

Organizational Growth and Dynamic Changing

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Abstract: This study applied a Cusp Catastrophe theory to construct a model of the firm growth. We are integrated the literatures on the firm life cycle and its stage objective vertical to develop the balanced scorecard key performance indices of the model control variables. Besides, we generated framework correlation of firm performance change and the growth adaptation through fitting the three years data of the firm case study in the asymmetry and bifurcation side of Cusp Catastrophe model. Moreover, Using R software to fitting the firm growth models and we find evidence supporting our hypotheses that the cusp model of the firm growth better than other models through statistical testing results.

Keywords: Balance scorecard, cusp catastrophe, firm growth, key indicator index

INTRODUCTION

The firm growth is a development of changing in life cycle that consist of many complex factors impact each other. The internal and external factors change overtime in an uncontrolled system. Then, the firm operated in the continuous condition must adjust their structures and strategies in order to ready respond to uncertainty changes of the external environments. Also to survival and develop a sustainable business. The control system is an important part to monitor the current status and take immediate action to control the critical error (Trkman, 2010). The more exactly monitor firm performance is the more optimize solute the firm adaptation to growth, while the failure firm are often differ monitor status be supposed to manage mistake and finally rejection to growth.

The key performance indicator of Balanced Scorecard (BSC) is one of the most useful frameworks; it is a corporative approach that provides a systematic development of the firm vision. Also makes the vision measurable and translates it into actions (Kaplan and Norton, 1993). Moreover, it uses to evaluate the performance of the firm management and operation system from top to bottom level. While the firm implements the BSC tools as a measurement tools to evaluate the firm performance that has been concern about static results rather than dynamic change. However, the lessons of the weakness in firm growth not show direct relation to dynamic changing behavior (Banathy, 1996).

This study on an apply Cusp Catastrophe theory to simulation the firm growth models. As a guide of the Cusp Catastrophe theory is one of the mathematic that

can used to explaining the dynamic system and widely accepted as a guide for understanding changing in various fields: Baack and Cullen (1992) using the Cusp Catastrophe theory to examined the conceptual of change in the relationship between technology and organization structure. Paul and Herbig fitted the Cusp Catastrophe model of discontinuous behavior in industrial adaptation process (Paul, 1991). The Cusp Catastrophe is popular theory in application to the complex system, complex environment and complex factors Barunik and Vosvrda (2009) and Zheng *et al.* (2010). It offers a guide to study the changing of nature in the organization system. The theory can also used as an organizing framework to assess evolutionary as well as revolutionary process in firms (Baack and Cullen, 1992)

We can organize the study into three steps; First, The models of organization life cycles were reviewed to determine the behavior of the firm case study and major criteria of the growth effectiveness exist in mutuality stage of development. Second, the key performance index of BSC and organization growth rate were used as input data into three models of the firm growth; the cusp model, the linear model and the regression model. Third, plot the three-dimensional surface of the Cusp Catastrophe form. Finally, evaluate the cusp model by using Cusp Package in R software and compared to those of linear regression model and logistic model.

BACKGROUND AND THEORY

Firm growth: Firm growth is a development of changing for which most firms attempt to bigger in their life cycle. It overcome at each stage manifests

themselves that arise from the growth and face to as variety factors from internal and external changing until success of their life cycle. The firms are move from one stage to another stage because the fit between the firm and its environment is so inadequate that either the firm's efficiency is seriously impaired or the firm's survival is threatened (Baird and Meshoulam, 1988). Furthermore, the development in life cycle does not continue to growth indefinitely but including number of limit factors. (Land and Jarman, 1992), they are manipulated in a random market provoked by a huge and complicated dynamic system. There could be many equilibrium points in each stage and they may display in the form of multimodal probability distribution located around the equilibrium points, if there is significant strategic control to entry in market, it will tend to be more stable than the firm without such enough control system.

