

Application of Activity-Based Costing Management System by Key Success Paths to Promote the Competitive Advantages and Operation Performance

Mei-Fang Wu, Shu-Li Wang, Feng-Tsung Cheng

Abstract—Highly developed technology and highly competitive global market highlight the important role of competitive advantages and operation performances in sustainable company operation. Activity-Based Costing (ABC) provides accurate operation cost and operation performance information. Rich literatures provide relevant research with cases study on Activity-Based Costing application, but the research on cause relationship between key success factors and its specific outcome, such as profitability or share market are few. These relationships provide the ways to handle the key success factors to achieve the specific outcomes for ensuring to promote the competitive advantages and operation performances. The main purposes of this research are exploring the key success paths by Key Success Paths approach which will lead the ways to apply Activity-Based Costing. The Key Success Paths is the innovative method which is exploring the cause relationships and explaining what are the effects of key success factors to specific outcomes of Activity-Based Costing implementation. The cause relationships between key success factors and successful specific outcomes are Key Success Paths (KSPs). KSPs are the guidelines to lead the cost management strategies to achieve the goals of competitive advantages and operation performances. The research findings indicate that good management system design may affect the well outcomes of Activity-Based Costing application and achieve to outstanding competitive advantage, operating performance and profitability as well by KSPs exploration.

Keywords—Activity-Based Costing, Key success factors, Key success paths approach, Key success paths, Key failure paths.

I. INTRODUCTION

ACTIVITY BASED COSTING (ABC) system originated in 1960, General Electric (GE) Company develops a job cost analysis (Activity Cost Analysis) to understand the indirect support costs of decision-making management or operating activity. Professor Kaplan and Cooper [1] expand this concept to academia and industry in the 1980s. Activity-Based Costing system (ABC) began to develop and implement on the manufacturing and service industries [2]. ABC system provides activity cost information, activity performance information and activity cost drivers more accurately. Analyze and use of these cost management information helps companies to delete the

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non-value added activity so as to reduce costs, to obtain the competitive advantage, to promote operation performance and to achieve the overall target profits of the company. Scholars and experts recommend to use ABC system to locate the visions of the enterprise in order to obtain more powerful competitive advantage [3]-[5]. ABC system provides sufficient and accurate information than Volume-Based Costing (VBC) system but higher application costs. A lot of cases of ABC system implementation literature has been published, but less articles explore how to manage the ABC system application procedure effectively.

Key Success Factors (KSFs) may ensure the success of the ABC system application, so that achieves operational performances and promotes competitive advantage. The main purpose of this paper is to explore the key success paths (KSPs) to guide and to ensure the right ways of ABC system implementation, in order to achieve competitive advantage and operational performance successfully. This research uses innovative method. All of the KSFs are extracted from the literature review to shorten the research period. Key Success Paths approach (KSPs) [6] to explore the KSPs. The KSPs represent the causal relationships between KSFs and specific outcomes of operational performances and competitive advantages.

II. LITERATURE REVIEW

Anderson and Young collected data from 256 senior managers to explore the key factors of ABC system application by using interviews and questionnaires [7]. The research findings indicate that the key success factors of implementation of ABC system for enterprise are summarized as: [8]

1. The Perpetrators Must Have Well Knowledge of Business Operation and Considerable Understanding of the Industrial Environment

The implementers need to know the purpose of the implementation of ABC system, to understand the management information which generates with current system of the enterprise, and to make high-quality operation decisions to cope with today's complex, dynamic environment as well. In addition, the enterprises should realize the external and internal problems one by one when the ABC system is applied. For example:

(1) Whom should be provided and how to use for operation for ABC information? (2) Are there any potential impacts for some specific products or customer group, as well as relevant

procedures for providing customer value by ABC system implementing? (3) How many input resources of the enterprise and how much expected benefits of the ABC implementation? The internal resources of the enterprise are time, accounting staffs, senior managers and faculties; and the external resources include business software and consulting experts.

2. To Communicate and Seek for Full Supporting and Commitments with Senior Managers

Senior managers' full supports and commitments are the most important key factor to achieve success of ABC system implementation. Fully communicate with senior managers with the purposes which are including: the usage of ABC system will enable organizations to change, the adequate internal candidates with sufficient skills and problem solving capability, and fit communication strategies to address the gap between culture and change management.

