

The Guideline of Overall Competitive Advantage Promotion with Key Success Paths

M. F. Wu, F. T. Cheng, C. S. Wu, M. C. Tan

Abstract—It is a critical time to upgrade technology and increase value added with manufacturing skills developing and management strategies that will highly satisfy the customers need in the precision machinery global market. In recent years, the supply side, each precision machinery manufacturers in each country are facing the pressures of price reducing from the demand side voices that pushes the high-end precision machinery manufacturers adopts low-cost and high-quality strategy to retrieve the market. Because of the trend of the global market, the manufacturers must take price reducing strategies and upgrade technology of low-end machinery for differentiations to consolidate the market.

By using six key success factors (KSFs), customer perceived value, customer satisfaction, customer service, product design, product effectiveness and machine structure quality are causal conditions to explore the impact of competitive advantage of the enterprise, such as overall profitability and product pricing power. This research uses key success paths (KSPs) approach and f/s QCA software to explore various combinations of causal relationships, so as to fully understand the performance level of KSFs and business objectives in order to achieve competitive advantage. In this study, the combination of a causal relationships, are called Key Success Paths (KSPs). The key success paths guide the enterprise to achieve the specific outcomes of business. The findings of this study indicate that there are thirteen KSPs to achieve the overall profitability, sixteen KSPs to achieve the product pricing power and seventeen KSPs to achieve both overall profitability and pricing power of the enterprise. The KSPs provide the directions of resources integration and allocation, improve utilization efficiency of limited resources to realize the continuous vision of the enterprise.

Keywords—Precision Machinery Industry, Key Success Factors (KSFs), Key Success Paths (KSPs), Overall Profitability, Product Pricing Power, Competitive Advantages.

I. INTRODUCTION

MACHINERY industry in Taiwan has been developed for more than 50 years and the export value is 77% of output value. The export value of precision machinery is US\$5 billion and ranked number fourth in the world, after Germany, Japan and Italy, and the annual growth rate is 34.5% [7].

Facing the fierce competition and rapid change global markets, and fast growth of emerging countries and the mainland China also, flexible manufacturing and quick response to customer are both of the advantage competitions of Precision Machinery industry in Taiwan. The ways to increase

value added are enhancing product differential with innovation and operational management performances that help to an irreplaceable position in the global market.

The main purposes of this paper are (1) extract the key success factors of operation management performance: Customer perceived value, Quality of customer satisfaction, After-sales service, Product design, Product performance and Institutional quality; (2) explore the relationships between key success factors and outcomes, Pricing power and Profitability, of business operation; (3) explores key success paths (KSPs) to guide precision machinery industry to increase the pricing power and profitability.

This paper collects data by interview approach from precision machinery industry in Taiwan and uses Key Success Paths (KSPs) approach [5] and f/s QCA software to explore key success paths to guide the firm of precision machinery in Taiwan pursues more pricing power and increase overall profitability.

II. LITERATURE REVIEW

There are four sessions in literature review: Precision machinery industry, Customer relationship management, Key success factors (KSFs) and Key success paths approach.

A. Precision Machinery Industry

Precision machinery industry is main infrastructure to provide efficiency of product manufacturing functions and to assure the quality required of the customers. The industry leads to develop advantage competition of country in global market and regard as important indicator of industrialization level.

Bases on concept of economics scale and low cost strategy, the business model of vertical integration with labor division provides global competitive advantage of precision machinery industry in Taiwan. Through specialization division, entrepreneurship, flexible and quick response operation, that create higher essential of core competency.

The rapid development of South Korea, mainland China and emerging countries take part of the precision machinery global market with low price strategy that cut down the market share and advantage in Taiwan. The challenges and threats of the industry are:

1. Power and investment of research and development (R&D) is less than 4% to 6% of development country.
2. Too much number of firms in precision machinery industry because of lacking entrance threshold with core technology for this industry.
3. Numbers of labor resources are attracted electrical and high technology industry.

