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THEORY AND ACTION RESEARCH ON A NEW FRAMEWORK AND APPROACH OF PERFORMANCE MANAGEMENT

By

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Abstract

Today, the activities relevant to performance management (PM) can be found in every corner of business, and its importance could be described by a famous business motto that whether a company measures its workforce in hundreds or thousands, its success relies solely on performance. Despite its importance as an enabler of successful business, some issues and shortcomings still exist in the performance management research and its implementation, which can be largely categorized into two main challenges.

The first challenge is reflected in the PM dilemma of SMEs. Most existing PM frameworks focus on mechanistic organisations of significant size, yet small and medium enterprises, which comprise 99 percent of business in the UK and 94.15 percent in China, benefit little from the extant PM research. The second PM challenge is combining PM with business and management process innovations. Even for an organisation with simple operating cores, current PM frameworks provide little guidance on how to introduce innovations during performance management system (PMS) building up and management. This issue further causes difficulties in managing performance in complex operating cores, which is exemplified by the challenges of carrying out PM in an R&D unit.

The above challenges are quite typical and should be dealt with in the level of performance management framework. We believe that existing PM frameworks are not built around an organisation's performance generation processes and therefore may not be able to handle many issues effectively, including those outlined above. Thus, the research objectives of this thesis are to develop a PM framework that is built around performance generation and also has mechanisms to address the above issues. Furthermore, we need to develop implemental approaches within the framework that can effectively deal with these challenges in real business cases.

To accomplish the aforementioned research objectives, a comprehensive typological literature review was carried out to analyse the characteristics and

features of the existing PM frameworks. Next, based on the literature research, a new PM framework, namely as the performance tree (PT) framework was introduced in Chapter five, which focuses on the performance generation processes of organisations and also contains mechanisms to accommodate different approaches for a wide range of organisations. In addition, two implemental approaches of PT frameworks were developed in the thesis for the sake of solving the pressing PM issues in SMEs and R&D unit.

This research has the following four main contributions:

1. A significant research gap was identified that the existing PM frameworks largely ignored the procedures of performance generation which could lead organisations to be near-sighted, unsustainable, and even experience strategic failure.
2. A new performance management framework, PT framework was developed in this thesis. The PT framework adopts a performance-based perspective to explain performance generation and management processes; also it contains mechanisms to accommodate different approaches for a wide range of organisations seeking to handle the pressing PM issues
3. An implemental approach of PT for classic Chinese manufacturer SMEs was developed in the thesis. Comparing with the existing PM approaches, the new one fully considers the managerial and operational characteristics of SMEs, such as fast-changing organisational chart and high demand for organisational adjustments.
4. An implemental approach of PT for Chinese R&D units under was developed in the thesis. The approach considers both the characteristics of R&D management and the specific PM needs, and hence a PMS in accordance with core operation of R&D units can be developed under its guidance. Meanwhile, a behavioural evidence-based performance measurement system is accommodated in the approach to better measure and evaluate R&D staff's performance.

Keywords: performance management; performance tree (PT) framework; small and medium enterprise (SME); R&D unit

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List of Abbreviations

AMA	American Management Association
AR	Action Research
BEI	Behavioural Event Interview
BI	Business Information
BPM	Business Process Management
BPMPS	Online Behaviour Data-Based Performance Monitoring & Prediction System
BSC	The Balanced Scorecard
BSM	Balanced Stakeholder Model
CAS	Chinese Academy of Sciences
CATWOE	Customer, Actors, Transformation, Weltanschauung, Owner, And Environment
CGM	Customized Generic Model Method
CM	Competency Model
CR	Critical Realism
EFQM	European Foundation for Quality Management Excellence Model
ER	Evidential Reasoning
ERP	Enterprise Resource Planning
HB	Name of the company in the first case
HR	Human Resources
HRM	Human Resources Management
JCAM	Job Competence Assessment Method
KP	Key Performance
KPI	Key Performance Indicator
MBNQA	Malcolm Baldrige National Quality Award Framework
MBOs	Management by Objectives
MCDM	Multiple-Criteria Decision Analysis
NHS	National Health Service
NPOs	Non-Profit Organizations
OD	Organisation Development
OECD	The Organisation for Economic Co-operation and Development

OLAP	Online Analytical Processing
PAKS	Personality, Ability, Knowledge, Skills
PCA	Principal Component Analysis
PIs	Performance Indicators
PM	Performance Management
PMS	Performance Management System
PSSC	Public Sector Scorecard
PT	Performance Tree
R&D	Research and Development
SME	Small and Medium-sized Enterprises
SNA	System of National Accounts
SSM	Soft System Methodology
TS	Name of the company in the second case
UNESCO	United Nations Educational, Scientific and Cultural Organisation
WBRD	Weighted Belief Distribution with Reliability

Chapter 1 Introduction

1.1 Research background

A famous motto in business states that "whether a company measures its workforce in hundreds or thousands, its success relies solely on performance" (Aguinis, Joo and Gottfredson 2011, p.503). The importance of (PM) has been widely realized by scholars and practitioners – a survey conducted by the Sunday Times highlights that PM is one of the most crucial functions in successful enterprises in the United Kingdom (Aguinis, Joo and Gottfredson 2011). Due to its significance in academia and industry, numerous studies have documented performance-relevant topics in multiple domains, including human resources (Becker and Gerhart 1996; Youndt et al. 1996), finance (Spremic, Zmirak and Kraljevic 2008; Manville and Greatbanks 2013), accounting (Otley 1999; Broadbent and Laughlin 2009) and operational research (Lambert, Cooper and Pagh 1998; Smith and Goddard 2002).

Despite the vast and continuing literature documenting performance-relevant topics, PM research is still in its nascent stages as a rigorous discipline (Thorpe and Beasley 2004). For example, there are currently no widely accepted definitions for the concept of performance (Armstrong and Baron 1998; Aguinis 2009; Dooren, Bouckaert, and Halligan 2015). In the initial stage of PM research, the definitions of performance were analogous to "financial yields"; these output-oriented definitions dominated the field until the early 1980s (Spicer 1978; Beesley and Kettle 1985). From this time, the operational and strategic issues relating to performance entered into the horizons of researchers and practitioners (London and Smither 2002; Lipe and Salterio 2000; Hartle 1995; Antonioni 1994). Accordingly, there was more emphasis on the processes of performance generation and the strategic contributions of performance when defining performance. Nowadays, new definitions of performance are still emerging. These consider dual or triple dimensions in output, process and strategic achievement (Bentes et al. 2012; Wildman et al. 2011; Cedergren, Wall and Norström 2010; Henri 2010).