(1) Need to Link with Competitive Strategy

ABC system must be linked with competitive strategy to determine organizational design, new product development, product mix, order strategy, pricing strategy and technology development direction. For example, when the company decides to choose low-cost product strategy, the ABC system should promptly provide the right product/manufacturing cost; when company decides to choose economies scale and efficiency strategy, the ABC system should provide the measurement with manufacturing processes flow, activities, and capacity in time. Apparently, ABC system must be integrated with company's competitive strategies closely to ensure the effectiveness of the implementation of ABC system.

(2) Need to Apply Education and Training System

To ensure organization have the appropriate, adequate numbers and these staffs have sufficient skills to cope with the implementation of the ABC system. Training programs need to include document and data reading, lectures and speeches, external professional consultants, with academic industry-university cooperation project as well.

(3) Need to Have Sufficient Information Systems Technician

ABC systems application needs to rely on a powerful information system that helps to achieve success easily. The Comprehensive information system design provides required functions and uses software to support necessary technician for ABC/ABM application.

- (4) ABC is a management system, rather than accounting system.
- (5) ABM information needs to incorporate with operational strategies as well.
- (6) ABC/M should have sufficient compatibility with current performance assessment and reward system.
- (7) The goal of ABC system implementation should be consistent with the goal of company's operation management.

According to the research findings, 75% enterprise obtains benefits from ABC system implementation, and 25% of

enterprise is not. In addition, the financial and accounting staff has highest level of satisfaction with ABC system, senior managers' second one, and then the end users of ABC system.

TABLE I
SUMMARY OF KEY SUCCESS FACTORS

Key Success Factors of ABC/M Implementation	References
1. Implementer should have well-understanding with professional knowledge and environment of the enterprise	[9], [10]
2. Needs to communicate with senior manager and obtains the supports and commitments.	
3. Connects with competitive strategies.	
4. Executes educational training.	
5. Implementer should have sufficient technology.	
1. Supporting from senior manager	[11]
1. Connects with competitive strategies (quality aspect).	
2. Connects with performance indicators and rewards system.	
3. Executes educational training.	
4. Plenty resources.	
5. Consistent and precise objectives.	
2. Attitude and capability of the leader	[12]
1. Organization culture.	
2. Match with the rewards system.	
3. Continuous educational training.	
4. Sufficient information.	
5. Delimited resistance attitude.	
6. Observes the process of changing.	
3. Implementer should have well-understanding with professional knowledge and environment of the enterprise	[13]
4. Needs to communicate with senior manager and obtains the supports and commitments.	
5. Connects with competitive strategies.	
6. Executes educational training.	

Be able to manage key success factors effectively that will promote company's competitiveness. Competitiveness refers to the abilities of the companies in the competitive market, also as a relevant indicator that expressed through the competition. All of the key success factors are summarized in Table I.

III. MATH

The algorithm process of Key Success Path (KSP) Approach [14] is shown in Fig. 1 and described as follows.

- Step1. Select and define KSFs: KSFs are the causal conditions that illustrate the outcome of an event. Proper KSFs have more explanatory power on causal relationships. This paper selects and defines proper KSFs from literature review to avoid the lengthy process time in QCA. Thus, better fitted KSFs from literature enable our research process to focus only on the study purpose.
- Step2. Data collection: The fuzzy QCA algorithm uses questionnaire, embeds KSFs in a questionnaire design with Likert scales, and interviews respondents to collect data.
- Step3. Set up fuzzy range scope: KSFs significantly affect the performance outcome of specific goal achievement. The algorithm applies fuzzy theory with common triangular membership function to divide KSFs into two or three different levels.

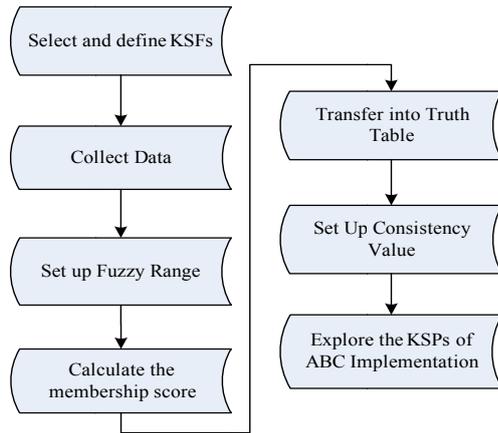


Fig. 1 Algorithm process of Key Success Path Approach

Triangular fuzzy number \tilde{A} is marked by (b, α, β) , where b is highest value of \tilde{A} membership in the X axis and its value is 1. The α, β values are the scattered left and right spread values, respectively, so $b - \alpha$ is the minimum value of \tilde{A} in X-axis, shown as point a in Fig. 2; $b + \beta$ is the maximum value of \tilde{A} in X-axis, shown as point c in Fig. 2. If the X value is smaller than $b - \alpha$ or greater than $b + \beta$, then the membership value of \tilde{A} is 0. The triangular membership function can be expressed as (1):

