

# Research on Management Accounting Framework based on Hall Three-dimensional Structure and DSM

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**Keywords:** Hall 3D Structure Model, Management Accounting, Enterprise Operation, Design Structure Matrix (DSM).

**Abstract:** The management accounting framework aims to improve the operation control ability. In view of the lack of internal relationship between management methods and operation control in the previous research on management accounting framework systems, this paper puts forward the purpose of this research. We use Hall's three-dimensional structure model for reference to construct the management accounting framework based on operation control, and study the characteristics of operation control with the contingency elements such as organizational structure, control methods, and ability improvement as the logical dimension; Taking eight tools such as comprehensive budget, performance evaluation and responsibility body as the knowledge dimension to promote the application of management accounting, the enterprise operation matrix is defined. Design Structure Matrix (DSM) method is used to study the quantitative correlation between operation control and management accounting tools, and reveal the quantitative relationship between management accounting tools. Finally, the case of China Unicom verifies hierarchical characteristics between management accounting tools.


## 1 INTRODUCTION

Enterprise operation is a complex system, which is realized by the exchange of various information as well as the cooperation of various management methods. Aiming at improving the quality of enterprise operational control, the management accounting framework combines different management accounting tools based on a certain logic. Existing research puts forward management accounting framework including value management, balanced scorecard, comprehensive budget and activity-based costing, and so on. However, these management accounting frameworks lack analysis of the internal relationship between management accounting tools and operational control since they are mainly revolved around a certain management accounting tool. In the meanwhile, the existing research ignores the defects of a single management accounting tool and the correlation among different management accounting tools since it mainly focuses on the impact of a single management accounting tool

on specific operational control. It is necessary to choose appropriate management accounting tools, and deeply analyze the correlation between operational controls and different management accounting tools and the synergy among management accounting tools according to organizational characteristics, so as to ensure that the selected management accounting toolset can effectively connect with the enterprise operational control mode. Therefore, it is of great theoretical and practical significance to build a management accounting framework based on operational control for the application of management accounting tools and the promotion of enterprise operational control ability.

Using Hall's three-dimensional structure model for reference, this paper constructed a management accounting framework based on operational control. We investigated the characteristics of operational control (logical dimension) such as organizational structure, control method, and ability improvement, management accounting tools (knowledge dimension) including a comprehensive budget, performance evaluation, and responsibility body.

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Based on the framework, we define the operation matrix. Using the method of DSM matrix, the quantitative correlation between operation control and management accounting tools, the quantitative correlation among management accounting tools were determined. The case study of China Unicom validates the central role of comprehensive budgeting in enterprise operations management. The research results reveal the significant correlation and hierarchical features among management accounting tools. Firstly, management accounting tools are hierarchical in nature according to the relevance of operational characteristics, and each hierarchical tool cooperates with and complements each other and has hierarchical characteristics. Secondly, the basic functions of management accounting tools at different levels are positioned variably with quantitative intrinsic relationships with each other. Thirdly, the management accounting practice based on the operational dimension is the process of deeply promoting the integration of business and finance.

## 2 LITERATURE REVIEW

Existing research puts forward management accounting framework including value management, balanced scorecard, comprehensive budget and activity-based costing, and so on. With the fundamental goal of continuously creating shareholder value, Serebryakova put forward a value management framework (VBM), which determines specific internal goals, selecting strategy and organizational design, identifying value drivers, formulating action plans, and selecting performance indicators and goals, performance evaluation, as well as feedback improvement (Serebryakova 2021). Pareek put forward a management framework based on the principle of the strategic management process, which takes the Balanced Scorecard (BSC) as the core and integrates tools such as budget, activity management, and shareholder value index (Pareek 2021). Ploder focused on the combination of agile project management and beyond budgeting (Ploder 2020). From the perspectives of economics, psychology, and sociology, Choi found imply that the patterns of budget ratcheting could be diverse based on how local government officials strategically respond to the dynamics between bargaining power and the pressure of justifying budgets (Choi 2021). The existing researches mainly discuss the influence of specific management accounting tools such as comprehensive budget, performance evaluation, and balanced scorecard on specific operational control