Similar to the definitions of performance, the development of PM also occurred in several stages. The modern meaning of PM arose from the business domain of the United States in the 1960s against the problematic theories of traditional performance measurement (Folan and Browne 2005; Amaratunga and Baldry 2002; Kaplan and Norton 2001). With rapid changes in the business environment and managerial ideas in the 1960s, an increasing number of scholars and practitioners realized that traditional performance measurement could lead organisations to be near-sighted, unsustainable, and even experience strategic failure (Amaratunga and Baldry 2002). Accordingly, the PM theories came to be more comprehensive by bringing more operational and managerial factors and elements into the PM process. Meanwhile, the traditional performance measurement encompassed the overall framework of PM, and only to be viewed as an important step in the PM process (Folan and Browne 2005).

In the early stages of PM research, the influence of traditional performance measurement was still very significant, as reflected in the output-oriented perspectives of the PM frameworks of this stage (Kaplan and Norton 2001). The PM frameworks reported by MacLean (1976), Otley (1980), and Spicer and Ballew (1983) represent the PM research in this phase when the primary pursuit was still profit maximisation. In the mid-1980s, more elements that reflect the operational and strategic characteristics of organisations, such as operational efficiency, customer satisfaction, and sustainable development, were incorporated into the PM frameworks. Distinct from the frameworks of the past that overemphasized outputs, these evolved parameters pursued a balance between financial and non-financial elements in the performance management system (PMS). The balanced scorecard (BSC) (Kaplan and Norton 1995; Kaplan and Norton 1996), performance prism (Neely, Adams and Crowe 2001; Neely, Adams and Kennerley 2002), and the frameworks developed by Otley (1999) are examples of PM research in this phase.

In the 21st century, with the development of globalisation and informatisation, the elements of communication and stakeholders have been deemed as the keystones in PM research, and they have been documented by fruitful PM studies (Armstrong and Baron 2005; Perrini and Tencati 2006; Moullin 2009).

Although the extant PM literature has covered most, if not all, of the industrial background and managerial context of organisations, some issues and shortcomings still exist in the PM research and its implementation. For example, most existing PM frameworks rely significantly on an organisation's current organisational chart and business process and thus are problematic in their application to organisations that are in need of organisational reengineering (Song 2016; Yang and Hsieh 2007). Moreover, a majority of existing PM frameworks are designed for larger organisations, so it is very challenging to develop a PMS for small-sized and fast-changing enterprises (Lu 2016; Tiwari and Saxena 2012). Meanwhile, building up a PMS and implementing it effectively is still very demanding work for organisations with highly complex and professionalized segments, such as R&D units (Roman 1964; Chiesa et al. 2007).

These pressing issues in today's PM domain can be largely categorized into two main PM challenges, as outlined below:

The first is reflected in the PM dilemma of SMEs. Most of the existing PM frameworks focus on mechanistic organisations of significant size, whose features can be described as "*centralized control systems, specialized and formalized work, simple coordination mechanisms, and attention directing to problem areas*" (Chenhall 2003, p.184). However, SMEs, which comprise 99 percent of business in the United Kingdom (Rhodes and Ward 2014) and 94.15 percent in China (National Bureau of Statistics of China 2015), benefit little from the extant PM research. One characteristic of SMEs (at least in China) is the frequent changes of organisational charts (will be further discussed in Chapter 2). Thus, a pressing issue is how to implement PM in organisations with frequently adjusted organisational charts effectively. The existing PM frameworks implement PMSs directly based on the current organisation charts, and frequent adjustments in the charts cause significant additional work and confusion in the PM process.

The second PM challenge is combining PM with business and management process innovations. Even for an organisation with simple operating cores, current PM frameworks provide little guidance on how to introduce innovations during PMS building up and management. This issue further causes difficulties in managing performance in complex operating cores. This is exemplified by the challenges of carrying out PM in an R&D unit, where suitable operating processes are among the keys in deriving performance of the unit.

Based on the research background above, it can be pointed out that existing PM frameworks are not built around an organisation's performance generation processes and therefore may not be able to handle many issues, including those outlined above effectively. Furthermore, we believe the above issues are quite typical and should be dealt with in the level of PM framework. Consequently, there is a need to develop an effective PM approach that can enhance the performance of both simple and complex operating cores by providing a mechanism for introducing innovation in its performance generation processes through PM.

Thus, our overall objectives are to develop a PM framework that is built around performance generation and has mechanisms to address the above issues. Meanwhile, we will also put efforts on developing practical approaches within the framework that can effectively deal with these issues in real business cases.

1.2 Research questions and objectives

This study is driven by four basic research questions:

The first question is "**what is the typological overview of the current state of PM frameworks? (RQ1)**". It is well known that the existing PM frameworks are developed from multiple perspectives, and none of them has been accepted by scholars and practitioners universally (see Chapter 2). Therefore, a literature-based typology study of current PM frameworks is a precondition of this thesis, since it will require categorizing and comparing the frameworks in detail before presenting an overview.

The second question is "**What PM framework can be developed around performance generation processes and also contains mechanisms to accommodate different approaches for a wide range of organisations seeking to handle the pressing issues discussed above? (RQ2)**". Accordingly, we will develop an innovative PM framework focusing on performance generation processes, and therefore with broad applications across organisations and rich approaches for operating cores with various complexities.

To supplement the new framework, we wish to further develop approaches to address some of the pressing issues flagged above. Accordingly, the third and fourth research questions are about the two significant challenges in the extant PM research:

"**What further approaches can be developed within the new framework to effectively handle implementation of PM for at least some Chinese small- and medium-size manufacturers with frequent changing organisational charts, as tested by case studies? (RQ3)**".

"**What effective approaches and methods can be developed to enhance performance by introducing innovations in a PM setting within the new PM framework, at least for Chinese small- and medium-size manufacturers and R&D units, as tested by case studies (RQ4)".**

Although, above two research questions were raised against the operational and managerial context of Chinese enterprises, the light will be also shed on the western SMEs and R&D units. Since some PM issues and challenges, such as effective PM in SMEs and R&D units, perplex both Chinese and western enterprises in different extents. Therefore, even the approaches proposed in this research could not be employed by the western enterprises directly, the PT framework and its accommodated tools can help the western enterprises to develop a tailored approach to relax the tensions in their PM implementations.

1.3 Research scope

The basic research scope of this thesis is the new PM framework and approaches for solving the two main challenges in the existing PM domain (mentioned above and details see Chapter 2). Accordingly, for the theoretical research section of this thesis, the beneficial studies documented on the topics of these challenges will be covered. Moreover, for the empirical section, the limitations are the internal and external operations of the companies in the case studies. Here, the companies' operations include both the physical process and the relationships among their stakeholders.

1.4 Research paradigm and methodology

This research is mainly carried out under a critical paradigm since we believe that the realities are socially constructed under constant internal and external influences. Meanwhile, on the epistemological level, the reality and knowledge of this research are constantly influenced by power relations from within society. Moreover, some typical methods of the critical paradigm are employed in this research, such as the theory of critical realism and action research.