M. F. Wu is with the Department of Industrial Engineering and System Management, Feng Chia University, Taichung 40724, Taiwan, R.O.C. (phone: +886-955-041647; e-mail: mfwu@fcu.edu.tw).

F. T. Cheng, C. S. Wu, and M. C. Tan are with the Department of Industrial Engineering and System Management, Feng Chia University, Taichung 40724, Taiwan, R.O.C. (e-mail: ftcheng@fcu.edu.tw, as310102@gmail.com, mandytan77777@gmail.com).

4. Too much centralization on specific foreign market of exports, mainland China and East Europe causes higher operation risk.

B. Customer Relationship Management

The definition of Customer Relationship Management (CRM) is a business model which interacts with customer, understands and influences customer behavior to upraise the rate of customer acquisition (CA), customer retention (CR), customer loyalty (CL) and customer's profitability (CP) [5].

Another definition is a variety of different perspectives to understand and position the customer and market to develop a mixed model of enterprise procedure and information technology to fit customization need of products and services (P & S). Its purpose of CRM is to manage the relationship between businesses and customers, to enable them to achieve the highest customer loyalty to upraise the rate of customer acquisition (CA), customer retention (CR), customer loyalty (CL) and customers profitability (CP)[2].

The other definition is providing relationship framework of CRM between enterprises and customers. The relationship should be achieved through customer acquisition, customer promotion and customer recognition. Through variety of management functions, such as integration of sales operation, strategies of marketing and service, development of products and services of industry to promote the satisfaction and loyalty of customers[8].

C. Key Success Factors

Key success factors (KSFs) are defined as: the things that must go right explicitly for the business. Other definition of KSFs is to be an ingredient, a unique characteristic, a heuristic tool, major skills and resources in a given market [10].

Key success factors (KSFs) are information ingredients with unique characteristics and are heuristic tools for thinking, skills, and resources allocation for successful outcomes [9].

III. METHODOLOGY

This paper applies "Key Success Paths (KSPs) Approach" [6] to overcome the weaknesses of f/s QCA methods, to explore key success paths (KSPs) to provide guideline for operation strategy of precision machinery industry.

The algorithm process of KSPs approach is shown in Fig. 1 and process are described as following [3]:

Step I. Select and Define Key Success Factors (KSFs)

Proper KSFs are the causal conditions that illustrate the outcomes of event more explanatory power and avoids the lengthy process time in QCA [1].

Step II. Data Collection

Embedded all of the KSFs and specific outcome in questionnaire design with ten Likert scales, interviews the senior manager and faculties to collect data. The collected data are demonstrated in Table I.

TABLE I
 DEMONSTRATED OF COLLECTED DATA

| KSFs | Cases | | |
|----------------|--------|--------|--------|
| | A Case | B Case | C Case |
| X ₁ | 3 | 8 | 2 |
| X ₂ | 7 | 8 | 9 |
| X ₃ | 7 | 2 | 8 |
| X ₄ | 7 | 2 | 8 |
| } | } | } | } |
| X _n | 5 | 9 | 4 |
| Y | 4 | 5 | 8 |