when applying the management accounting framework to operational control. For example, Cools study the role of budgets in a creative context (Cools 2017). They find expected creative firms use their budgets in a more interactive way and responsive creative firms use their budgets in a rather diagnostic way. Artz study the effect of performance measure used on the functional strategic decision. Lima presents the results of the strategic planning process and the use of the Balanced Scorecard as a strategic management system for the Center for Sustainable Development/Research Group on Energy Efficiency and Sustainability (Greens), University of Southern Santa Catarina (Unisul) (Lima 2021). Malagueño investigate the effect of BSC in SMEs on their financial performance and innovation outcomes (Malagueño 2018).

An appropriate management accounting system depends on the specific environment and organizational structure design of the organization itself. In the process of selecting management accounting tools, enterprises should deeply analyze the correlation between operational control and different management accounting tools and the synergy among management accounting tools according to organizational characteristics, so as to ensure that the selected management accounting toolset can effectively connect with the operational control mode of enterprises. As a result, it can give full play to the efficacy of management accounting, improve the level of enterprise operational control, and then promote the high-quality development of enterprises by building a management accounting framework based on operational control.

## 3 MANAGEMENT ACCOUNTING TOOLS

The application of management accounting tools in enterprises is to solve the management problems that restrict the ability of enterprise value creation. Therefore, enterprises should not only consider the internal relationship with enterprise operational control but also consider the correlation between management accounting tools when they implement management accounting tools. For quite a long period of time, the common topic concerned by both the practical and academic circles engaged in the research of management accounting is how to operate management accounting to better support the operational control of enterprises; what are the key elements of an effective management accounting

framework; what is the relationship among these factors and enterprise operational control activities; what is the relationship between the internal elements of the management accounting framework? Based on operational control, this paper answers the above questions in the way of constructing a management accounting framework.

### 3.1 Management Accounting Framework based on Hall's Three-dimensional Structure

Hall's three-dimensional structure analysis method, a system engineering methodology put forward by American system engineering expert Hall in 1969, can be used to solve the planning, organization, and management problems of large and complex systems. Hall's three-dimensional structure divides the whole system engineering into different stages and steps closely connected before and after and combines various professional knowledge and skills needed to complete these stages and steps. Hence, it formed a three-dimensional structure composed of the time dimension, logic dimension, and knowledge dimension. This paper builds a management accounting framework based on operational control by drawing lessons from Hall's three-dimensional structure analysis method.

Firstly, the time dimension of Hall's three-dimensional structure represents the whole process of system engineering activities arranged in time sequence from beginning to end. The enterprise operation process is divided into the planning stage, scheme formulation stage, implementation stage, and continuous improvement stage. Therefore, this paper defines the above four stages as time dimensions.

Secondly, the thinking procedure that should be followed in each stage of the time dimension is represented by the logical dimension of Hall's three-dimensional structure. The planning stage and the programming stage need to be conducted under the guidance of the organization's strategic objectives. In this paper, the procedures to be followed in these two stages are defined as organizational functions. In the implementation stage, enterprises need to effectively control the operation process to ensure the effective implementation of the scheme. In this paper, the procedures to be followed in the implementation stage are defined as control activities.

Enterprises need to make the operation plan to create value continuously in the stage of continuous improvement. This paper defines the procedure to be followed in this stage as capability improvement.

In the end, the knowledge dimension of Hall's three-dimensional structure represents the professional knowledge needed to complete these stages and steps. Management accounting is carried out around enterprise operational control, and it is a control system that directly participates in enterprise operation process management. Management accounting tools are the concretization of management accounting concepts and form important support for the operational control of enterprises. Therefore, this paper positions management accounting tools as a knowledge dimension. As shown in Fig. 1, this paper establishes a management accounting framework based on operational control by using Hall's three-dimensional structure model for reference, and studies the internal relations and quantitative methods among management accounting tools based on enterprise operation characteristics.

