and the equals sign happens if and only if a = b = c.
Applying Cauchy inequality, we have:

$$X+Y+Z\geq 3.\sqrt[3]{XYZ}\Rightarrow\sqrt[3]{XYZ}\leq\frac{m}{3} \quad (13)$$

$$\frac{1}{X}+\frac{1}{Y}+\frac{1}{Z}\geq 3.\sqrt[3]{\frac{1}{X}.\frac{1}{Y}.\frac{1}{Z}}=\frac{3}{\sqrt[3]{XYZ}}\geq\frac{9}{m} \quad (14)$$

$$\sqrt{\frac{1}{X^2}+\frac{1}{Y^2}+\frac{1}{Z^2}}\geq\left(3.\sqrt[3]{\frac{1}{X^2}.\frac{1}{Y^2}.\frac{1}{Z^2}}\right)^{1/2}=$$

$$=\frac{\sqrt{3}}{\sqrt[3]{XYZ}}\geq\frac{3\sqrt{3}}{m} \quad (15)$$

From (10), (14) and (15), infer:

$$V(X,Y,Z)\leq\frac{4}{3}\pi\frac{1}{\left(\frac{9}{m}+\frac{3\sqrt{3}}{m}\right)^3}=\frac{4\pi}{3(9+3\sqrt{3})^3}m^3 \quad (16)$$

Based on Cauchy's inequality, for V to have the maximum value, X, Y, Z must be equal.

Suppose $\begin{cases} X+Y+Z \le m \\ Y \le y_0 \end{cases}$, and m > $3y_0 > 0$

According to the homogeneity of the V function, we have:

$$V(X,Y,Z) \le V(X,y_0,Z) =$$

$$= \frac{4\pi}{3} \frac{1}{\left(\frac{1}{y_0}+\frac{1}{X}+\frac{1}{Z}+\sqrt{\frac{1}{y_0^2}+\frac{1}{X^2}+\frac{1}{Z^2}}\right)^3} \quad (18)$$

Take Y = y_0 , from the conditions (X+Y+Z) ≤ m infer (X+Z) ≤ ($m-y_0$).

Apply Cauchy inequality: $a+b \ge 2\sqrt{ab}$ where a, b are two arbitrary non-negative real numbers and equals signs occur if a = b and only if. We have:

$$2\sqrt{XZ} \le X+Z \le m-y_0 \Rightarrow \sqrt{XZ} \le \frac{m-y_0}{2} \quad (19)$$

$$\frac{1}{X}+\frac{1}{Z} \ge \frac{2}{\sqrt{XZ}} \ge \frac{4}{m-y_0} \quad (20)$$

$$\frac{1}{X^2}+\frac{1}{Z^2} \ge \frac{2}{XZ} \ge \frac{8}{(m-y_0)^2} \quad (21)$$

From (18), (20) and (21), infer:

$$V \le \frac{4\pi}{3} \frac{1}{\left(\frac{1}{y_0}+\frac{4}{m-y_0}+\sqrt{\frac{1}{y_0^2}+\frac{8}{(m-y_0)^2}}\right)^3} \quad (22)$$

V reaches its maximum value ((22) if equals sign occurs) and only if

$$Y = y_0 < X = Z = (m-y_0)/2 \quad (23)$$

=> **Quality Bridge reaches MAX**

DISCUSSION

From the mathematical analysis above, we come to the conclusions as shown in Table 2.

According to conclusion 3 (Table 2) shows that the demand for quality reaches its maximum value if and only if the three spatial scales are equal in size. We can look through the following example to illustrate the quality planning.

Assessing the quality of investment activities in the form of Public - Private Partnership under the perspective of "Quality Planning"

Public - Private partnership is one of the solutions applied for infrastructure development worldwide. This type of contract is particularly common in developing countries where the state budget is not sufficient, capital resources from the private sector should be utilized to reduce the burden on public investment.

In the world, some countries have successfully applied

Table 2: Variation of quality bridges according to spatial scales

No.	Properties and constraints	Conclusion
1	Homogeneity of quality demand	When there is at least one developmental framework, it will contribute to increasing demand for quality.
2	Frame of weakness	If there is at least one weak framework, it may be difficult for quality demand to reach the expected value. In other words: in order for the quality bridge to reach the desired value, all levels must grow to a minimum.
3	(X+Y+Z) ≤ m with m > 0	Demand for quality reaches its maximum when the three spatial scales are equal in size.
4	$\begin{cases} X+Y+Z \le m \\ Y \le y_0 \end{cases}$ with $0<y_0<m<3y_0$	When the activities of the enterprise are limited but not too low (y_0 not too small), the demand for quality reaches its maximum value when the spatial frameworks must be adjusted to reach the balance.
5	$\begin{cases} X+Y+Z \le m \\ Y \le y_0 \end{cases}$ with $m > 3y_0$	In some cases, the Y-framework is minimized due to the impact of a large-scale economic crisis or some other reason (y_0 value is limited), so that the demand for quality V reaches its value. At the maximum, the two X and Z degrees must be adjusted accordingly to match the Y value so that the demand for quality always reaches MAX.

PPP in road transport infrastructure such as Chile, Australia, etc. and there are unsuccessful countries like Mexico and Hungary, which can be considered as typical failures when implementing PPP method.

For Mexico, from 1987 to 1992, the Mexican government licensed 52 projects under the PPP model. By the end of 1995, 34 projects had attracted US $ 9.9 billion in committed capital from private enterprises [8].

