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# Applying PCI in Combination Swivel Head Wrench

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**Abstract.** Taiwan's traditional industries are subject to competition in the era of globalization and environmental change, the industry is facing economic pressure and shock, and now sustainable business can only continue to improve production efficiency and quality of technology, in order to stabilize the market, to obtain high occupancy. The use of process capability indices to monitor the quality of the ratchet wrench to find the key function of the dual-use ratchet wrench, the actual measurement data , The use of process capability $C_{pk}$ index analysis, and draw Process Capability Analysis Chart model. Finally, this study explores the current situation of this case and proposes a lack of improvement and improvement methods to improve the overall quality and thereby enhance the overall industry.

## 1. Introduction

Global competition in the era of intense competition and environmental changes, making Taiwan's traditional industries are facing economic pressures and industrial competition, the original Taiwan's traditional industries to a simple OEM production, gradually affected by globalization and lost the competitive advantage, today's traditional industries in Taiwan can Yong Continued operation to be diversified, automated, diversified services, and high-quality technology. However, under the current trend of demand for profitability, shortening of delivery and diversification of orders, only to continuously improve production efficiency and improve quality, and the establishment of flexible production capacity in order to compete in a fierce competitive environment, And achieved a high market share [1].

According to the report of the Taiwan Hand Tools industry [2], Taiwan's hand tools totalled NT $ 69.15 billion in 2014, about 2.2% higher than in 2013, and the total output value increased year by year. Billion, grew 18.61%(Figure1).

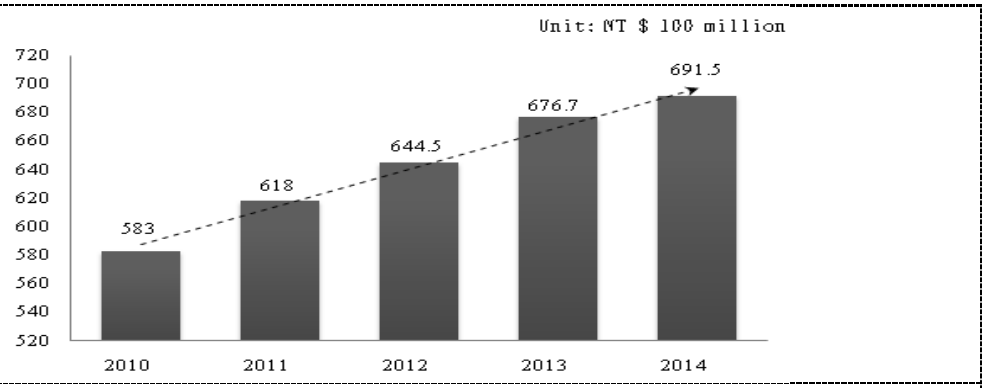


**Figure 1.** Taiwan hand tools total output value

In this study, Taichung City N Industrial Co., Ltd., the company mainly produces precision machining of metal parts, CNC lathe processing, meat grinder, food machinery parts, automobiles, locomotives and bicycle parts, rods and wrenches and many other products, Dual-use ratchet wrench for one of the products. In this study, we can improve the manufacturing process of N-use ratchet wrench with process capability index. We hope to improve the problem of poor quality, failure rate and quality management by means of process capability index. This study will discuss the current situation and propose a deficiency and improve the way to improve the overall quality, thereby enhancing the overall industry.

## 2. Literature

### *2.1. Quality Management.*

The concept of quality management changes with the times, the use of the product point of view, including the characteristics of the product itself and the quality of the product; used in the process of the point of view, including the quality of technical processes [3]. In the process of use, [4] argue that quality management is the organization's commitment to continuous improvement through the culture of customer satisfaction, the two authors compare quality control between the Japanese company and the Japanese Original Will be affected by environmental characteristics, company type, company characteristics, and employee characteristics. Comprehensive quality management methods, are to effectively improve the quality and control.