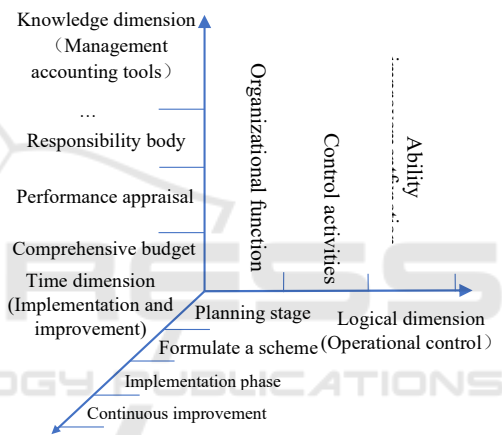


Figure 1: Management accounting framework model based on operational control.

### 3.2 Enterprise Operation Matrix

Usually, based on the changes of the internal and external environment, enterprises choose the management accounting tools they need. In fully competitive industries, enterprises are more willing to apply management accounting tools to improve operational efficiency and benefits when the internal and external environment of enterprises tends to be complex and changeable, to enhance their competitiveness.

We construct the enterprise operation matrix based on the above analysis. The logical dimension refers to the collection of elements controlling operation activities, which constitutes the ordinate of enterprise operation matrix, and describes the static planning and dynamic allocation of organizational structure, control mode, ability improvement, and

other elements realizing business objectives under the condition of functional division. Knowledge dimension means the collection of management accounting tools. The abscissa of enterprise operation matrix proposed in this paper consists of comprehensive budget, performance evaluation, responsibility body, lean cost, supply chain, sales support, integration of industry and finance, decision support, and other methods. See Table 1.

Table 1: Operation control dimension and management accounting tool dimension of enterprise operation matrix.

		Operation control		
		Organizational function	Control activities	Ability improvement
Management accounting tools	Comprehensive budget			
	Performance appraisal			
	Responsibility body			
	Lean cost			
	Supply chain			
	Sales support			
	Integration of industry and finance			
	Decision support			

Enterprise operation matrix reflects the internal logical relationship between operation control dimension and management accounting tools. The correlation between the elements of the enterprise operation matrix is different due to the influence of the enterprise operating environment. From the perspective of system engineering, the correlation and impact of operation matrix elements can be scientifically quantified and evaluated. Therefore, we further select the verification method for the quantitative correlation of enterprise operation matrix elements. If we can prove that there is an internal correlation between the constituent elements of the operation control dimension and management accounting tools, the internal correlation between management accounting tools can also be indirectly proved.

#### 4 CASE ANALYSIS

The correlation and influence of operational matrix elements can be scientifically quantified and

evaluated from the perspective of system engineering. Therefore, the Design Structure Matrix (DSM) method was selected as the verification method of quantitative correlation, which is used to describe the interdependence between different elements in complex systems (Loureiro 2020). The enterprise operation matrix composed of operation control and management accounting tools is a complex of the correlation of factors such as products, processes, organizations, and activities. Therefore, the quantitative research using the DSM model is suitable for the enterprise operation matrix model proposed in this paper.

In order to analyze the characteristics of operation control and management accounting tools, we introduce the Delphi evaluation method to evaluate the score of the correlation of the constituent elements of China Unicom's enterprise operation matrix quantitatively. Using a valuation scale ranging from 0 to 5 (0=Unconsidered; 1=Worth a little consideration; 2=Worth considering; 3=Partly true; 4=Meaningful; 5=Makes sense).