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

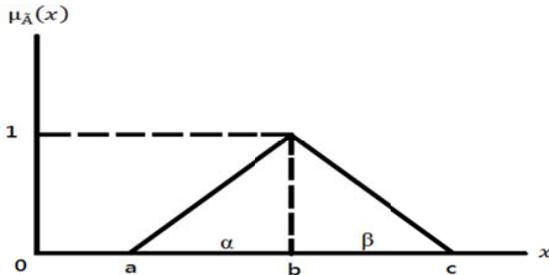


Fig. 2 Triangular membership function

Step4. Calculate membership scores: After establishing the fuzzy range scope of triangular membership function, the next step is to calculate the membership score with collected data. Ideally, the calibration on membership degree in a set should be based outright on the researcher’s substantive and theoretical knowledge [6]. The paper uses a rudimentary three-value fuzzy set with three breakpoints [6]. A membership score of 1.0 indicates full membership in a set (e.g., point b in Fig. 2, A score of 0.0 indicates full non-membership in a set (e.g., left spread value of point a and right spread value of point c in Fig. 2) and crossover point [e.g., point of $(b - \alpha)/2$ and point of $(b + \beta)/2$ in Fig. 2].

Step5. Convert into truth table: This step can be conceptualized as a bridge with three pillars. Firstly, define the direct

correspondence that exists on the corner between the rows and the vector space by fuzzy set causal conditions [6]. Secondly, assess the distribution at cases across different logically possible combinations of causal conditions (or corners of the vector space). Some corners of the vector space may have strong membership while other corners may have weak membership. Third, assess the consistency at each causal combination [6].

A truth table is necessary to reconstruct a raw data matrix by using Boolean algebra as a qualitative comparison technique for representing data. Each logical combination of values on the KSFs is represented as one row of the truth table [6] and is assigned a specific outcome value (either 1 or 0) based on the scores of the cases which share the same combination of KSFs.

If there are six binary and three performance levels of KSFs, for example, the truth table will contain $2^{K \cdot M}$ (i.e., 262,144) rows. K represents the number of KSFs (i.e., causal conditions), and M represents the number of performance levels (i.e., subsets). If the outcome value divides into a two-value set, there are two subsets of possible raw data matrix.

Step6. Calculate the consistency and coverage values.

Consistency measures the degree to which the entire KSF combinations of causal relationships are subsets of the outcomes. Coverage measures how much of the outcome is covered (or explained) by each KSF combination of the causal relationships as a whole. These measures are computed by examining the original fuzzy membership score in light of the causal relationships [6]. The respective formulae of consistency and coverage are shown [6]:

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

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

where X_i represents the multiple (i) of causal condition (X) and Y_i represents the multiple (i) of outcome (Y).

Not all of the causal relationships are KSPs or KFPs. The threshold criteria should be based on the consistency value. Therefore, the most important work in Step 6 is to trash the causal relationships. If the consistency value of causal relationship is less than 0.75, the causal relationship must be trashed [6]. Therefore, the qualified causal relationships with a high value set of outcomes are identified as KSPs. KSP is a causal relationship among KSFs and represents the outcome of events that uses Fuzzy QCA algorithm method to explore and provide a connection between multiple combinations of KSFs and specific outcomes of events. It also provides a way to pursue successful goals.

Step7. Verify the reproducibility and feasibility of the KSP theory and its arguments. A rigorous theory and its arguments must be applied to verify reproducibility and feasibility, including methodology, formula, model, and laboratory experiment or empirical study.