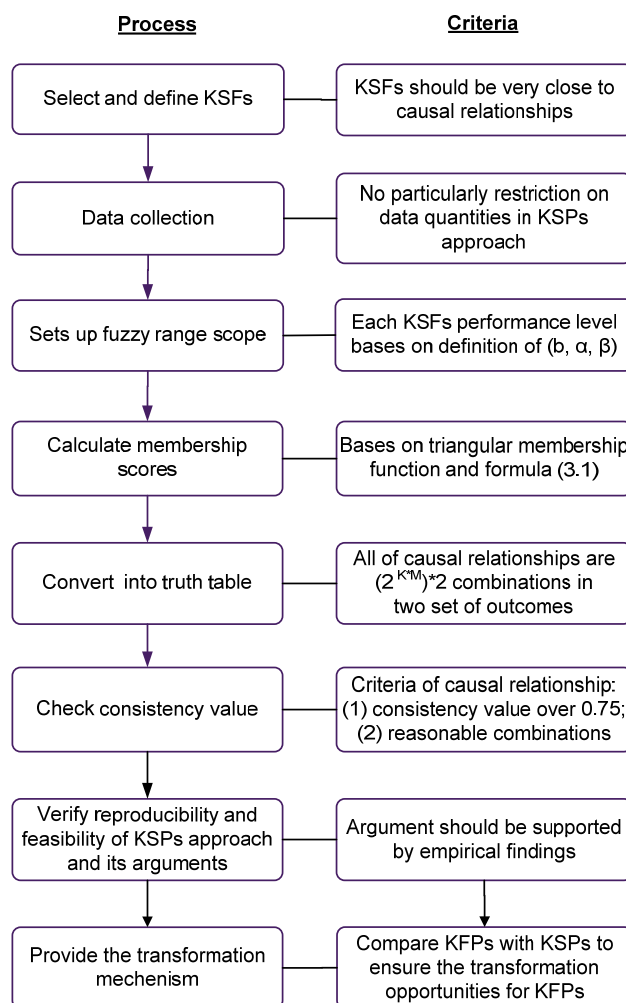


Fig. 1 Key Success Paths Approach Process

The advantages of key success paths (KSPs) approach are: (1) combine all of the key success factors (KSFs) to explore the key success paths, avoid the absence of anyone of KSF, (2) provide multiple performance levels for all of the KSFs in the KSPs or KFPs

Set up Fuzzy Range Scope. The algorithm applies fuzzy theory with common triangular membership function to divide KSFs into three different performance levels. The triangular membership function show as (1) [3]:

$$\mu_A(x) = \begin{cases} 1 - \frac{[b-x]}{\alpha}, & b - \alpha \leq x \leq b \\ 1 - \frac{[x-b]}{\beta}, & b \leq x \leq b + \beta \\ 0, & \text{otherwise} \end{cases} \quad (1)$$

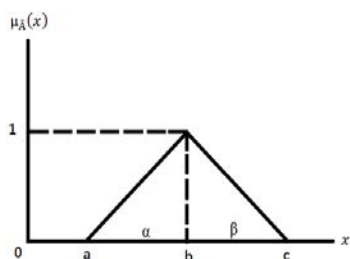


Fig. 2 Triangular Membership Function

Each performance level of KSFs should set up its own membership fuzzy range to calculate the fuzzy set membership score with (1). This paper divides the variance between the highest and lowest value of each KSF into three performance

levels, selects KSFs from first four rows in the Table I for demonstrating the algorithm procedures and fuzzy range scope are listed in the Table II.

TABLE II
FUZZY RANGE SCOPE FOR KSFs

| | Low Level | Medium Level | High Level |
|----------------|------------|--------------|------------|
| X ₁ | under 4.00 | 4.00~6.00 | over 6.00 |
| X ₂ | under 7.67 | 7.67~8.33 | over 8.33 |
| X ₃ | under 4.00 | 4.00~6.00 | over 6.00 |
| X ₄ | under 4.00 | 4.00~6.00 | over 6.00 |
| Y | under 5.33 | 5.33~6.66 | over 6.66 |

Step III. Calculate Membership Scores

This step uses a rudimentary three-value fuzzy set with three breakpoints [4] to calculate the membership score. The membership scores are presented in Table III.