##### 4.1 Quantifying the Impact of Operational Control on Management Accounting Tools

The quantitative correlation of the operational control matrix evaluation is shown in Table 2. The quantitative correlation between organizational function  $\alpha$  and control activity  $\beta$  is 5, while the quantitative correlation between control activity  $\beta$  and organizational function  $\alpha$  is 4, indicating that organizational function  $\alpha$  has a greater influence on control activity  $\beta$  than control activity  $\beta$  has on organizational function  $\alpha$ . Meanwhile, there is another typical correlation relationship between capability enhancement  $\gamma$  and control activity  $\beta$ . The quantitative correlation effect of capability enhancement  $\gamma$  on the correlation with control activity  $\beta$  is 3, while the quantitative correlation effect of control activity  $\beta$  on capability enhancement  $\gamma$  is 1. It shows that the influence of ability improvement on control activity  $\beta$  is greater than that of control activity  $\beta$  on ability improvement. Similarly, the quantitative correlation effect of organizational function  $\alpha$  on capability enhancement  $\gamma$  is 1, while the quantitative correlation effect of capability enhancement  $\gamma$  on organizational function  $\alpha$  is 2. It shows that the influence of capability enhancement on organizational function  $\alpha$  is greater than that of organizational function  $\alpha$  on capability enhancement.

The quantitative relevance of operational control activities to the assessment of management

accounting tools is represented in a domain mapping matrix, as detailed in Table 3. Among them, comprehensive budget A, as a tool of strategy implementation, is affected by the quantitative correlation of organizational function  $\alpha$ , control activity  $\beta$ , and ability improvement, all of which are 5. Organizational function  $\alpha$  is to define the mission and rules of the organization, control activity  $\beta$  advances the implementation goals, and capability enhancement  $\Upsilon$  is to match and invest resources, indicating that the operational control elements are all important in influencing the quantitative relevance of the comprehensive budget, and advancing the comprehensive budget A is influenced by the combination of organizational function  $\alpha$ , control activity  $\beta$ , and capability enhancement  $\Upsilon$ . At the same time, another typical correlation is that the quantitative correlation of organizational function  $\alpha$ , control activity  $\beta$ , and ability promotion affects decision support G by 3, 2, and 1 respectively. It shows that decision support G has a great correlation with organizational process  $\alpha$ , but  $\Upsilon$  is less affected by ability improvement, and the influence of control activity  $\beta$  on decision support G is between them. Other management accounting tools are influenced by the quantitative relevance of operational control elements as detailed in Table 3.

Table 2: Operational control dimension matrix DSM.

	$\alpha$	$\beta$	$\Upsilon$
Organizational function $\alpha$	$\alpha$	4	2
Control activity $\beta$	5	$\beta$	3
Ability improvement $\Upsilon$	1	1	$\Upsilon$

Table 3: Management accounting tools and operations control matrix DMM.

	Organization al function $\alpha$	Control activity $\beta$	Ability improvemen t $\Upsilon$
Comprehensive budget A	5	5	5
Performance evaluation B	5	4	3
Responsible body C	5	5	4
Lean cost D	3	4	5
Supply chain E	3	4	3
Sales support F	2	4	3
Integration of industry and finance G	4	5	2
Decision support H	3	2	1

The multi-domain matrix is an analysis of the characteristics of the application of management accounting tools in a business and is reflected as an

intrinsic link between management accounting tools in a business operations control environment. The multi-domain matrix constructed by using operational control dimension DSM (Table 2) and domain mapping matrix (Table 3) is shown in Table 4, and the quantitative correlation between management accounting tools is calculated according to DSM method.

Table 4: Operational control and management accounting tool MDM.

