Managing Value-Based Activity Flexibility on Integrated ERP*

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Abstract On the background of integrated ERP development, activity-value-flexibility management (AVFM) is defined. By using economic-value-added (EVA) and corporate value creation as the objective of AVFM, custom value deviating rate, capital cost deviating rate, cash-flow-out per purchase deviating rate and cash-flow-in per sell deviating rate are developed to be the key responding variates for AVFM, and they also decide the rational quantity range for AVFM tactics. Method for rational AVFM tactics solution could be got by means of redesigning activity information process on integrated ERP.

Key words integrated ERP; value-based activity; flexibility-management; information-integration

With the fast development of e-commerce and increasing impact on business management, the function of enterprise resources planning (ERP) should not only be confined itself to resources and information inner enterprise, and integrated ERP is being called for agile-flexible supply chain management (SCM) on the platform of e-commerce application, which is marked by agility of responding customers demand changes\cite{1~4}. Activity based costing (ABC) and activity based management (ABM) put foreword by Kaplan et al.\cite{5} had been dominant methodology of cost calculating and managing on traditional ERP\cite{5}, and to integrated ABC and EVA can further develop the decision-making-needed information\cite{6~8}. The above mends focus on apportioning capital cost to activity costing, which is the base of rigid budget controlling. On integrated ERP, there are still issues needed further to be developed for flexible ABM according to agile SCM: 1) under the restrictions of both continuing cost reducing and capital value-added increasing, how dose activity management accommodating the improving SCM agility, viz. how to establish the objective for flexible ABM; 2) for activity information in traditional ERP centering accounting ledger and lacking ones for flexible ABM\cite{9~10}, so it is needed that how to process useful information for flexible ABM; 3) under financial budget control, what kind of structure should flexible ABM system have. These issues are directly related to how degree integrated ERP could support agile business management on e-commerce.

1 Information Structure for AVFM on Integrated ERP

1.1 Integrated ERP Settings for AVFM
On integrating SCM, customer relationship management (CRM) with ERP, relationship between integrated ERP and activity chain (value chain) in enterprise can be pictured as Fig.1.

On the model of integrated ERP settings, AVFM can be defined as the agility and flexibility in choosing proper activity operation techniques to respond the changing agile supply chain under the restriction of enough value-creation and quality control benchmark.

1.2 System objective of AVFM
It should be firstly supposed that 1) There are no stock; 2) Equipments for activity operation are rented and rend is sourced from long-term capital, activity cost contains the rent on consumed manufacturing ability; 3) Products cost totally can absorb activity cost.

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Main analyzed variates are defined as:

1) \( I \) means enterprise gross income of sale during the period, \( A_i \) \((i=1,2,\cdots,n)\) means a certain activity, \( Q_{di} \) is the consumption quantity of \( A_i \), \( \rho_i \) is the custom value coefficient of \( A_i \), and \( \sum_{i=1}^{n} \rho_i = 1 \), so the custom value of \( A_i \) is \( P_i = I \rho_i / Q_{di} \).

2) \( Q_{di} \) \((i=1,2,3)\) means the quantity of materials, labors, equipments consumption, and \( C_j \) \((i=1,2,3)\) accordingly means the unit price of each resource, so unit cost of \( A_i \) can be expressed as
\[
C_i = \sum_{j=1}^{n} Q_{di} C_{dj}.
\]
Total asset is \( \theta \) and the assets occupied by \( A_i \) have entirely been utilized, where
\[
\theta_j = C_j = \sum_{i=1}^{n} Q_{di} C_{dj} = \sum_{i=1}^{n} \theta_{ij}, \text{ and the resource } i \text{ absorbed by } A_i \text{ can be defined } \theta_{ij} = Q_{di} C_{dj}, \text{ also } \theta = \sum_{i=1}^{n} \sum_{j=1}^{n} Q_{di} \theta_{ij}.
\]

3) Value-creation of \( A_i \) is \( \pi_j = P_j - C_j \).

4) Margin of budget (\( \gamma \)) and actual figures (\( \lambda \)) is defined as \( \Delta(\cdot) = (\cdot) - (\cdot) \).