The organization growth perspective is like life cycle of an organism. It has a regular pattern of development: birth, growth, maturity, decline and death (Lester *et al.*, 2003; Miller and Friesen, 1984). Similarly, the organizational life cycle of businesses has been conceived of as generally having stages of development: start-up, growth, maturity, revival and decline. Several organization growth models have been proposed by researchers are distinguished by variable perspective that have been proposed in range of three to ten stages (Smith *et al.*, 1985; Quinn and Cameron, 1983; Lester *et al.*, 2003; Adizes, 1979). Whether the model is three or ten stages, There were no debate as to the validity of applying the biological concept of life cycle to organizational. Our study base on organizational growth perspective on the five stage firm performance of Miller and Friesen (1984), wherefore the model can be defined as a loose set of organizational activities and structure.

If the firms fail to develop growth, that can implies they fail in implement measures the growth performance, they will most likely enter the early stage of the current life cycle: the firms are declining not only firms employees but also firms sale and profit. Generally, to compensate for the decline and succeed in growing, the firm managers have to change its business goals, strategies and strategy implementation devices to fit the internal and external characteristics of each stage. Thus, different stages of the company's life cycle require alterations in the management control system; objectives, strategies, managerial processes, technology, culture and decision making (Baird and Meshoulam, 1988). Moreover, The organization should understand the opportunities of the growth as well as identify critical problems overcome during the stage of organization growth. Instead of operated regression of its life cycle (Donald and Thuhang, 2008).

Cusp catastrophe theory: The organization growth is a system in a non smooth behavior, while the catastrophe theory is a technique that yields non-continuous behavior. It can explain and predict the models with non smooth behavior in the form of S-curve typify and complement linear predictive models. Halal and Lasken (1980) explain that the firm managers can apply Cusp Catastrophe theory to better understand predict and control the catastrophic changes that frequently occurred in the organization. There are also several researches presenting the remarkable use of Cusp Catastrophe in dealing with other management problems (Halal and Lasken, 1980; Wright, 1983; Sheridan, 1985). The Cusp Catastrophe is a descriptor used not only quantitative but also qualitative. It is one of the complex systems, consists of singular mathematical points and can be locally modeled by seven elements. The elementary behavior usually depends on the number of control variables. This study is focus on applied mathematical model with two control variables; divergent variables and convergent variables. If there are two control variables, the element will be in a Cusp Catastrophe form. In a Cusp Catastrophe model, a behavior variable (z) is distinguished from two control variables (a , b), as shown in Eq. (1):

$$V(z; a, b) = bz - \frac{1}{2}az^2 + \frac{1}{4}z^4 \quad (1)$$

$$a = a_0 + a_1X_1 + a_2X_2 + a_3X_3 + \dots + a_vX_v \quad (2)$$

$$b = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + \dots + b_vX_v \quad (3)$$

$$z^3 - az - b = 0 \quad (4)$$

The given values of control factors a and b determine the value of dependent variable (z) and are calculated on the actual measurement of independent variables $X_1, X_2, X_3, \dots, X_v$, as an initial approximation. The control variables represent factors which critically affect the system and the behavioral variable represent the system's response to these control variables. For an application in management, the behavioral variable would represent some aspect of organization performance, while the control variables would comprise indices determinants of this performance (Halal and Lasken, 1980). Suppose that the control factors are linearly related to independent variables, the approximate value of control factors can be written as Eq. (2) and Eq. (3). And when the system has an equilibrium with a function of the control parameters, a and b are the solutions of Eq. (4).

SIMULATION MODEL

The firm case study: The measurement of firm life cycle stage in the case study of interview with a company of selected CEO and Other executive followed by interview and response the check list of questionnaire (Appendix A). We constructed a questionnaire base on various models of organizational life cycle (Kazanjian, 1988; Miller and Friesen, 1984). It's used to classified the firm stage; we interviewed a board of director and two dean division manager; Production unit and Office unit. Moreover, the executive board of general director and the company consultants.

Fujin co., ltd is a good business company specializing in clothing. It has more than twenty years of experience domestic wholesale. The production line is starting from designing and tailor, but outsourcing in the process line of sewing and sagging. It employs 100-130 people to work at its manufacturing facilities in Fujian district and its sales offices in Shahe, Guangzhou province, China. The firm case study has developed experienced to growth through birth stage, growth stage until current is maturity stage, (Miller and Friesen, 1984).