The theory of critical realism (CR) was raised in the mid-1970s as an echo to the repudiations from the antirealists since even the most determined realists found that it was increasingly difficult to keep a traditional realism standpoint at that time (Patomäki and Wight 2000; Danermark, Ekstrom and Jakobsen 2001). Therefore, in the CR theory, reality was not viewed as unchangeable entity ontologically anymore, and new mechanisms were brought into the theory to relax the tension between subjective and objective entities (Collier 1994). For example, under this re-established realist standpoint, words can be written by people with subjectivity, but they become intransitive once they are written down, and hence, they can be disseminated or kept across countries and eras with objectivity. In addition, most of the criticisms from positivists have been accepted and absorbed in the CR theory (Collier 1994), accordingly, a new naturalism system that classifies reality into layers is attached in the CR (Niiniluoto 1999; Collier 1994). Moreover, the explanatory critique was adopted into the CR theory system as the main methodology to adhesive the gap between facts and corresponding values (Collier 1994). The last innovation in the CR theory is that the reality has been distinguished in layers, which are layer of real, layer of actual, and layer of empirical (Collier 1994; Archer et al. 2013).

In this thesis, we mainly employ the idea of three-layer reality to guide our research, so knowledge about this part will be elaborated with more details in Section 4.1.

1.5 Research Contribution

There are four main contributions in this research:

1) A comprehensive literature research is conducted in this thesis, in which, the existing PM frameworks are categorized by their inherent characteristics and features to shed light on their advantages and limitations in PM implementation. Furthermore, a significant research gap is pointed out that the existing PM frameworks largely ignored the procedures of performance generation which could lead organisations to be near-sighted, unsustainable, and even experience strategic failure.

2) An innovative PM framework, namely as the Performance Tree framework, is developed in this thesis. Different from the dependence of organisational chart or business and management procedures in most existing PM frameworks, the PT framework adopts a performance-based perspective to explain performance generation and management processes and, further, to guide PM implementation in a wide range of organisations. Meanwhile, the concrete implemental details can be included in the PT framework by developing specified approaches for organisations with different characteristics and managerial needs, such as SMEs and R&D units.

3) An implemental approach for classic Chinese manufacturer SMEs under the PT framework is developed in the research. Comparing with the existing

PM approaches, the new one fully considers the managerial and operational characteristics of SMEs, such as fast-changing organisational chart and high demand for organisational adjustments. Additionally, based on the feedback of its application in a Chinese manufacturing SME, the new approach can guide these SMEs to optimize or build up their PMS with acceptable time and costs.

4) An implemental approach for R&D units of classic Chinese manufacturer SMEs under the PT framework is developed in the research. This new approach relieves the dilemma of R&D PM by applying the knowledge of R&D management in combined with PM. Therefore, the PT built up under the guidance of this approach consider both the operational characteristics and PM needs of R&D units. Furthermore, a purposefully designed R&D performance monitoring system is accommodated in the approach to help managers to measure and monitor the performance of R&D staff.

1.6 Thesis structure

The layout of this thesis is presented in Figure 1-1. There are five main parts: introduction, literature review, theoretical contribution, empirical research, and results and conclusions.

The first chapter addresses background information, and introduces the objectives, paradigm, methodology, scope, and structure of the thesis.

Chapter two presents a literature review of the general situation, state of the art examples, and main challenges in the PM domain. Studies documented on PM for SMEs (one of the two challenges identified in the literature review) are also reviewed at the end of this chapter.

Chapter three reviews the literature on the second identified challenge of PM; the operation of PM in R&D units. This chapter starts with basic definitions, followed by the development of R&D management frameworks, and then types of R&D structures. Articles about the competency model are reviewed at the end of the chapter as an effective tool to measure and manage the performance of individual R&D staff.

Chapter four provides a brief introduction to the methods employed in this thesis; the soft system methodology, principal component analysis, and evidential reasoning rule are three main qualitative and quantitative methods applied this research.

Chapter five is the theoretical contribution of this thesis, in which an innovative PM framework is introduced. Details about the structure of the performance tree (PT) framework and the corresponding organisational analysis tool (performance map tool) can be found in this chapter.

Chapter six presents the application of the PT framework in a typical Chinese SME. This case harks back to the first PM challenge by presenting the capability of the PT framework in assisting a Chinese SMEs to carry out flexible and effective PM.

Chapter seven introduces a sub-framework of the PT for an R&D unit, due to the highly complex and professional nature of R&D PM.

Chapter eight shows the PT sub-framework is applied in a Chinese R&D unit to improve its PM operations and show the capacity of the PT framework in solving the second challenge of PM.

Chapter nine includes the findings and conclusions of the thesis. Some future research outlooks are also addressed at the end of the chapter.