5) Cash-flow-in per income of sale coefficient is defined as \( c_i = C_i / I \) and cash-flow-out per purchase coefficient as \( c_o = C_o / C \), \( C_N = C_i - C_o \), thereinto \( C_i \), \( C_o \) and \( C_N \) respectively mean gross cash-flow-in on sale, gross cash-flow-out on purchase and gross net cash flow in the period;

6) Tax rate is \( t_o \), \( t = 1 - t_o \), and weighted average capital cost is \( r \);

EVA expresses capital value-added[11]
\[
EVA = c \sum_{i=1}^{n} (\pi_j Q_{di} - r \sum_{i=1}^{n} \theta_i Q_{di} = \sum_{i=1}^{n} (\pi_j Q_{di} - r \theta_i) Q_{di}) = \sum_{i=1}^{n} (\pi_j - r \theta_i) Q_{di} \quad (1)
\]

For \( A_i \) there has \( EVA_i = \pi_j - r \theta_i \), and

\[
EVA = \sum_{i=1}^{n} EVA_i = \sum_{i=1}^{n} EVA_i Q_{di}, \text{ therefore the margin of } EVA_i \text{ can be calculated as follow}
\]
\[
\Delta EVA_i = \Delta \pi_j - r \theta_i \Delta r - r \Delta \theta_i = \Delta P_j - C_i - \theta_i \Delta r - r \Delta \theta_i \quad (2)
\]

Cash flow controlling is the focus of corporate value management, which centers maximizing the margin of cash-flow-in from income of sale subtracted cash-flow-out for resources purchase[12].
\[
C_N = Ic_j - C_{C_o} = \sum_{i=1}^{n} I \rho_i c_i - \sum_{i=1}^{n} C_i Q_{di} = \sum_{i=1}^{n} (P_j - C_{C_o}) Q_{di} \quad (3)
\]

Net cash flow attributed from \( A_i \) can be express as \( C_{N_i} = P_j c_i - C_{C_o} \), the margin of budget and actual figures of net cash flow is
\[
\Delta C_{N_i} = \Delta P_j c_i + c_i \Delta P_j - C_i \Delta C_{o} - C_o \Delta C_j \quad (4)
\]
The quantity of resources consumption is controllable factor in activity execution, so activity technique level can be described by the proportion of each resource in overall resources consumed by the activity, and resource-technique coefficient is described by $\varphi_i = \Delta Q_{i\alpha} C_i / C_i'$, which mean the degree of activity cost change caused by the change of consumed resource $i$ quantity in the activity, then

$$\frac{\Delta C_i}{C_i'} = \sum_{i=1}^{m} \frac{\Delta Q_{i\alpha} C_i}{C_i'} = \sum_{i=1}^{m} \varphi_i$$  (5)

Different technique on a certain activity would have different proportion of resources consumption. If there are $m$ kinds of techniques on $A_i$ operation, quantity index of $(\sum \varphi_i)_j (j = 1, 2, \ldots, m)$ can be defined for supporting AVFM decision-making.

On Eqs.(2) and (4), basic control equation can be established for AVFM

$$\left\{ \begin{array}{l}
\Delta EVA_i \leq 0 \\
\Delta C_{\beta j} \leq 0 \\
(\sum \varphi_i)_j' \in \{j, j = 1, 2, \ldots, m\}
\end{array} \right.$$  (6)

### 1.3 3-Dimentioanl Activity Information Model

On Eqs.(2), (4) and (6), integrating microcosmic activities value-creation system with macroscopical corporate value-added management system to achieve a complete value-creation financial management system needs an informational coupling mechanism among them. For this purpose, a 3-dimentioanl activity-based information model is design on the key factors of ABM, CRM, SCM, EVA and corporate value valuation, which is described in Fig.2.

![3-dimentioanl activity information model](image)

Fig. 2  3-dimentioanl activity information model

### 2 Control Variates Analyses for AVFM

#### 2.1 Objective Parameters of the $\alpha$ side

On Eq.(2), $\Delta P_t - \Delta C_i$ comes from margin of activity value-creation on the $\beta$ side, $\theta t\Delta r$ oriented from margin of capital cost, and $r\Delta \theta t$ generated by that of activity asset occupying. On Eq.(4), $P_t/\Delta c_j$ comes from budget margin of cash-flow-in, $c_i/\Delta P_t$ from budget margin of custom value, $C_i'/\Delta c_j$ from cash-flow-out actual alteration and $c_{i\alpha}/\Delta c_i$ from actual change of activity cost. On Eqs.(2), (4) and (6), to fulfill the objective of capital value-added and corporate value-added on the $\alpha$ side, activities value-creation should gain no less than the budget on the $\beta$ side, and the $\gamma$ side should harmonize the activities cost controlling with capital risk and capital liquidity.