The questionnaires results imply that firm has been running for four years in maturity stage (Quinn and Cameron, 1983). It is running with more stabilized in financial and perform low level of liability with high value of equity than in growth stage. Their CEO's strategic were maintain revenue of ordinary product instead of new innovation. As well as, structure was more formalization; they were focusing on planning and strategy while the middle managers were focus on daily operation. The measurement framework of Balanced Scorecard (BSC) was implemented to training of involving staff. While they apply for their relate division for almost three years, they was succeed in implement the BSC to be performance measure tool of the firm performance, their BSC result are usefulness to interpreted the firm performance. Until now they have total five years accomplished in implementation BSC. They can using BSC makes the firm vision measurable and translate it systematically into actions. Moreover using to evaluating the performance of management and operation.

Accordingly, The Firm go through different stage will have different phrase in which strategies, organizational structures and control system styles based on stage of life cycle Then we summarize several research models of same characteristics as current firm's stage, maturity stage of Miller and Friesen (1984) to represent the critical problems and characteristics faced in the firm case study,

characteristics of other models similar to those of Miller and Friesen (1984) To success in adaptation to growth in the next stage, we were cluster the scenario of effectiveness in the firm growth. This firm in maturity stage is marked by security and slight slowdown. By this stage, the firms are growth in a market with gather asset and up profit. The primary area of business has become a money spinner because it controls a sizable market share and continues to yield profits, but experiences still slow growth. In order to avoid the decline stage, mature companies often take a variety of actions to renew their growth, such as acquiring other companies and expanding product lines. Some business theorists consider the foray into new markets a separate stage, namely, the diversification stage. The firm takes action to maintain growing sale and profit, also improve their internal process to acquire well functional facilities and worker qualifications. Equivalently to increasing the market share and reducing the customer unsatisfied. Figure 1, the scenario can provide a good summary of the priority based on four perspective of balanced scorecard in the firm growth.

Financial perspective; the firm at this maturity stage of life cycle should balancing the financial objective of the stage by balancing the debt and profit. According financial situation of this stage is almost aggressive; company should also work more cost consciously with high return of the investment on the other side limited the debt in the good condition.

Customer perspective; A successful action in customer perspective requires more power relative to expand firm market share and customer satisfied. According, Organization should consider objectives to retain good relationship of current customer and then we selected customer's complaint to measure the performance. The firm should also build public image of organization and its products. When the firm can maintain their market share, It is implies the firm can retain current customer. Then we also selected market share is one of the key performance index.

Internal business perspective; We selected defect rate and outsourcing rate to using in measure in this stage objective, when this is the least focal factor at maturity stage need to take action in current asset both considerate the appropriate outsource and also must improve employee satisfaction to maintain production capacity. Also, the defect rate shows how many errors in production occur on average. It is an important part of quality control. Firm try to reduce their defect rates by using defect rates at different times in the internal process, management can solving the critical problem where defects are occurring.

Development and learning perspective; Organization should improve individual knowledge of