TABLE III
FUZZY MEMBERSHIP SCORE FOR THE KSFs

| KSFs | X ₁ | | | X ₂ | | | X ₃ | | | X ₄ | | | Y | | |
|------|----------------|------|------|----------------|------|------|----------------|------|------|----------------|------|------|------|------|------|
| | H | M | L | H | M | L | H | M | L | H | M | L | H | M | L |
| A | 0.09 | 0.11 | 0.80 | 0.60 | 0.30 | 0.10 | 0.60 | 0.30 | 0.10 | 0.60 | 0.30 | 0.10 | 0.10 | 0.15 | 0.75 |
| B | 0.85 | 0.05 | 0.10 | 0.70 | 0.25 | 0.05 | 0.30 | 0.10 | 0.60 | 0.30 | 0.10 | 0.60 | 0.20 | 0.20 | 0.60 |
| C | 0.20 | 0.20 | 0.60 | 0.75 | 0.10 | 0.15 | 0.70 | 0.25 | 0.05 | 0.70 | 0.25 | 0.05 | 0.80 | 0.15 | 0.05 |

Step IV. Convert into Truth Table

This step can be conceptualized as a bridge with three pillars. (1) The direct correspondence that exists between the rows of a crisp truth table and the corners of the vector space defined by fuzzy set causal conditions [3]. (2) Assess the distribution at cases across different logically possible combinations of KSFs. (3) assess the consistency at each causal combination with the argument that it is a fuzzy subset of the specific outcome [4].

This paper selects the first four binary, and divides each binary into three performance level for illustration, the truth table will contain 2^{K*M} (i.e., 2^{4*3}=4,096) rows. K represents the

number of KSFs; M represents the number of performance levels. If the outcome value divides into two-value set, there are two subsets of possible raw data matrix.

Truth table is necessary to reconstruct a raw data matrix by using Boolean algebra as a technique of qualitative comparison to represent data. Each logical combination of values on the KSFs is represented as one row of the truth table [4], and assigned an outcome value (either 1 or 0) based on the scores of the cases which share the same combination of KSFs. The partial truth table associated with high performance outcome presents in Table IV.

TABLE IV
PARTIAL TRUTH TABLE ASSOCIATED WITH HIGH PERFORMANCE

| Causal Relationship | 1h | 1m | 1l | 2h | 2m | 2l | 3h | 3m | 3l | 4h | 4m | 4l | Cases | Out-H | Consistency |
|---------------------|----|----|----|----|----|----|----|----|----|----|----|----|-------|-------|-------------|
| 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0.830508 |
| 2 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0.886364 |
| 3 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 |
| 4 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0.6 |
| 5 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |

Step V. Calculate Consistency Value.

Consistency measures the degree to which the entire KSFs combinations of causal relationships are subsets of the specific outcomes [4]. The calculation of consistency and coverage value are shown in (2) and (3):

$$\text{Consistency } (X_i \leq Y_i) = \frac{\sum \min(X_i, Y_i)}{\sum \min X_i} \quad (2)$$

$$\text{Coverage } (X_i \leq Y_i) = \frac{\sum \min(X_i, Y_i)}{\sum Y_i} \quad (3)$$

X_i represents the multiple (i) of KSFs (X), and Y_i represents the multiple (i) of outcome (Y).

Two threshold criteria for identifying KSPs or KFPs are: (1) consistency value should over 0.75; (2) combination of KSFs in causal relationship should be reasonable. If consistency value of causal relationship is under 0.75, then the causal relationship must be trashed in the first step [4], [6].

The second threshold criterion is to thresh the unreasonable causal relationships in the truth table. The 6th row in Table IV should be threshed because only X₄ in high performance level and missing rest of the others; the 7th row should be threshed because X₁ and X₂ are missing and X₄ is in medium and high performance level in the same row. The qualified causal relationships associates with high value set of outcome are identified as KSPs.

Step VI. KSPs

The qualified and reasonable causal relationships should transform from truth table into KSPs. These two causal relationships with specific KSFs combinations and their associated outcomes are names “KSPs” in this paper.

There are 10 KSPs been explored in Table V. The 1st KSP combines with three KSFs of medium performance level and one KSF of high performance level of KSFs, and causes to high performance level of outcome Y with strong explanatory power because of its consistency value is 0.972.