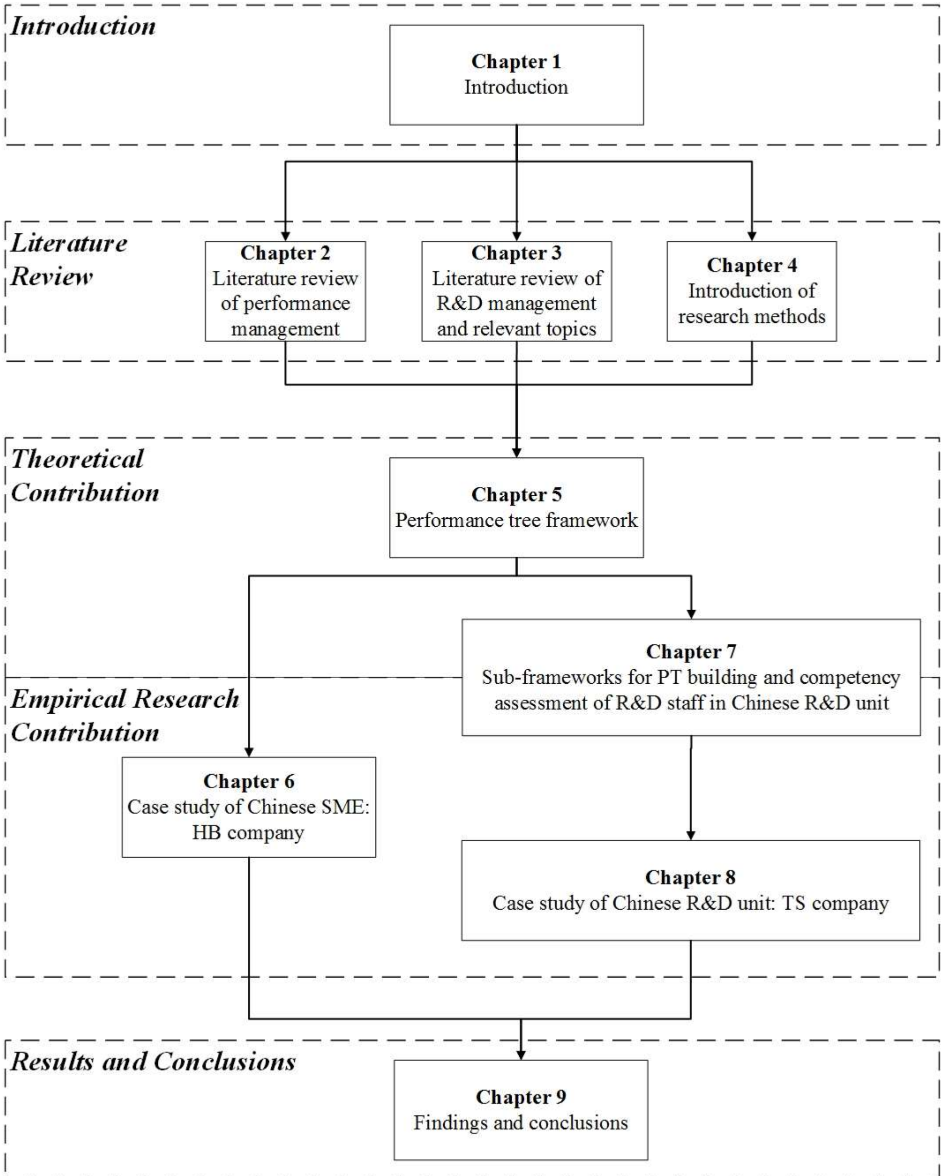


Figure 1-1 Thesis structure

Chapter 2 Literature Review of Performance Management

A comprehensive typological literature review will be conducted in this chapter. We are going to begin with reviewing types of efforts on defining the concepts of performance and performance management (PM). Next, a number of existing PM frameworks will be discussed along with their characteristics and features to identify the significant research gaps in the current PM domain. Furthermore, some fundamental elements existed in the existing PM frameworks universally will be extracted and analysed as the foundation of the new PM framework put forward in this thesis. In the end, we are going to focus on the PM of SMEs, which is a theory preparing for the case study in Chapter 6.

2.1 Definition of performance

A vast amount of literature exists that attempts to define the concept of performance from multiple aspects, such as accounting, operation, and even behavioural science (Li 2010). In this research, focus is placed on definitions in the business realm that explain the concept in managerial contexts.

Although performance-related topics have drawn much attention since prior decades, performance has not yet been well defined as an academic concept. Some scholars point out that many disagreements exist regarding the core contents of the performance concept (Li 2010; Fitzgerald et al. 1991; Moon and Fitzgerald 1996). Fitzgerald and Moon (1996) state that the performance concept is constructed multidimensionally, and hence, the elements in this concept are complex and ambiguous, which are the main causes of the disagreements.

Despite that the controversy about the nature of performance exists as a whole; some consensus can be achieved in the business management domain. Generally speaking, the scholars in this field attempt to understand and explain the concept of performance from three angles solely or combined.

An organisation's output is the most widely-adopted angle to define the concept of performance. As Rogers (1994) states, the organisation's output contributes the most to the accomplishment of its strategies and operation targets. Law et al. (1996) defines organisational and individual performance in an organisation as the output of the transaction of the person, environment, and occupation. In an empirical research conducted by Lumpkin and Dess (1996), organisational performance is stated as an output variable of the corporations. Similarly, Faulk II (2002) and de Waal (2003) also define the concept of performance from the dimension of outputs. However, they move forward a single step by indicating how and where the outputs originate, which are 'organisational and human activities' and 'job duties'.

However, the inadequacy of output-oriented performance definitions is also argued by many authors. Campbell (1990) points out that the behaviour dimension should be included in performance, since sometimes the outputs are uncontrollable for an organisation due to the existence of systematic risks. Mwita (2000) further clarifies Campbell's (1990, p.187) point and states that "what is implied in Campbell's argument is that performance measurement can only focus on an individual/group's final output, if and only if, system factors are controllable."

The action (or behaviour) is the second important dimension to define performance, which is more controllable in an organisation comparing with unstable outputs. Lebas (1995) emphasise that a comprehensive performance concept should contain two parts -- outcomes led by organisational objectives and successful implementation of actions to achieve the objectives. Otley (1999) points out that an organisation's performance consists of results achieved, and corresponding works attribute to them. Ermolayev and Matzke (2007) give a clear definition that the "performance is intentional action", which indicates the actions within an organisation should be guided by strategy-leading intentions.

Since the outputs in performance concepts always refer to short-term outcomes, such as finance results or productivities, some authors remind that the long-term effects should also be considered properly. Mwita (2000, p.22) defines performance as "… embracing three interrelated variables: behaviours (processes), outputs, and outcomes (value added or impact)." Moreover, some scholars imply the role of long-term impacts in performance by referring concepts of sustainable competitiveness (Balkyte and Tvaronavičiene 2010; Wagner and Schaltegger 2003) and sustainable development (López, Garcia and Rodriguez 2007; Davidson 1996).

Performance can be defined by dimensions of output, action, and impact, solely or combined. Overemphasizing a single dimension may lead to serious operation issues, such as strategy myopia (overemphasized short-term output) or global inefficiency (overemphasized local actions). Therefore, in this study, the definition conducted by Mwita (2000) is adopted, as it properly weighs the three basic dimensions.

2.2 Definitions of performance management

Due to the reason stated in the former section, no definition is accepted for the subject of PM universality. In this literature review, we will discuss some prevalent concepts contributing to the following research in line with our research interests.

Generally speaking, most existing definitions for PM can be characterized into two categories: abstract and concrete. Abstract definitions explain PM through summarizing its key characteristics or elements. Concrete definitions clarify the contents of PM by listing its logical or practical steps. In some cases, the special definition of PM is also a brief PM framework.

2.2.1 Abstract definition

Daniels (1989) proposes that the PM model can be defined within the context of private sector organisations as, a systematic, data-oriented approach to managing people at work that relies on positive reinforcement as the major way of optimizing performance. Similarly, some studies support the idea that PM should help organisations accomplish their strategic objectives through improving individual and organisational performance implementations (Nanni, Dixon and Vollmann 1992; Armstrong and Baron 1998).

Simons (2000) summarizes three elements in a well-running PMS. They are: (1) formal, (2) information-based routines, managerial procedures, and (3) maintain or alter patterns in organisational activities. This idea is supported in Rogers (1990), in which, the PMS is described as a cascade pouring through the entire organisation to link individuals of the organisation and overall strategies. Smith (2002, p.105) states that a similar idea was used in the National Health Service (NHS) PMS: "performance management in the NHS can be defined as a set of managerial instruments designed to secure optimal performance of the health care system over time, in line with policy objectives."