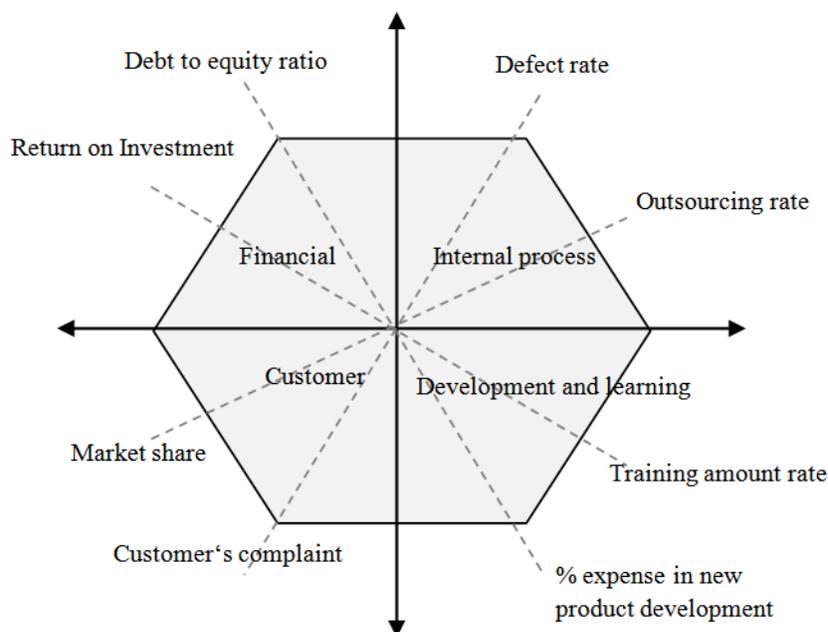


Fig. 1: Four perspective of organization stage objective

management and workforce and maintain the stabilities of employee to improve team work and to reach higher labor productivity. Then, we using training amount rate is one of the key performance index. The firm also needs to initiate the new product because to lead the market, customer changing their demand all the time, the new product cans effective firm growth directly. The expense in researching the new product is also the index to monitor the firm developed.

Setup parameters: The organizational growth models are the cross section relation function between behavior variable and control variables. First of all, behavior variable (z), using the three years data of the firm case study calculated the organization growth rate. Later on, control variables, the same period data of the selected key indicators of four perspective data in BSC (Harrison and St. John, 2005).

First, behavior variable (z), organization growth rate, Firm growth is a performance of an organization, which is a dynamic measure of change overtime, which was created several different formulas to examining the growth. We used sale growth rate to represent organization growth rate, one of the most commonly identified measures of overall firm growth is Sale growth. The study of firm growth has approaches to assessing the amount of growth that a firm has experienced. However, the relate research study very little that specific appropriate measures of firm's growth. We used an equation of the organizational

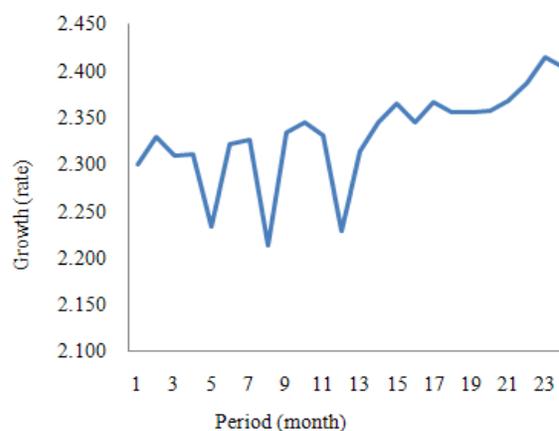


Fig. 2: The firm growth

growth rate from the data of the sale in three years. The performances of the firm case study conformed to the growth rate as shown in Fig. 2 that illustrates the movements of growth rate during year 2008 to 2010. We plotted the sale rate data of the firm case study, Fig. 2 show The firm growth changing over time, it is implied that forming the growth not in the linear regression or logistic pattern.

After, we considered this factors base on object of maturity stage especially the factors are without evaluate the same objective (Horn, 1993), as well as easy to understand and practical, moreover able to monitor past performance and plan future performance (ICAS, 1993). Table 1, the eight key performance

Table 1: List of the performance

Key factors	Performance (2 years)	variables
Organization growth rate	Increasing 5.86%	z
Debt to equity ratio	Decreasing 11.3%	X ₁
Return on investment	Increasing 9.3%	X ₅
Customer complain rate	Decreasing 33.21%	X ₂
Market share	Increasing 5.13%	X ₆
% impossible products	Increasing 28.12%	X ₇
outsourcing		
Defect rate	Decreasing 14.2%	X ₃
Training amount rate	Increasing 16%	X ₈
expense rate in new product	Decreasing 10.5%	X ₄

factors were defined and used as input data in the mathematic model in the next part. (4.3) Fitting and evaluation the models.