TABLE V
 KEY SUCCESS PATHS (KSPS)

| KSPs | X ₁ | X ₂ | X ₃ | X ₄ | Cases | Out-H | Consistency |
|------|----------------|----------------|----------------|----------------|-------|-------|-------------|
| 1 | M | H | M | M | 0 | 1 | 0.972222 |
| 2 | M | H | M | H | 0 | 1 | 0.972222 |
| 3 | M | H | H | M | 0 | 1 | 0.972222 |
| 4 | M | H | H | H | 0 | 1 | 0.972222 |
| 5 | H | M | L | L | 0 | 1 | 0.871795 |
| 6 | H | M | L | H | 0 | 1 | 0.871795 |
| 7 | H | M | H | L | 0 | 1 | 0.871795 |
| 8 | H | H | H | H | 0 | 1 | 0.830508 |
| 9 | H | H | L | H | 0 | 1 | 0.772727 |
| 10 | H | H | H | L | 0 | 1 | 0.772727 |

IV. EMPIRICAL STUDY AND FINDINGS

The paper extracts six key success factors (KSFs) from literature review as: Customer perceived value, Quality of customer satisfaction, After-sales service, Product design, Product performance and Institutional quality, and twenty-four sub-key factors. The research embedded 6 key and 24 sub key success factors, three specific operation outcomes: profitability, pricing power and integrated those two outcomes in questionnaire design with ten Likert scales and interview 100 senior managers and faculties of precision machinery industry in Taiwan. The key and sub-key success factors and outcomes are illustrated in Table VI.

After data collection, this research calculates simple average score for six key success factors by its sub-key success factors, divides each key success factors into three performance level with high, medium and low level, and also divides three outcomes into two level, success and fail to explore causal relationships between key success factors and outcomes.

TABLE VI

| KEY AND SUB-KEY SUCCESS FACTORS AND OPERATIONAL OUTCOMES | |
|--|---|
| Key Success Factor/Outcome | Sub-Key Success Factor |
| X ₁ : Customer perceived value | <ul style="list-style-type: none"> • Important weight of machinery prices • Important weight of machinery brand |
| X ₂ : Quality of customer satisfaction | <ul style="list-style-type: none"> • Important weight of leadership in market position • Important weight of break down rate of machinery • Important weight of efficiency of machinery • Important weight of yield rate of machinery • Important weight of degree of corrosion and wear resistant of machinery • Important weight of usage year of machinery • Important weight of handling speed of customer complaints • Important weight of handling speed of customer complaints |
| X ₃ : After-sales service | <ul style="list-style-type: none"> • Important weight of maintenance convenience of machinery • Important weight of consulting and information service of machinery • Important weight of maintenance cost of machinery • Important weight of features and design of machinery • Important weight of competency of computerizing and automation of machinery |
| X ₄ : Product Design | <ul style="list-style-type: none"> • Important weight of competency of appearance of machinery • Important weight of ergonomic operation of machinery • Important weight of feed speed of machinery • Important weight of flexible working condition of machinery |
| X ₅ : Product Performance | <ul style="list-style-type: none"> • Important weight of safety operation of machinery • Important weight of easiness of maintain of machinery • Important weight of stability and reliability of quality of machinery |
| X ₆ : Institutional quality | <ul style="list-style-type: none"> • Important weight of operation noise and vibration of machinery • Important weight of operation accuracy of machinery |
| O ₁ : Overall Profitability, OP | <p>The precision machinery industry uses customer relationship dimension and machinery design capabilities dimension to reduce and reduce production costs to upraise the overall profitability.</p> <p>The precision machinery industry uses the concepts of CRM and SCM to access, enhance and maintain customer thinking enhance the corporate to upraise pricing power.</p> |
| O ₂ : Pricing Power, PP | |
| O ₃ : Combine with OP and PP | Consolidated operation outcomes of the profitability and pricing power profitability and pricing power of |

Sets up fuzzy range scope with common triangular membership function for the collection data, calculates membership scores with three breakpoints, transfer into truth table with f/s QCA software [4].