### *2.2. Process Capability Index.*

Process Capability Indices Originally proposed by [5], the concept of process capability indicators and ideas, when the product quality characteristics were stable and subject to normal distribution, the definition is:

$$C_p = \frac{USL - LSL}{6\sigma} = \frac{d}{3\sigma}$$

Where, USL for the process quality characteristics of the upper limit, LSL for the process quality characteristics of the lower specifications, the standard deviation of the quality characteristics, d for the deviation. Since $C_p$ only considers the degree of process variation and ignores the mean value of the process, the [6] constructs $C_{pk}$ with the process average as the center. In addition, he also suggests that in the unilateral rule, Looking for large process capability indicators $C_{pu}$ and $C_{pl}$. Among them, $C_{pk}$, $C_{pu}$ and $C_{pl}$ of the expression is as follows:

$$C_{pk} = min\left\{\frac{USL-\mu}{3\sigma}\ ,\ \frac{\mu-LSL}{3\sigma}\right\} = \frac{d-|\mu-m|}{3\sigma}$$

$$C_{pu} = \frac{USL-\mu}{3\sigma}\ ,$$

$$C_{pl} = \frac{\mu-LSL}{3\sigma}\ ,$$

Which μ is the average of the process, m is the midpoint of the specification interval. Although Cpk can reflect the process mean (μ) deviation from the specification center (m), but can not reflect the deviation from the target T, and $C_p$ when the degree of variation tends to 0, $C_{pk}$ value will be divergent to infinity.

To measure a product usually has many processes, [7] defined the minimum individual PCI $C_0 = (1/3)\Phi^{-1}\left[(\sqrt[t]{2\Phi(3c)-1}+1)/2\right]$, where c is the integrated PCI, t is the total number of process, Φ is the standard normal cumulative distribution function, and Φ−1 is the inverse of Φ.

## 3. Process capability index $C_{pAP}$

In this section, a new PCI $C_{pAP}$ will be developed to measure the process capability of a product. Let the accuracy index A = μ/USL and the precision index P = σ/USL and using Equation (5), the new PCI CpAP can be presented as:

$$C_{pAP} = \frac{USL-\mu}{3\sigma} = \frac{1-A}{3P}.$$

Hence, the accuracy and precision of all the process of a product can be evaluated. Also, quality managers can use the new integrated PCI to identify the substandard quality characteristics of the product. To more effectively use the new PCI $C_{pAP}$, we establish four steps as follows.

Step 1: The total number of process t must be known and c must be decided. Then, $C_0$ can be determined.

Step 2: Collect data for each process.

Step 3: Calculate the $C_{pAP}$ of all process using Equation.

Step 4: Identify the poor process in order to improve product quality and performance.

## 4. Numerical example

The tightening of the screws and nuts requires a wrench to adjust. If there is a difference in the quality of both ends of the ratchet wrench, it will make it impossible to fully interface with a variety of angles ratchet, error, yield can not be raised and other issues, easy to cause wrench fracture and easy to turn. So the quality of the wrench process is very important, the relationship between the dual-use ratchet wrench key factors.

In general, the process of the function or specification requirements must meet the product specifications, in order to ensure quality, such a process specification, we call the important "quality characteristics", therefore, this study to N company wrench process, for example, there are three important quality characteristics, namely $C_{pkA}$, $C_{pkB}$, $C_{pkC}$ (Figure2).

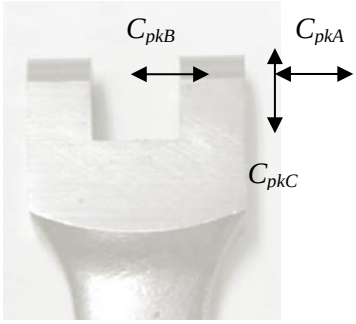


**Figure 2.** The reciprocating ratchet wrench has three quality features

As shown in Figure2, the two-purpose ratchet wrench has three "quality characteristics", namely: the right side of the wrench $C_{pkA}$, wrench left $C_{pkB}$, depth $C_{pkC}$, the three important quality characteristics

of the process will be the focus, 3 important quality characteristics are looking for the purpose, so through the Institute of the development of quality assessment model, can identify the quality of the product quality of the important quality of the process, and improve the method and improve product quality and yield. The analysis section is as follows:

Step 1: the two-purpose ratchet wrench has three important quality characteristics, are looking for the head. Wrench on the right side of $C_{pkA}$, wrench left $C_{pkB}$, product specifications are 6.10 ±0.15, depth $C_{pkC}$ product specifications for 9.3 ±0.2.

Step 2: 30 samples were taken by random sampling to calculate μ and σ, respectively.

Step 3: Calculate the three sets of process capability indicators by the formula Equation. The values of the USL are 6.25, 6.25 and 9.50 respectively, and the LSL values are 5.95, 5.95 and 9.10 respectively. The values of d are 0.15, 0.15 and 0.2, respectively, and the values of m are 6.10, 6.10,9.3.