The firm case study's data is used for simulation the models with assuming an unconstrained model. We applied in the Cusp Catastrophe fit package in R software as in Eq. (4) of control variable (a, b) and state variable (z). Where independent variables (X₁, X₂, X₃, X₄) were used as the bifurcation side of the model are counted in equation (3), while independent variables (X₅, X₆, X₇, X₈) were used as the asymmetry side as stated in Eq. (2). Also, the software can solve the asymmetry and bifurcation parameters of the cusp model. In the empirical investigation of the organization state model, cusp fit package in R software was used in the tests. We fit the data to linear regression, logistic and also Cusp Catastrophe model. The hypothesis is that Cusp Catastrophe model fits to the data better than the linear and logistic model, indicated by higher R-square value and lower AIC/BIC value. First of all, the three models are compared by using the value of asymptotically chi-squared distributed with degrees of freedom. If the chi-square testing value is higher than the value from the chi-square table that is the cusp model is significantly different from the linear model. Also, R-square test is known as a measurement of the goodness of fit indicated by a value between 0.0 and 1.0. Generally, the higher R-square value, the more the model fits to the data.

The Akaike and Bayesian Information Criteria (AIC/BIC) are used to compare between the cusp model and logistic. It is a method that measures the fitness of a set of observations. In addition, AIC/BIC includes a penalty function, which is an increasing function by the number of estimated parameters. The hypothesis is accepted when the AIC/BIC of the Cusp Catastrophe model is lower than the logistic model.

Table 2 shows the statistic results comparison among three models of Fujin Co.ltd Company. Chi-square values shown in Table 2 indicate that the cusp models are significantly different from the linear

Table 2: Evaluated model

Models	R ²	Log Lik	Npar	AIC	AICc	BIC
Linear	0.674	51.766	10	-83.533	-66.609	-71.752
Logistic	0.827	59.352	11	96.704	74.704	83.746
Cusp	0.792	-10.962	12	45.925	74.289	60.062

Chi-square test of linear and cusp model X-squared = 125.5, df = 2, p-value = 0

regression models. Although the pseudo R-square value in the Cusp Catastrophe model is quite the same to that of logistic model, the AIC/BIC of Cusp Catastrophe models are lower than logistic models. Therefore, the Cusp Catastrophe model represents company's situation better than the logistic model.

RESULTS

This study focuses on the possibility of applying the Cusp Catastrophe model to simulation the firm growth model and then plotting the firm performance in a pattern of cusp model. The firm case study is on maturity stage period of organization life cycle with three years collected data. We study on whether a company will be changing to grow successfully or not depending on mostly their performance results of key indicator indices (BSC). Thus, an inappropriate adjustment of the key factors (BSC) in a critical performance situation will increase the bifurcation factors and, later on, leads the firm to an unstable state and rejection of the growth.

We using the "Cusp" package in R program developed by Grasman *et al.* (2009) to simulate and plotted the three dimension control planes of the firm. These three-dimensional surfaces plotted from the solutions of equation (4) represent the behavior of the independent variables. Figure 3 shows the scatter plot of the Fujin co., ltd company on the cusp three-dimension surfaces. In addition, the dependent variables define the control plane beneath the surface. A bifurcation set consist of independent values for which three possible sets of behavior variables exist. Two of the three possible sets are stable; adaptation to growth and rejection to growth, whereas, the one in the middle is unstable that are in the process of Cusp Catastrophe occurring to interrupt the system. However, it is easier to distinguish among three categorizes of organization state base on Cusp Catastrophe response surface. Those are stable, semi-stable and unstable state.

Firstly, our research study show the last three years growth status through their key indicator indices result in the scenario of the cusp model; both also. The Fig. 3 is show. The result of company evaluation the path jumps over the inaccessible region. It is plotted around "upper surface area", while there have a little data plotted in the lower surface area. As the projection of three dimensions to two dimensions figure, it show a