TABLE II
MAIN AND SUB-KEY SUCCESS FACTORS

Main KSFs	Sub-KSFs
Senior Manager Supports and Commitments	The attitude and degree of senior manager supports and commitments for ABC system
	Ability of negotiation and communication between senior manager and work team
	The full understanding of operation environment and competitive status
	The understanding of connection with ABC system and competition strategy
	The understanding with implementation goals
	The understanding that ABC is not only costing system but also management system.
Employee Participation	The commitments to provide sufficient resources for applying ABC system
	The willingness to participate in ABC work team
	The willingness of employee to participate the ABC training program
	Promote and execute the organization culture of ABC
	The willingness to provide the accurate information
	The capability of communication and negotiations of employee
Design of Management System	Understanding the benefit of ABC application
	The capability of benefit assessment of ABC application
	The company should have rationalized management system
	The company should have the performance appraisal and reward system
	The company should have the capability to work with the goals of continuous improvement
	The company should have the capability to develop product and improve production process
IT Technology	IT staff should have adequate resources and equipment
	IT staff should have sufficient professional capability to analyze and design system
	Willingness of IT staff to participate ABC work team
	Full understanding of production process of IT staff
	Possess the IT technology will highly promote the willingness to implement the ABC system
	Possess the IT technology will effectively shorten the implementation period
Possess the IT technology will promote the success of ABC system implementation	
Possess the IT technology will cost down ABC system implementation	

The adage "All roads lead to Rome," indicates that there will always be paths that guide businesses in pursuing successful NPD outcomes by combining multiple KSFs at different performance levels. The decision to select KSPs should be based on the business' current competitive advantage status. In fact, there is more than one benchmarking path to lead the NPD strategies toward achieving more successful outcomes.

IV. EMPIRICAL STUDY AND FINDINGS

1. Key Success Factors and Specific Outcomes

There are four main KSFs: senior manager supports and commitments, employee participates, management systems and IT technologies and 26 sub-dimensions. The specific outcomes are: core competencies, operational performances and profitability. All of the KSFs are shown in Table II, and all possible specific outcomes are shown in Table III.

TABLE III
SPECIFIC OUTCOMES OF ABC IMPLEMENTATION

Main outcomes	Sub-Outcomes
	KSFs will affect the success of ABC system implementation
	The higher degree performance of KSFs, the higher succeed probability of ABC system implementation.
◇ Core	The more items of higher degree performance of KSFs, the higher succeed probability of ABC system implementation.
Competencies	ABC can assist companies to formulate effective business strategy
◇ Operational	ABC can assist companies to clarify operation problems and offer improving alternatives
Performance	ABC can promote employee's work willingness and work performance
◇ Profitability	ABC can promote company resources allocation efficiency
	ABC can improve product mix strategy to upraise company's profitability
	ABC can assist company to formulate performance index and assessment mechanism
	ABC can promote company's overall capability

2. Explore Key Success Paths (KSPs)

(1) Single Outcome Exploration

The research uses f/s QCA and EXCEL software to convert questionnaire data into fuzzy scores and truth table. Filter out the key success paths (KSPs) with the consistency number which is greater than 0.75, and show the finding in Table IV.

- Only one KSP may help company to obtain the outstanding core competency. The single KSP (causal relationship) indicate that high degree performance of senior manager's commitments and IT technology is required and important.
- There are eight KSPs with outcomes of operation performance. Exams relationship between KSFs and outcome of operation performance to all of the KSPs, the research findings indicate that only one KSF, management system design, is the most important role. All of this KSF in each KSP are in high performance degree and will impact the succeed outcomes. In 5th KSP, even only management system design perform in high degree that still make outcome succeed.
- In terms of succeed profitability outcome, management system design in all paths to a high performance degree, so the inference management system design has considerable importance in promoting the company's profitability.

TABLE IV
KSPs WITH SINGLE OUTCOME

Outcome	Number of KSPs	Senior manager's support and Commitment	Employee Participation	Design of Management System	IT Technology	Cases	Consistency
Core Competency	1st	H	M	M	H	2	0.997151
	1st	M	H	H	H	1	0.996751
	2nd	M	M	H	H	0	0.996377
	3rd	H	H	H	M	0	0.996094
Operation Performance	4th	M	H	H	M	0	0.995807
	5th	M	M	H	M	0	0.995754
	6th	H	H	H	H	24	0.992248
	7th	H	M	H	H	1	0.991629
	8th	H	M	H	M	2	0.981731
Profitability	1st	H	M	H	H	1	0.997717
	2nd	M	M	H	H	0	0.997283
	3rd	H	M	M	H	2	0.997151
	4th	M	H	H	M	0	0.996855
	5th	M	M	H	M	0	0.996815
	6th	H	M	H	M	2	0.993269
	7th	M	H	H	H	1	0.988627
	8th	H	H	H	H	24	0.984496
	9th	H	H	H	M	0	0.984375

(2) Integrated Outcome Exploration

This section explores a KSP with integrated outcomes, namely: core competency and operation performance, core competency and profitability; operation performance and profitability; and core competency, operation performance and profitability. The research findings are shown in Table V.