2.2.2 Concrete definition

Pollitt (1999) identifies four key elements in defining the concept of PM under a special context, which are

- Setting performance objectives in line with strategies
- Assigning responsibilities in an organisation through its organisational chart
- Measuring performance with methods, metrics, and standards agreed
- Feedback measurement results to their generators (or line managers)

Mwita (2000) lists several critical components contributing to a successful PMS. The clarification of organisational and individual performance objectives is the system's initial requirement, and then, the planning and linking works are needed to convert the objectives into an implemental approach of the organisation. Accordingly, the training and assessing steps are followed to ensure all objectives are equipped with capable human resources working through the approaches. Last but not least, some internal and external communications are fairly crucial in the performance accomplishing processes. For instance, HR managers should communicate with staff through performance agreements or contracts; line managers need to communicate with subordinates through performance meetings or feedback.

Lebas (1995) defines a well-functioning PMS in the same view but focusing on different elements, which are: training, teamwork, dialogue, management style, attitudes, shared vision, employee involvement, multi-competence, incentives, and rewards.

McNamara (1997) also summarizes indispensable elements for a comprehensive PMS, as follows.

- Setting goals
- Monitoring employees' achievement of those goals
- Sharing feedback with employees
- Evaluating employees' performance
- Rewarding performance or firing employees

Here, we only list some special definitions for the concept of PM with wide influences. In fact, numerous definitions with different performance factors or elements can be found in the existing research (Lansbury 1988; Chappelet and Bayle 2005; Bouckaert and Halligan 2007; Moynihan 2008; Ates et al. 2013).

Comparing with the abstract definitions, the concrete ones supply more details about the practice of PM. Some of the special definitions may be viewed as sort of the PM frameworks already, since there are so many implemental details in them. Comparing with the general ones, the scopes of application are narrower for the definitions under this category.

2.3 Performance management frameworks

Scholars have been putting forth enormous effort on accumulating literature that is relevant to PM. Due to the complex and interdisciplinary natures of performance-related topics, the literature has been documented not only from the corporation management discipline but also the fields of management science, economics, accounting, human resource management (HRM), and strategy management.

Studies in different areas summarize the PM literature from various perspectives. For instance, management science literature focuses on the performance appraisal and evaluation aspects; HRM scholars' interests are in the relationship between staffs' psychological factors and their performance; studies with an accounting background emphasize how to attribute organisational performance to financial indicators.

Facing up to a mass of literature and various perspectives, it seems tough to exhaust all of them in this study. Therefore, the focus of this dissertation will be concentrated on the well-known PM frameworks that are both in line with our research interests and contribute to the research below.

Based on the general characteristics of the current PM frameworks, two categories are drawn from them. The first category is the generic and versatile PM frameworks for most organisations, without referencing special organisational structures, managerial features, or industrial features. While, the second category is PM frameworks addressing special organisational or managerial contexts, such as those for public sectors, manufacturing corporations, and high-tech companies, etc.

2.3.1 General PM frameworks

General PM frameworks shed light on the steps or procedures of carrying out PM in various types of organisations. This category of frameworks contains either multiple theoretical elements or practical guidance about PM.

In general, depending on the frameworks' starting points, this category of the PM frameworks can be further divided into two sub-types. The starting points of the general PM frameworks are either a company's objectives and strategies (e.g., BSC, Otley, etc.) or a benchmark of a group of references (e.g., EFQM). The PM frameworks starting from objectives and strategies are usually designed to set up a PMS in a particular firm, while benchmark type of PM frameworks mainly aim to diagnose and optimize an existing PMS in an organisation.

2.3.1.1 PM frameworks starting from objectives and strategies

Sink and Tuttle (1989) propose a PM framework containing a list of major performance aspects in achieving an organisation's top strategies and objectives, as outlined in Figure 2-1. The authors emphasize that the seven performance aspects are interrelated with each other in practice; however, the details below of how to manage and process these interrelationships are not elaborated upon in this research.

1) Effectiveness, which involves "doing the right things, at the right time, with the right quality";

2) Efficiency, which simply means "doing things right";

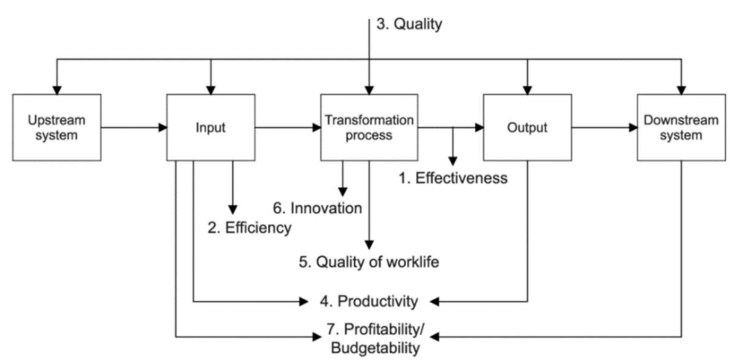
3) Quality, to make the term more tangible; quality is measured at six checkpoints;

4) Productivity, ratio of output to input;

5) Quality of work life, which is an essential contribution to a system which performs well;

6) Innovation, which is a key element in sustaining and improving performance;

7) Profitability/budget ability, which represents the ultimate goal for any organisation.



Source: *Sink and Tuttle (1989)*

Figure 2-1 Seven performance criteria model

Another classic PM framework in early PM research is the PMS model raised by the United States Office of Personnel Management (United States Office of

Personnel Management 2017). In this framework, five key stages of the PM are stated and the strategic elements are embodied in stage one (planning and setting expectations).

1) Planning work and setting expectations;
2) Continually monitoring performance;
3) Developing the capacity to perform;
4) Periodically rating performance in a summary fashion;
5) Rewarding good performance.

Nowadays, this framework only expresses some common sense of PM but, at that time, the significance of the PMS framework is reminding users to view PM as a comprehensive system instead of a single measurement.

Different from the above frameworks designed from the practical elements, some scholars also project PM frameworks through the theoretical perspective of "ideal type" rationalities in the PMS (Broadbent and Laughlin 2009).

1) Underlying rationalities description;
2) Ends defined derived using;
3) Performance indicators (PIs) derived using;
4) Choice of means to use to achieve the objectives and PIs using;
5) Probability of different stakeholders owning ends and means;
6) Underlying authority structure.

This highly conceptual PM framework exhausts most of the possible elements in a PMS, and hence, guides the managers to hold a comprehensive view in building up a PMS. However, the ambiguousness also goes with the abstraction in this framework; some points can be understood in multiple ways in a special managerial context (for instance, the 'rationalities description' in point one can be an explicit strategy statement or blurred strategic preferences, which require completely different actions in management practices).

Otley (1999) proposes a framework consisting of five core issues in constructing a well-running performance control system for an organisation, by raising five questions. The issues are structured in a loop, which includes the elements of objectives, strategies, target-setting, incentive and reward structures, and information feedback.

The first and second questions are about the top design of the performance control system, which require the users to think through what are the orientations and purposes of their system, and the rest of the procedures largely depend on the answers to these two initial questions. Then, the top objectives decided in the steps before should be deployed into organisational and departmental levels. Accordingly, more specified performance targets need to be decomposed for each functional segment of the organisation. The last two questions are about implementation of the system, which focus on issues of rewarding and communication, respectively.