However, the above figure of capital attraction reflects unexpected results. The reason Mexico made a mistake in bidding was that it chose the company with the shortest collection time, which led to high pressure on fee collection. In addition, the government requires each toll road to have a toll-free parallel road. On the other hand,

the calculation of construction costs is not good (average price team is 25%), while the survey on the number of vehicles through the wrong route, resulting in a 30% lower revenue than expected, is a big cause. Project failed. The government must take over 50% of licensed projects and carry the debt of banks and construction companies.

For Hungary, Hungary's M1/M15 road project is the first toll road in Central and Eastern Europe. In 1995, the project was completed on schedule and estimated cost. However, the survey data of vehicle density is wrong, the number of vehicles using the route is 40% lower than expected, the high fee cannot compensate for low vehicle volume, the Hungarian government has to buy and take over the project.

The aforementioned failures when engaging private parties in PPP projects require the parties to carefully plan, calculate and forecast costs and revenue close to reality, adjust compliance with the agreements set out in the contract, comply with laws and increase transparency. In addition, the project must be reasonable, ensure environmental conditions, and receive the support of the public.

For Vietnam: up to now, 336 PPP projects have been signed contracts (140BOT; 188BT; 8 other type projects). Mobilized 1,609,295 billion VND. Although the implementation process is still limited, some PPP projects have contributed positively to improve the quantity and quality of urban transport infrastructure system, energy, etc. in a timely manner, addressing pressing needs on public services, contributing to macroeconomic stability, stimulating demand for domestic production, and increasing the competitiveness of the national economy [8].

According to the World Economic Forum (WEF), in 2017, the quality of Vietnam's overall infrastructure ranked 79th, up 02 places compared to 2014, up 16 places compared to 2012, and increased. 44 places compared to 2010.

Besides the achieved results, the reality shows that the implementation process still has many shortcomings. By the end of 2017, the projects have completed the construction phase, are operating business, but have emerged some shortcomings at all 3 levels as follows:

- PPP has been officially implemented in Vietnam for over 10 years and currently there is no investment law in the form of PPP.
- Unprofessional management model due to too many state actors participating in the decision (National Assembly, Government, Ministry - Sector, locality).
- People do not have the option to upgrade and renovate single-track roads but still have to pay fees, causing bad public opinion.
- Projects through the auditing process have applied the form of contractor appointment to select investors, with potential risks of waste, loss of state budget, and doubt about quality.
- The financial support work of the banking system lacks consistency and consistency and measures to control support.
- Vietnamese investors are not highly professional, paying much attention to profit targets but overlooking other goals (such as environment, society, production costs, etc.) that the management system does not have adjustment and control solutions [28].
- The project publication and project portfolio have not been seriously, publicly and transparently implemented.
- Regulations on the roles and responsibilities of competent state agencies and investors are still unfair (sharing risks, legal disputes, etc.).
- For BT projects, apart from appointing contractors but not auctioning land funds to investors, causing damage to the state and lack of transparency.
- The process of selecting and managing subcontractors is not closely monitored, causing prolonged progress and quality is not guaranteed.
- Monitoring of contract performance and contract sanctions are still lax.
- Inadequate fees, placement of toll booths, charging time cause bad public opinion in society, causing damage to businesses and the economy.

With the above assessment, from the perspective of "Quality Planning" in the form of PPP investment, all 3 frameworks need to be adjusted to drive the success of PPP investment including:

- Frame level 1:

Completing the Investment Law in the form of public-private partnership (PPP) soon.

Having clear orientations, policies, objectives and mechanisms to attract investment towards the success of PPP investments.

- Frame level 2:

Promptly promulgate legal documents of the Government, ministries and branches on the basis of law and practice of the economy to realize the final goal.

Separating state management and business management functions to ensure fairness to investors.

Taking the principle of transparency as a basis to attract investment.

There is a need for state support policies for investors in terms of capital, site clearance, and financial supply subjects.

Establish a standard management process in accordance with the law, with a clear division of responsibilities among stakeholders [27].

Transparent process of inspection on technical quality, schedule and capital to avoid risks and legal disputes.

Develop a process of selecting contractors in a spirit of openness and transparency, with the aim of selecting qualified, highly professional contractors and as a basis for inspection and examination.

- Frame level 3:

Transparency in contractor selection, mandatory bidding.

Develop a process to supervise and control investors and contractors involved in construction activities of PPP.

Comply with PPP contracts in all aspects including operation management, especially conditions of transport services, environment, traffic safety, etc.

The location of toll booths must be carefully considered to ensure fairness and social support.

If these frameworks are always adjusted and operated in a uniform, synchronized manner, surely the type of PPP contract will be successful.

CONCLUSIONS

For successful quality operations, frame levels need to be developed in a balanced manner, and the product quality as well as service quality should meet the requirements when and only if the three frame levels have equilibrium values. That is, from the timely orientation of macro level guidance by the system of laws; until the establishment of institutions, mechanisms and programs implemented by ministries, branches and governments (decrees, circulars, guiding documents) and the organization and implementation process of projects the set. This shows that, in order to stabilize the production industry to keep up with the development of advanced countries, the least developed countries need to perform the work of "quality planning", so that the quality reaches the optimal value. Particularly in the construction industry, to achieve good quality products, it is necessary to perform well the quality planning according to three spatial frameworks.

With the trend of globalization, countries need to share their needs, especially the industry of providing road transport infrastructure, to specialize in the manufacturing process of products based on taking advantage of each country's own resources, with the aim of lowering costs and meet the requirements of developing industries on the basis of globalization.

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