- Specific outcome which combine core competency and operation performance; core competency and profitability, or operation performance and profitability of KSPs show that most important KSF is high performance degree of management system designed. The research findings indicate that company needs to pay highly attention to management system design to achieve the success of the specific outcome. The research findings show in Table V.
- Finally, if the company would like to achieve success outcome with combining three of specific outcomes, core competency, operation performance and profitability, the company needs to good care and pay more effort to deal with management system design as well.

(3) Research Findings Conclusion

Activity-Based Costing/Management (ABC/M) system implementation needs very huge resources, such as funds, time, human resources, and so on. This research not only provides single specific outcome but provides integrated specific outcome of KSPs also. The most important key success factor is management system design to guide company to achieve the success outcome through this research. There are many KSPs

may obtain the success outcomes by combine different performance degree of KSFs. The company may achieve to success by combining different performance degree of KSFs that company may follow the competitive advantage of their own.

ABC management system application will provide precise operation information to the company to promote the efficiency and effectiveness. Both in single and integrated outcomes of KSPs, high performance degree of management systems design is the most important item in four main KSFs. The research findings indicate that company should be strong with good management system design which is based on ABC/M system.

V. CONCLUSION

This paper uses KSPs approach to explore the ways to implement ABC system. KSPs provide precise causal relationship that can be followed in order to correct the error, avoid excessive investment resources and waste. In the rapid technology development and highly competitive environment, companies have to implement ABC system, in addition to provide precise cost information, cost drivers consume information, but also help enterprises improve business operation performance. This study provides causal combination, KSPs, allow companies to efficiently and quickly choose the path with the current status for their own to use minimal resources to achieve the greatest business operating outcomes.

TABLE V
KSPs WITH INTEGRATED OUTCOMES

Specific Outcomes	Number of KSPs	Senior manager's support and Commitment	Employee Participation	Design of Management System	IT Technology	Cases	Consistency
Core Competency & Operation Performance	1 st	H	M	M	H	2	0.99715
	2 nd	M	H	H	H	1	0.99675
	3 rd	M	M	H	H	0	0.99637
	4 th	H	H	H	M	0	0.99609
	5 th	M	H	H	M	0	0.99580
	6 th	M	M	H	M	0	0.99575
	7 th	H	H	H	H	24	0.99224
	8 th	H	M	H	H	1	0.99162
	9 th	H	M	H	M	2	0.98173
Core Competency & Profitability	1 st	H	M	H	H	1	0.99771
	2 nd	M	M	H	H	0	0.99728
	3 rd	H	M	M	H	2	0.99715
	4 th	M	H	H	M	0	0.99685
	5 th	M	M	H	M	0	0.99681
	6 th	H	M	H	M	2	0.99326
	7 th	M	H	H	H	1	0.98862
	8 th	H	H	H	H	24	0.98449
	9 th	H	H	H	M	0	0.98437
Operation Performance & Profitability	1 st	H	M	M	H	2	0.99715
	2 nd	M	M	H	H	0	0.99365
	3 rd	M	H	H	M	0	0.99266
	4 th	M	M	H	M	0	0.99256
	5 th	H	M	H	H	1	0.98934
	6 th	M	H	H	H	1	0.98537
	7 th	H	H	H	M	0	0.98046
	8 th	H	M	H	M	2	0.97884
	9 th	H	H	H	H	24	0.97674
Core Competency & Operation Performance & Profitability	1 st	H	M	M	H	2	0.99715
	2 nd	M	M	H	H	0	0.99365
	3 rd	M	H	H	M	0	0.99266
	4 th	M	M	H	M	0	0.99256
	5 th	H	M	H	H	1	0.98934
	6 th	M	H	H	H	1	0.98537
	7 th	H	H	H	M	0	0.98046
	8 th	H	M	H	M	2	0.97884
	9 th	H	H	H	H	24	0.97674

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