This framework clarifies several important aspects in a comprehensive performance control system; however, the implementation details are left to the users to finalize. To further improve the framework capability in guiding the PM implementation, an evolved framework consisting of twelve questions are reported in Ferreira and Otley (2009) (see Figure 2-2).

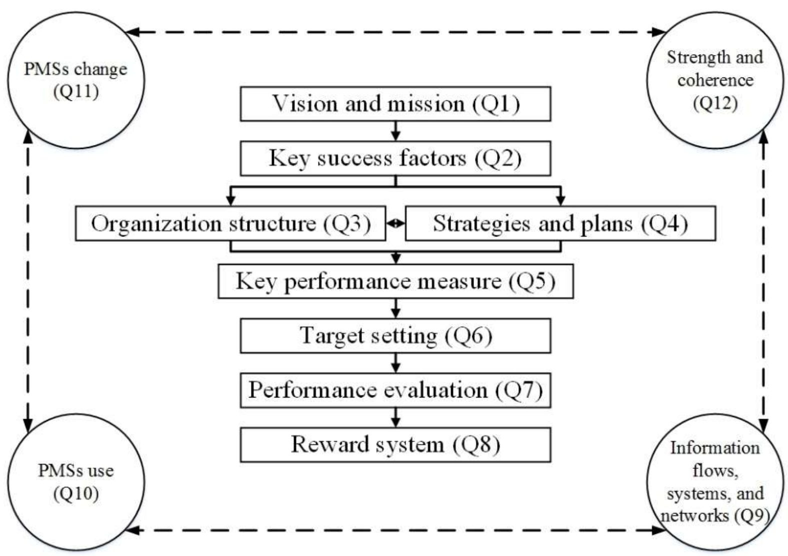
Meanwhile, the name of the new framework is also changed from a 'performance control system' to a 'PMS', which indicates that more managerial details were added to the framework, such as organisational chart, HRM procedures, performance measurements, etc.

Different from the original framework starting from asking about an organisation's objectives, the new framework adds more steps to guide the users to develop their top target gradually. Vision and mission are the starting points of PM, since they orientate all of an organisation's operational and managerial elements. Then, in steps 2 and 3, it further leads the users to make the top objectives explicit by considering local managerial needs and constraints. Finally, in the fourth step, the top strategies and objectives need to be stated clearly to guide the following steps.

Steps 5 to 7 direct the organisation further by deploying` measurements against the strategies and objectives. In the processes, the framework asks its users to clarify the role of the performance measurement system in the whole operation. Then, the users should position the measurement system on a proper level of the overall operations, which can be individual-based or departmentally-oriented. Furthermore, the implemental details should be addressed in the system to make the questions regarding ‘How to do it’, ‘Who does it’, and ‘When to do it’ explicit.

The next several questions (8–10) focus on follow-up procedures of the measurements, such as performance incentive, feedback, and improvement. In these steps, the information generated from the performance measurement are re-input into the management cycle to further improve the operation flows.

The last two steps (11–12) make the procedures a close cycle, since the possibility of improvement of the entire system is considered here. It should be emphasized that the needs for changes in organisational structure are evaluated at the last step, which indicates an important idea from the author – the PMS is tightly attached on the organisational chart; organisational structure changes are needed if the users want to improve their operational performance substantially.



Source: *Ferreira and Otley (2009)*

Figure 2-2 PMS framework developed by Ferreira and Otley

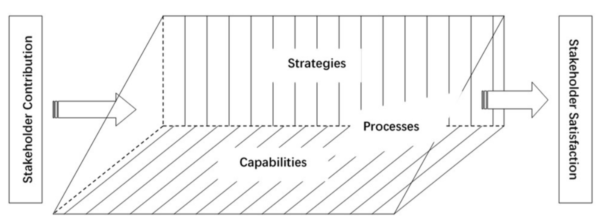
A PM framework designed from a perspective of management science is raised by Smith and Goddard (2002), and they further prove that at least four function blocks are indispensable in a PMS, which are as follows:

- Formulation of strategy;
  - Performance measurement instruments;
  - Analytic techniques;
  - Encouraging appropriate organisational responses.

Similar to the frameworks above, this one also begins with the strategic issues. However, the characteristics of this framework are worth mentioning the role of the analytic techniques in PM processes.

The performance prism is another widely adopted PM framework, which consists of five basic perspectives that need to be considered in PM practices (see Figure 2-3).

Stakeholder contribution holds the input end of the framework, since all organisations are run by the types of resources invested from the stakeholders. Then, the perspectives of strategies, processes, and capacities consist of the course of PM because these three elements convert all input resources into the desired output. Stakeholder satisfaction is placed at the end of the PM processes, again, since it is the universal mission of organisations (Neely, Adams and Kennerley 2002; Kennerley and Neely 2002).



Source: Neely, Adams and Kennerley (2002)

Figure 2-3 Performance prism model

The details of the performance prism framework are also presented by several questions in self-evaluation style, for instance, the needs and expectations of stakeholders are necessary for identifying their satisfaction; key operation procedures should be located in defining organisational processes.

- Stakeholder Satisfaction: who the key stakeholders are and what are their needs or expectations;
- Strategies: what strategies the organisation should adopt to satisfy key stakeholders;
- Processes: what critical processes the organisation need to undertake according to organisational strategies;
- Capabilities: what capabilities the organisation needs to cultivate staff to enhance processes;
- Stakeholder Contribution: what contributions the organisation requires from the stakeholders.

Thekdi and Aven (2016) reported a general PM framework integrating operational risk control concerns.

- Increased performance (shown through metrics/indicators or interpreted as judged increased performance);
- Meeting economic objectives/targets/requirements;
- Meeting economic and socio-economic objectives/targets/requirements;
- Meeting economic and sustainability objectives/targets/requirements;
- Being in line with management by objectives (MBOs) regime;
- Being in line with total quality management perspectives.

The performance pyramid (see Figure 2-4) is another PM framework widely used in enterprises, which mainly aims to create linkage among levels of factors attributing to performance generation, and hence, to ensure the achievement of organisational performance objectives (Lynch and Cross 1992).

Under the guidance of the performance pyramid framework, an organisation's performance objectives are structured in a top–down manner—confirm the top strategies and objectives first and then decompose them layerwise. However, the above sequence is reversed in PM implementation, which means performance measurement and improvement actions are carried out in a bottom-up way—the lower objectives support the upper objectives, continually until reaching the top level objectives.