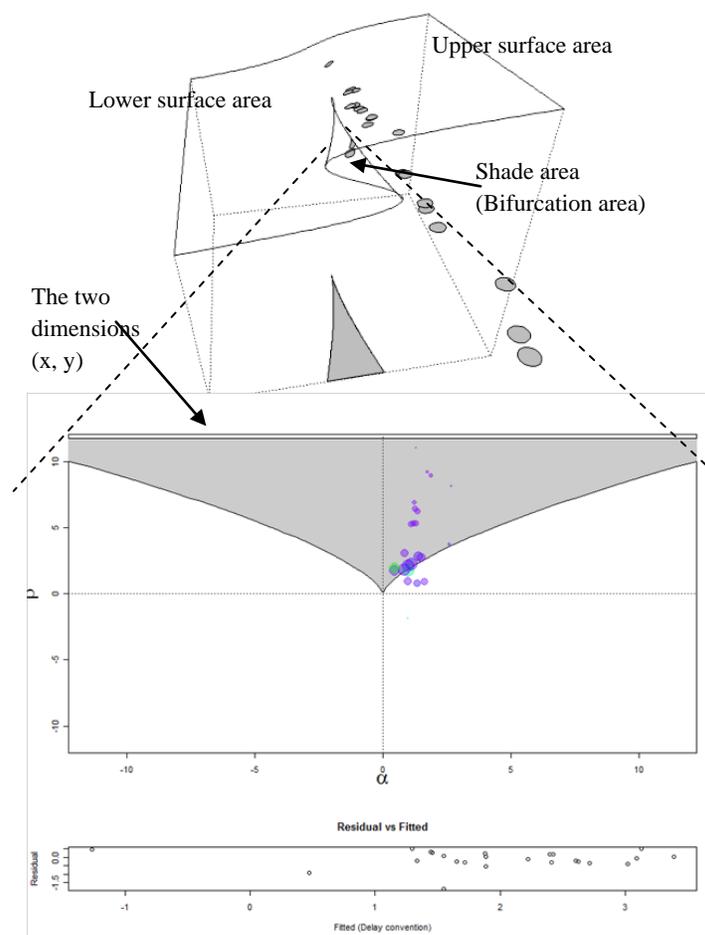


Fig. 3: The firm case study plotted on cusp catastrophe model

few plotted on the shade area, that is corresponding to the firm last three years accomplished in implementing the BSC as a tool to assists the organization in developing a better performance system. They can keep organization growth rate although many external factors affected their business. Hence, the firm growth model can usefulness to summarize their performance in the clearly scenario.

In addition, the firm growth model also demonstrates the significant independent factors correspond to the firm growth. Accordingly different stages of the firm's life cycle require alterations in the key success factors, we examine eight independent variables of the criteria for its effectiveness growth change, while the firm is in the maturity stage they can adjust their control system, management styles, reward systems, organization structures, communication and decision-making processes and corporate strategies to suitable related to dynamic changing of the current status of growth firm's life.

CONCLUSION

The purpose of this study was to interpretation the firm growth model using Cusp Catastrophe theory. We provide the evidence supporting the proposition that the firm growth can describe in the behavior of organism life cycle. The research method and design of this study allow for a statement concerning the association key performance indices base on the firm stage success objective determinants the firm growth; Using factors analysis between the BSC independents variables and the firm growth rate, their results corresponding to accept the correlation of this assumption. And we using the statistical testing method to evaluate the models, its results compare the firm growth construction by the cusp model is significant than linear and logistic model.

Our finding are contribute to the existing firm growth model helps in understanding that organization system is a dynamic behavior, therefore, assists to confirm the current situation of organization, helps to

monitor and predict what is seemly to occur and then gives early warning of the critical state. Proper these control factors giving benefits to the organization keep stability and growth. It is expected that the framework can be a useful tool for empirical research or assist organization in documenting its growth model, demonstrating its operation status and giving early warning of coming latent error.

Appendix A

Evaluation Organizational life cycle stage
Questionnaire

- Year of Company founded
- Total number of employee
- Turnover rate of employee
- Number of external competitor
- What level of external competitor effect organizational performance
- Growth in net sale (%)
- Net income margin (%)
- Characteristic of Structure
 - Simple
 - Functional
- Decision making style
 - Centralized
 - Decentralized
- Size of Organizational
 - Small
 - Large
 - largest
- Strategy
 - Prospector
 - Analyzer
- Number of products/services comparing in the past
 - Increasing
 - Decreasing
- Organizational life cycle stage
 - Existence
 - Survival
 - Success
 - Renewal
 - Decline

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