$C_{pkA}$ = (0.15 - | 6.10-6.10 |) / (3 ×0.03) = 1.67
$C_{pkB}$ = (0.15 - | 6.10-6.10 |) / (3 ×0.03) = 1.67
$C_{pkC}$ = (0.2 - | 9.56-9.30 |) / (3 x 0.09) = -0.22

Step 4: Calculate the quality of the right $C_{pkA}$ (1.67), the left side of the $C_{pkB}$ (1.67) of the process capacity indicators have reached the quality level, are greater than 1; only depth $C_{pkC}$ (-0.22) did not meet the process quality indicators of quality standards, it is clear wrench depth $C_{pkC}$ of the accuracy and accuracy of the lack of quality improvement should be the process should be given priority to improve the process.

From the above steps, you can draw the PCAC mode diagram (Figure3):

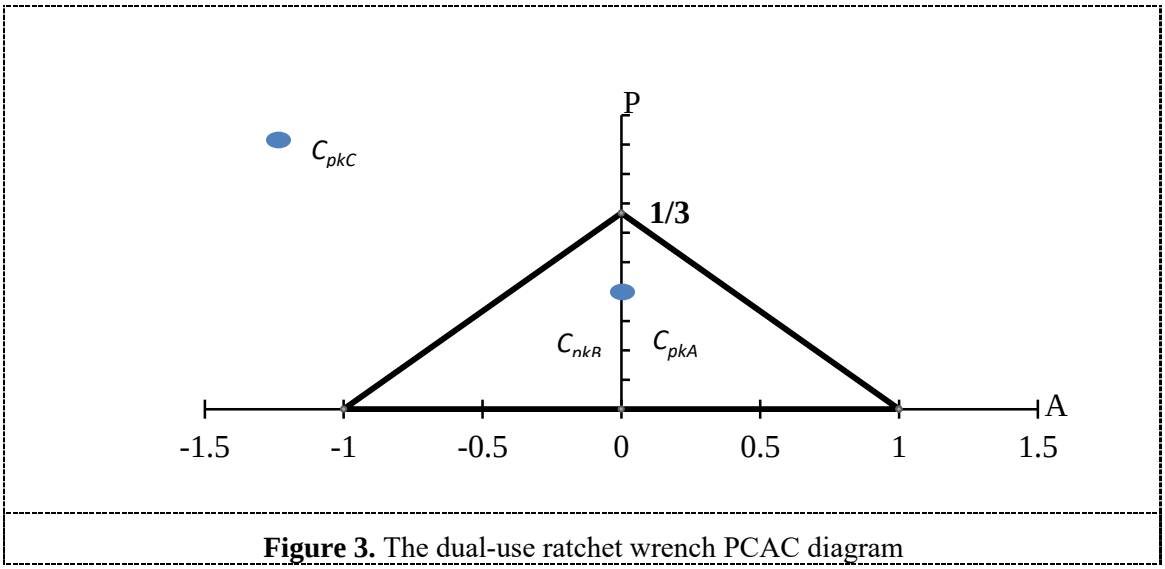


**Figure 3.** The dual-use ratchet wrench PCAC diagram

## 5. Conclusion

In this study, the case study method, N company's dual-use ratchet process, the use of process capability $C_{pk}$ indicators to improve the process yield and improve product quality. Therefore, according to the present study, the main research results are as follows:

$C_{pkA}$ (1.67) on the right side of the wrench, $C_{pkB}$ (1.67) on the left side of the wrench, and the $C_{pk}$ value is greater than 1. According to the corresponding relationship between the $C_{pk}$ values of the different quality levels, the quality of $C_{pkA}$ and $C_{pkB}$ is excellent. Quality characteristic depth C $C_{pkC}$ (-0.22) is -0.22, less than $C_{pk}$ value of the standard value of 1, on behalf of the depth of the quality characteristics of C, need to improve the quality of the next step.

Discussion and discovery, the depth of C will be bad quality reasons, the processing conditions are not good, the power of the General Assembly variant and fracture, the depth is too deep, then easy to break with the ratchet and the lack of force, too shallow is not easy to turn.Further that the depth of C

to improve the quality, need to replace the tool and knife mill, will make the company to increase costs and increase the burden on the company, so do not change. With the ratchet processing part of the downstream manufacturers, so this study is limited to the data cannot be measured ratchet, accurate measurement.

## 6. Acknowledgments

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