Two threshold criteria for identifying KSPs are: (1) consistency value should over 0.75; (2) combination of KSFs in causal relationship should be reasonable. If consistency value of causal relationship is under 0.75, then the causal relationship must be trashed in the first step [4], [6]. The qualified causal relationships associates with high value set of outcome are identified as KSPs.

A. Key Success Paths of Overall Profitability

There are 9 key success paths explored in Table VII to guide precision machinery industry to upraise the overall profitability.

TABLE VII
 KEY SUCCESS PATHS OF UPRAISING OVERALL PROFITABILITY

| KSPs | X ₁ | X ₂ | X ₃ | X ₄ | X ₅ | X ₆ | Case | Consistency |
|------|----------------|----------------|----------------|----------------|----------------|----------------|------|-------------|
| 1 | H | M | M | M | M | M | 1 | 0.999188 |
| 2 | H | H | H | M | H | H | 3 | 0.996178 |
| 3 | M | H | H | M | H | H | 0 | 0.995624 |
| 4 | H | H | H | M | H | M | 0 | 0.994751 |
| 5 | M | H | H | M | H | M | 0 | 0.994475 |
| 6 | H | H | H | H | H | H | 13 | 0.994301 |
| 7 | H | H | H | H | H | M | 2 | 0.990525 |
| 8 | M | H | H | H | H | M | 0 | 0.984456 |
| 9 | M | H | H | H | H | H | 3 | 0.982211 |

Exams all of 9 KSPs, the findings of research are as following:

1. More than one path leads precision machinery industry upraises overall profitability as well.
2. Several identifiable KSPs are rarely or never taken even though they may be possible to implement. (These are “remainders” in the fuzzy set theory). All of these remainders, 3rd, 4th, 5th and 8th KSP have strong explanatory power but do not been adopted yet.
3. The performance level of key success factors should be reached medium level or even high level that will make operation outcomes achieve to success outcomes of overall profitability.
4. When the performance level of value cognition of customer is high, even if the performance of the other five factors are in medium level, the company reaches the goal of upraising overall profitability because of acceptance of higher price of the machinery in 1st KSP.

B. Key Success Paths of Pricing Power

There are 16 key success paths explored in Table VIII to guide precision machinery industry to upraise the pricing power. The findings are as following:

1. More than one path leads precision machinery industry upraises pricing power as well.
2. Several identifiable KSPs are rarely or never taken even though they may be possible to implement. (These are “remainders” in the fuzzy set theory). All of these remainders, 1st, 2nd, 3rd, 8th and 10th KSP have strong explanatory power but do not been adopted yet.
3. The performance level of key success factors should be reached medium level or even high level that will achieve to higher pricing power.
4. When the performance level of value cognition of customer is high, even if the performance of the other five factors are in medium level, the company reaches the goal of upraising pricing power because of acceptance of higher price of the machinery in 4th KSP.
5. When the performance level of institutional quality of machinery is high, even if the performance of the other five factors are in medium level, the company reaches the goal of upraising pricing power because of high core competency of machinery will increase price acceptance of the machinery in 16th KSP.