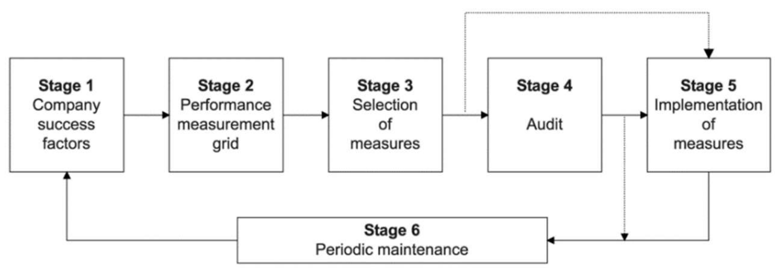
In this framework, users need to pay attention to four hierarchies of the performance targets, which are (1) business units, (2) business operation system, (3) departments and work centres, and (4) operations. Accordingly, the building-up of works of the performance pyramid start from clarifying an organisation's mission and vision and decomposing them into each functional segment (i.e., departments, divisions, units, and job positions) to form local performance objectives. In the next level, all business units of the organisation should refine their performance targets into short-term targets (usually related to cash-flow and profitability) and long-term targets (generally related with competitiveness and market position). The business operating system links the objectives and operational measurements together through generating performance with quality and quantity matching with the requirements of the performance objectives. On the last layer, the indicators are extracted against four key dimensions (i.e., quality, delivery, cycle time, waste) in performance measurement to carry out performance monitoring and appraisal.

Source: *Lynch and Cross (1992)*

Figure 2-4 Performance pyramid framework

Some studies document the advantages of the performance pyramid framework regarding its comprehensiveness and logic connections in performance indicators (Abran and Buglione 2003; Neely et al. 2000) (Figure 2-5). On the other hand, the lack of a way to identify key performance indicators from the general ones is one of the main issues of the framework (Anderson and McAdam 2004).

Medori and Steeple (2000) proposed a framework with six logic steps, which takes the auditing factor into PM (see Figure 2-5). The strategic factors of an organisation need to be summarized and clarified in the first step, and then, a "performance measurement grid" is asked to be constructed in the second step according to the strategic factors and competitive priorities (quality, cost, flexibility, time, delivery and future growth) in the operations. In the next two steps (Step 3 and 4), new measurement metrics and indicators should be extracted based on the grid contents. Next, the current PMS should be audited considering new metrics and indicators to finalize the new system. Finally, the new system will be implemented and maintained periodically to ensure it fits with the organisation's latest strategies and operations (Step 5 and 6).



Source: *Medori and Steeple (2000)*

Figure 2-5 PM model with considering auditing factor

In summary, the PM frameworks introduced above are designed for multiple types of organisations without considering their special industrial or managerial contexts. Moreover, all of them begin from developing or clarifying top objectives (i.e., mission, vision, strategy, or performance targets), and then deploying them layerwise to form local performance targets to guide core business process operations.

2.3.1.2 PM frameworks starting from external standards

Different from the PM frameworks aiming to guide organisations to carry out a comprehensive PM implementation or build up a PMS, some frameworks are designed for performance diagnosing or benchmarking purposes, which usually do not orient on the strategies or objectives of a special organisation.

The European Foundation for Quality Management Excellence Model (EFQM) framework is a non-prescriptive framework designed to assist companies carrying out self-assessment and self-diagnosis and further improve their management systems and performance. In practice, the EFQM framework is usually adopted benchmarks to set assessment and diagnosis standards.

The framework consists of nine key criteria and 32 sub-indicators corresponding with each criterion. The dimension of performance is placed at the end of the framework, which is viewed as a logical result of the good operations above.

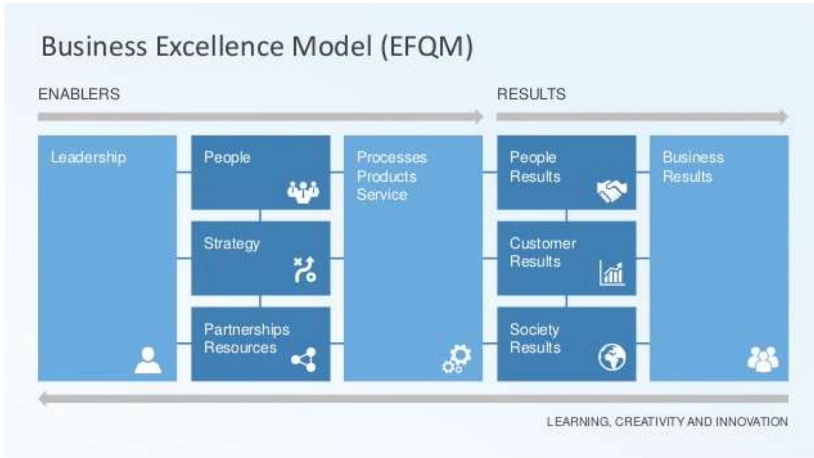
The EFQM framework mainly focuses on the performance from a financial aspect, which of the profit, budget control, and finical health are the key embodiments.

The nine key criteria are grouped into two categories. The “Enablers” category of the criteria (***leadership, people, policy and strategy, partnerships and resources, and processes***) includes operational and managerial elements that can be viewed as inputs for a well-running business. Furthermore, the “Results” category consists of expected outcomes (***people results, customer results, society results and key performance results***) as a consequence of the sound operation and management above. As what has been stated in Bou-Llusar et al. (2009), the ‘Enablers’ criteria examines what the organisation does, and the ‘Results’ represent what the organisation achieves.

Detailed relationships among the criteria of the EFQM framework can be found in Figure 2-6.

Some assessment and evaluation methods are also proposed to be applied with the EFQM framework. The PDCA (Plan, Do, Check, Action) method is a five-step assessment method that helps organisations to carry out the self-assessment and benchmarking steps properly. The RADAR (Results, Approach, Deploy, Assessment and Review) kit is a more comprehensive method for implementing the EFQM framework, and the idea of the cycle of Deming is reflected in the method (Barandika et al. 2013).

The EFQM framework presents a universal best-practice for organisations to carry out general and PM. It needs the users to set objectives and operational plans through integrated approaches to ensure them being deployed in a comprehensive way. Furthermore, the organisations are asked to compare their operational results with benchmarks and then to explore possible actions to improve the performance.



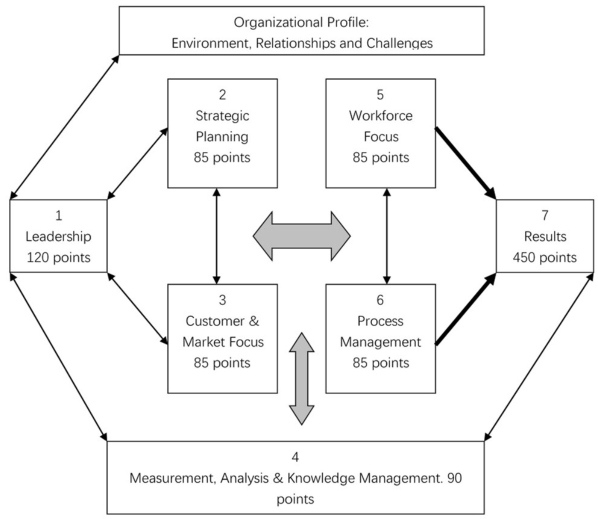
Source:*https://www.linkedin.com/pulse/developing-model-sustainable-growth-tourism-patrick-quinn*

Figure 2-6 Business excellence model (EFQM)

The best-practice logic and benchmarking methods are also adopted by a similar performance framework initiated in the US—Malcolm Baldrige National Quality Award framework (MBNQA) created by U.S. Commerce Department. In the MBNQA framework, the 1,000 points are assigned to seven key criteria linking with each other by a modelised logic of best-practice (Li 2010) (Figure 2-7).