#### 2.2 Analysis of Activity Technique and Custom Value-creation on the $\beta$ Side

On the $\beta$ side, changes capital cost $r$ and cash flow coefficient $c'$ are not taken in account, there are $r' = r$ and $c' = c$, then Eqs.(2) and (4) are transformed to

$$\Delta EVA_i = \Delta P_t - \Delta C_i t - \theta t\Delta r - r \Delta \theta t = \Delta P_t - \Delta C_i (t + r)$$  (7)

$$\Delta C_{\beta j} = P_t/\Delta c_j + c_i/\Delta P_t - C_i'/\Delta c_j - c_{i\alpha}/\Delta C_i = c_i/\Delta P_t - c_{i\alpha}/\Delta C_i$$  (8)

On Eqs.(6)–(8), there is inequation

$$\Delta C_i \geq \max(\Delta P_t, \frac{c_i/\Delta P_t}{c_{i\alpha}/\Delta C_i})$$  (9)

On activities budget implementing, income of sale $I$, unit price of resources $C_i$ and quality of $A_i$ demand $Q_{i\alpha}$ are all uncontrollable factors. It is supposed that $I' = I$, $C_i' = C_i$ and $Q_{i\alpha}' = Q_{i\alpha}$, so controllable factors can be legibly discussed. The quantity of resources consumption is controllable factor in activity execution, so on Eqs.(6), (9) can be developed as

$$C_i \sum_{i=1}^{m} \varphi_i \geq \max\left[ \frac{I'_t\Delta P_t}{Q_t (t + r')}, \frac{I'_tC_i'/\Delta P_t}{Q_{i\alpha}'C_{i\alpha}} \right]$$  (10)

A constant calculated by the budget is defined as
The Eq. (11) describes that how activity technique can respond changes of activity-based customs value under the settled capital cost and capital liquidity. There are two main countermovement factors influencing activity execution, $\rho_i$ and $\phi_j$. If actual custom value for $A_l$ declined, to achieve the object of Eq. (6), in $A_l$ execution, resources with lower $\phi_j$ could be substituted by ones with higher $\phi_j$ to enhance efficiency. While if actual custom value for $A_l$ rose, resources with higher $\phi_j$ could be replaced by ones with lower $\phi_j$ to enhance efficiency. When $O_{ct}\neq'=''+$, activity technique change be independent with the risk of capital structure and capital liquidity and be induced by custom value changes. When $O_{ct}\neq<''+$, to respond custom value changes, activity technique changes would be restricted by capital structure risk, and when $O_{ct}\neq>''+$, that would be confined by capital liquidity risk.

2.3 Analysis of Activity Technique and Corporate Value-Creation on the $\gamma$ Side

On the $\gamma$ side, it is supposed that there are no changes of resources price and custom value, and the relationships between activity technique and capital cost and cash flow is stressed. So $P'=P$ and $C'_i=C_i$, besides, $\Delta C_i = \sum_{l=1}^{L} \phi_i c'_l = \sum_{i=1}^{I} \Delta \theta_l = \Delta \theta_j$, then Eqs. (2) and (4) are transformed to

$$\Delta \theta_j \leq \frac{\theta'_l \Delta \tau}{(t+r)}$$

(14)

$$\sum_{l=1}^{L} \phi_i \geq \frac{\Delta C_o}{c'_o - \Delta C_o}$$

(15)

Here two variables are defined as follows: capital cost deviating rate $\lambda = \frac{\Delta \tau}{r'}$, constant $\tau = 1 + \frac{t}{r'}$ and deviating rate of cash-flow-out per purchase coefficient $\kappa = \frac{\Delta C_o}{c'_o}$, then Eqs. (14) and (15) can be developed to

$$\frac{\lambda}{\lambda - \tau} \leq (\sum \phi_j) \leq \frac{\kappa}{1 - \kappa}$$

$$\{j'\} \subseteq \{j, j=1,2,\ldots,m\}$$

(16)

Generally, there are $0 < r < 1$ and $0 < c_o < 1$ as well as $r > 1$, and $\frac{\lambda}{\lambda - \tau}$ has continuing positive relationship with $r$, while $\frac{\kappa}{1 - \kappa}$ has continuing negative relationship with $c_o$, and there are always rational solutions for Eq. (14) which can be regarded as the edge for activity technique varying on the restriction of capital risk increasing and cash overflow when custom value is constant. To achieve the objective of $\Delta EVA_l \leq 0$ and $\Delta C_{M_l} \leq 0$, if the risk of capital going up, the resources with lower $\phi_j$ should be replaced by ones with higher $\phi_j$ in adopted activity technique, which is restricted by cash overflow. On the other hand, if cash-flow-out going up, the resources with higher $\phi_j$ should be replaced by ones with lower $\phi_j$ in technique adoption, which is restricted by capital structure risk exceeding. If activity technique adopt tactic of lower $\phi_j$ resources replacing higher $\phi_j$ ones, liquidity risk would be elevated not involving capital structure risk change, on the contrary, if technique adopt tactic of lower $\phi_j$ ones replacing higher $\phi_j$ ones, capital structure risk would be increased not involving liquidity risk. Therefore there exists the reversed relationship between cash-flow-out and capital structure risk when both of them go beyond the budget, which can possibly be equilibrated by properly adopted varied activity techniques to fulfill the objective of capital and corporate value-added.
3 Integrated Design of AVFM System