	$\alpha$	$\beta$	$\Upsilon$	A	B	C	D	E	F	G	H
$\alpha$	$\alpha$	4	2								
$\beta$	5	$\beta$	3								
$\Upsilon$	1	1	$\Upsilon$								
A	5	5	5	A	32 5	37 5	31 5	26 5	23 5	29 5	16 5
B	5	4	3	34 0	B	31 8	27 1	22 7	20 4	25 1	13 7
C	5	5	4	39 0	31 6	C	30 8	25 8	22 9	28 6	16 0
D	3	4	5	30 0	24 7	28 2	D	19 7	17 2	22 1	12 7
E	3	4	3	28 0	22 9	26 2	21 9	E	16 0	20 3	11 7
F	2	4	3	25 0	20 7	23 4	19 3	16 1	F	17 9	10 7
G	4	5	2	34 0	27 6	31 7	26 8	22 2	19 5	G	14 0
H	3	2	1	18 0	14 3	16 8	14 5	12 1	11 0	13 3	H

#### 4.2 Quantifying the Correlation between Management Accounting Tools

The management accounting tool DSM is derived from the multi-domain matrix MDM (Table 4) by optimizing the ranking according to the correlation value and increasing the color scale, as shown in Table 5. Firstly, the quantitative relevance of comprehensive budgets to other management accounting tools is at the top of the list. It can be seen that the strategic position and function of comprehensive budget have quantitatively verified the position of the comprehensive budget as the core tool of enterprise management and control. Secondly, the quantitative correlation among comprehensive budget, responsibility body, and performance evaluation is above 316, which also shows that these three management accounting tools together constitute the key elements to enhance the operational capability of enterprises. Thirdly, among the impacts on the comprehensive budget, the quantitative

relevance of the responsibility body 390 ranks first, the quantitative relevance of the performance evaluation system 340, while the quantitative relevance of the business-financial integration 340, the quantitative relevance of the lean cost 300, the quantitative relevance of the supply chain 280, the quantitative relevance of the sales support 250, and the quantitative relevance of the decision support 180, indicating that the responsible body is the core element to achieve the budget decomposition. Fourthly, the financial integration to comprehensive budgeting is relatively large and must be considered in the process of implementing the management accounting framework. Fifthly, the quantitative relevance of lean cost, supply chain, and sales support to other management accounting tools is at the medium level, which is related to the fact that they

are operation-oriented management accounting tools and the management attributes supporting the operation level. Sixthly, the quantitative correlations among lean cost, supply chain, and sales support are less than their quantitative correlations among comprehensive budget, performance evaluation, and accountability body, indicating significant hierarchical nature of quantitative correlations among management accounting tools. Seventhly, the quantitative relevance of decision support to various management accounting tools is weak, which is related to the fact that decision support is based on the information integration attribute of various management accounting tools, and also related to the fact that decision support is the management attribute supporting the management of enterprises.

Table 5: Management accounting tool DSM.

	A	C	B	G	D	E	F	H
A	A	375	325	295	315	265	235	165
C	390	C	316	286	308	258	229	160
B	340	318	B	251	271	227	204	137
G	340	317	276	H	268	222	195	140
D	300	282	247	221	D	197	172	127
E	280	262	229	203	219	E	160	117
F	250	234	207	179	193	161	F	107
H	180	168	143	133	145	121	110	G

To sum up, DSM is used to prove that there is a quantitative correlation between the operation control elements of the case enterprise and the management accounting tools, as well as in the management accounting tools, so as to demonstrate the effectiveness of the enterprise operation matrix.

management, and it constitutes the key method affecting enterprise operation ability together with responsibility body and performance evaluation. The results reveal that there are significant correlations and hierarchical characteristics among management accounting tools.

## 5 CONCLUSIONS

In order to overcome the defects of the former management framework system lacking quantitative research on the internal relationship between management methods and operation control. Firstly, this paper uses Hall's three-dimensional structure model to construct a management accounting framework based on operational control. Secondly, taking the contingency elements such as organizational structure, control methods, and ability improvement as the logical dimension, this paper studies the characteristics of enterprise operation control, takes eight tools such as comprehensive budget, performance evaluation, and responsibility body as the knowledge dimension to promote the application of management accounting and defines the enterprise operation matrix accordingly. Finally, a case study is conducted to verify the core role of comprehensive budget in enterprise operation

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