TABLE VIII
 KEY SUCCESS PATHS OF UPRAISING PRICING POWER

| KSPs | X ₁ | X ₂ | X ₃ | X ₄ | X ₅ | X ₆ | case | consistency |
|------|----------------|----------------|----------------|----------------|----------------|----------------|------|-------------|
| 1 | H | H | M | M | M | M | 0 | 0.999175 |
| 2 | H | H | M | M | H | M | 0 | 0.99913 |
| 3 | H | M | M | M | H | M | 0 | 0.999097 |
| 4 | H | M | M | M | M | M | 1 | 0.998377 |
| 5 | M | H | H | H | H | H | 3 | 0.993647 |
| 6 | H | M | H | H | H | H | 1 | 0.993002 |
| 7 | H | M | H | H | M | H | 1 | 0.992337 |
| 8 | H | H | M | M | H | H | 0 | 0.990767 |
| 9 | H | H | M | M | M | H | 1 | 0.990342 |
| 10 | H | M | M | M | H | H | 0 | 0.989439 |
| 11 | H | H | H | H | H | M | 2 | 0.98688 |
| 12 | M | H | M | H | M | H | 1 | 0.984165 |
| 13 | M | H | M | M | H | M | 1 | 0.982847 |
| 14 | H | M | M | M | M | H | 1 | 0.981163 |
| 15 | H | H | H | H | H | H | 13 | 0.978518 |
| 16 | M | M | M | M | M | H | 1 | 0.969647 |

C. Key Success Paths of Consolidated Outcomes

There are 17 key success paths explored in Table IX to guide precision machinery industry to upraise the pricing power. The findings are as following:

TABLE IX
 KEY SUCCESS PATHS OF UPRAISING CONSOLIDATED OUTCOMES

| KSPs | X ₁ | X ₂ | X ₃ | X ₄ | X ₅ | X ₆ | case | consistency |
|------|----------------|----------------|----------------|----------------|----------------|----------------|------|-------------|
| 1 | H | H | M | M | M | M | 0 | 0.999175 |
| 2 | H | H | M | M | H | M | 0 | 0.99913 |
| 3 | H | M | M | M | H | M | 0 | 0.999097 |
| 4 | H | M | M | M | M | M | 1 | 0.998377 |
| 5 | H | H | H | M | H | H | 3 | 0.996178 |
| 6 | M | H | H | M | H | H | 0 | 0.995624 |
| 7 | H | H | H | M | H | M | 0 | 0.994751 |
| 8 | H | M | H | H | H | H | 1 | 0.993002 |
| 9 | H | M | H | H | M | H | 1 | 0.992337 |
| 10 | H | H | M | M | M | H | 1 | 0.990342 |
| 11 | M | H | M | H | M | H | 1 | 0.984165 |
| 12 | M | H | M | M | H | M | 1 | 0.982847 |
| 13 | M | H | H | H | H | H | 3 | 0.982211 |
| 14 | H | M | M | M | M | H | 1 | 0.981163 |
| 15 | H | H | H | H | H | M | 2 | 0.977405 |
| 16 | H | H | H | H | H | H | 13 | 0.972819 |
| 17 | M | M | M | M | M | H | 1 | 0.969647 |

1. More than one path leads precision machinery industry upraises higher profitability and pricing power as well.
2. Several identifiable KSPs are rarely or never taken even though they may be possible to implement. (These are “remainders” in the fuzzy set theory). All of these remainders, 1st, 2nd, 3rd, 6th and 7th KSP have strong explanatory power but do not been adopted yet.
3. The performance level of key success factors should be reached medium level or even high level that will achieve to higher profitability and pricing power.
4. When the performance level of value cognition of customer is high, even if the performance of the other five factors are in medium level, the company reaches the goal of upraising higher profitability and pricing power because

- of acceptance of higher price of the machinery in 4th KSP.
5. When the performance level of institutional quality of machinery is high, even if the performance of the other five factors are in medium level, the company reaches the goal of upraising higher profitability and pricing power because of high core competency of machinery increases price acceptance of the machinery and then increases profitability as well in 17th KSP.

V. CONCLUSION

The research findings provide 9 to 17 KSPs to lead precision machinery industry to pursue higher overall profitability, pricing power and consolidated outcomes which is based on implementing customer relationship management dimension of three KSFs and product design dimension of three key success factors. The company adopts proper KSPs according to their own advantage competition as well to improve the efficiency and competitive advantage of the company.

The data collection can be enlarged into global market and key success factors can be increased or adjusted to fit the needs of research design and purposes of the papers. The findings of the research could be different since the data, the KSFs and outcomes of operation management are differently.

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