3.1 Synthesized Boundary of AVFM Tactics

On the $\beta$ side, the variety of capital cost $r$ and cash flow $c$ are excluded in discussions of activity tactic for responding to the custom value changes, and on the $\gamma$ side, resources price and custom value are supposed constant in the discussions of activity tactic in answer to the deterioration of capital structure and cash flow. When the varieties $r$, $c$ and $\rho_i$ are all concerned, Eq.(11) can be further developed into

$$\sum \phi \geq \max \left( \frac{ht\Delta \rho_i}{1 + \tau}, \frac{C_i \lambda}{\tau}, \frac{hc_i \Delta \rho_i}{c_i^*} - C_i^* \right) \quad (17)$$

Variety rate of $c_i$ is defined as $\mu = \frac{\Delta c_i}{c_i^*}$, Eq.(16) is further transformed to

$$\frac{\lambda}{1 - \tau} + ht\Delta \rho_i \leq \sum \phi \leq \frac{-\kappa}{1 - \kappa} - \frac{\kappa \mu P_i c_i^*}{C_i^* (1 - \kappa)} - \frac{\Delta \rho_i h(c_i^* - \mu c_i^*)}{c_i^* - c_i^* \kappa} \quad (18)$$

When synthesizing Eqs.(17) and (18), the situation would become quite complex as follows

$$\max \left\{ \frac{h t \Delta \rho_i}{1 + \tau}, \frac{C_i \lambda}{\tau}, \frac{hc_i \Delta \rho_i}{c_i^*} - C_i^* \right\} \leq \sum \phi \leq \left( \frac{-\kappa}{1 - \kappa} - \frac{\kappa \mu P_i c_i^*}{C_i^* (1 - \kappa)} - \frac{\Delta \rho_i h(c_i^* - \mu c_i^*)}{c_i^* - c_i^* \kappa} \right) \quad (19)$$

In Eq.(19), it actually is the solution for Eq.(6) on supposing that there is no margin between actual figure and budget on aspects of sale income and resources unit price, and all parameters can be calculated with budget figure except $\kappa$, $\mu$, $\lambda$ and $\Delta \rho$. The adopted scale of activity technique tactics can be possibly found for activity rationally responding the variation of $\kappa$, $\mu$, $\lambda$ and $\Delta \rho$ under the condition that budget of capital and corporate value-added at least could be reached.

When synthesizing $\alpha$ side, $\beta$ side and $\gamma$ side information processing, the direct relationships among activity technique, capital and corporate value added are established, on which risk of liquidity and capital structure could be adjusted by means of adopting variant activity technique under the ultimate object of financial value-added management. In addition, the situations that Eq.(19) had rational solutions would be diverse according to budget rectification and real situation changes.

3.2 Integrated System Design

Price of resources and products is decided by market and activity is only the accepter of them. By SCM could lower resources price be got, and by CRM could higher sale be received. So timing information generated from SCM and CRM integrated in ERP can support efficiently activities chain (network) programming. Therefore, financial capital and corporate value-added management systems and ABM systems can be integrated on the ERP platform by the informational coupling mechanism on 3-dimention activity information model and key parameters on each side. The complete procedures of parameters feedback and control are shown in Fig.3.

![Fig.3](image-url)
4 Conclusions

On integrated ERP growing as basic infrastructure for agile-flexible SCM, AVFM would further improve the agility and flexibility of SCM. By using EVA and corporate value creation as the objective of AVFM, custom value deviating rate, capital cost deviating rate, cash-flow-out per purchase deviating rate and cash-flow-in per sell deviating rate are developed to be the key responding variates for AVFM, and they also decide the rational quantity range for AVFM tactics. Accordingly, the more rational kinds of activity techniques are standby, the more possibility for realizing AVFM there will be. Besides, method for rational AVFM tactics solution could be get only by means of redesigning activity information process on integrated ERP.

The localization of this research supposes that zero stock and timing equipment renting. It means the benefit from AVFM would be killed by the opportunity cost of material resources and equipment storage. As a result, it is further proved that AVFM would progress agility and flexibility of SCM on integrated ERP.

References


Brief Introduction to Author(s)

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