The starting point of the MBNQA framework is the factor of leadership, and then, leadership leads to well-planned strategy and market positioning. Furthermore, all top objectives of the guide of operational steps (5 and 6), and thence to good operational results. What is more, the profit factor is placed at the upper part of the model as a leading target for businesses, as well, the measurement step runs through all the above managerial and operational steps to ensure that performance yields match the top objectives.

The soft system methodology (SSM) is a method that is usually applied to construct a non-perspective PM framework (Liu et al. 2010; Dulaimi, Khalfan and McDermott 2006; Morcos and Henshaw 2009). The SSM could bring innovative factors into the processes of strategy decomposition and job deployment since it does not need to rely on the formed organisational factors of a firm. Therefore, innovations for business procedures come to be possible in this framework through asking some fundamental questions to the multiple stakeholders of a business, such as regarding *what to do*, *how to do it* and *who is to do it*.



Source: *Li (2010)*

Figure 2-7 Malcolm-Baldrige Quality Award Framework

On account of wide scope of stakeholders are involved in the process, thus the conclusions and suggestions formed through SSM are usually feasible and innovative. However, there are some preconditions to apply SSM to an organisation, such as the modellers should be rich in application experience, and also, the users must hold a critical view to the results generated by SSM since they can be unrealistic or infeasible sometimes (Wang, Liu and Mingers 2015; Mingers, Liu and Meng 2009). The details of this approach will be discussed elaborately in the chapter below.

Comparing with the frameworks starting from a clear and special strategy, the non-prescriptive frameworks (EFQM and MBNQA) contain more details to help organisations carry out self-assessment based managerial and operational diagnoses. However, these PM frameworks are designed with fixed logic, so they can add very limited innovative factors to the companies. Meanwhile, they assume a complete PMS exists in the organisation already; therefore, they cannot assist users to build up a new system from zero.

2.3.2 Special PM framework

These frameworks offer quite detailed instructions towards implementation in special organisations. Since differentiations of PM practices exist in various types of organisations, applicable scopes of the frameworks are narrowed. For example, some of them are designed for the public sectors and some are for classic manufacturing corporations.

Vukšić, Bach, and Popovič (2013) report a PM framework for organisations with relatively clear business processes. The authors highly emphasized the role of the business intelligence system in these organisations and designed a checklist to guide the performance practice. This checklist is presented in Table 2-1.

Table 2-1 Checklist of business process based PM framework

Process Management and Measurement	
Level of process performance measurement:	Process measures are defined and documented for each process.
	Performance targets are in line with process goal.
	Performance indicators are communicated on a regular basis within the organisation.
	Performance measures are used by management.
	Business processes are continuously analysed and managed using the historical data.
Dynamics of process performance measurement:	Business processes are measured "ad-hoc" when a BPM project is conducted.
	Business processes are measured, analysed and managed continuously, based on real-time data.
Influence of performance management on firm management:	Performance results are used for business process improvement or reengineering.
	Performance results are used in setting of improvement targets.
	Performance results are used in decision making on a daily basis (based on operational data).
	Performance results are used by top management for tactical and strategic decision making.

	Performance results (of processes) influence employees' salaries.
BI Management and Measurement	
Focuses of BI in the firms	Marketing Customers Sales Risk management Profitability Asset and cost management Strategy and process management
Organisation of BI within firms	Dedicated organisational unit Part of wider organisational unit
Dynamics of BI analytics	Ad hoc usage Analytical processes are fully embedded and integrated
How would you characterize use of BI inside the firm?	Running the business Measuring and monitoring Integrated performance management Fostering business innovation and people productivity Creating strategic agility and differentiation
Relationship between BPM and BI:	Does BPM give data as input for BI? Are BI and BMP separately treated? Separate governance structure for BPM resp. BI Are BPM and BI managers or specialists discussing topics together (regularly)?
Impact of BI to BPM aspects:	BI exposes the problematic aspects of current BP BI provides input for assessing BP against standards and for continuous process improvement BI system provides input for BP redesign projects

BI is used to measure, analyse and manage business processes and the following functions are used:	Data Warehouse and OLAP Dashboards Analytical tools Optimisation tools Data about process performance is extracted from transaction/operational IS (ERP). Data about business processes is collected manually (based on activity duration measurement and interviews with employees)

Source: *Vukšić, Bach and Popovič (2013)*

Kucukaltan, Irani and Aktas (2016) designed a performance evaluation and management system for the logistic industries based on the perspectives of the BSC methods. In this framework, the authors analyse and raise key performance aspects and indicators highly crucial in the logistic industry. Moreover, a performance indicator list is attached in the literature (see Table 2-2) to guide the organisations to apply the framework.

Table 2-2 BSC based PM framework for logistic industries

Performance Indicators
Financial Perspective · Cost · Profitability · Sales growth · Equity ratio · Return on investments · Cash flow · Revenue growth · Accounts receivable turnover · Market share · Interest coverage ratio

Learning and Growth Perspective

- IT Infrastructure
- Managerial skills
- Educated employee
- Social media usage for brand building
- Past performance
- Willingness for information sharing
- Order entry methods
- Relationships with other stakeholders
- Cultural match

Internal Process Perspective

- On-time delivery
- Circumstance of delivery
- Transport capacity
- Warehouse capacity
- Research and development capability
- Geographical location
- Ethical responsibility
- Responsiveness to changes
- Flexibility to changes
- Purchase order cycle time
- Accuracy of forecasting
- Value-added activities
- Quality system certifications
- Effectiveness of delivery invoice methods
- Quality of delivery documentation
- Environmental awareness/understanding

Stakeholders Perspective

- Customer satisfaction
- Employee satisfaction
- Government satisfaction
- Supplier satisfaction
- Investor (financier) satisfaction
- Community satisfaction
- Environmental group satisfaction
- Non-government organisation satisfaction

Source: *Kucukaltan, Irani and Aktas (2016)*

Saiz, Rodriguez, Bas, and Verdecho (2010) propose a PM framework for the collaborating small and medium-sized enterprises (SMEs). The potential users of this framework, instead of a single organisation, are several SMEs linked by the supply chain or value chain. The authors employ the MAT (Methodology, Architecture, Toolset) approach to design the framework on the levels of theoretical structure, practical procedures, and implementation tools.

Six main steps are included in the theoretical and practical structure of the framework. The supply chain domain should be clarified and confirmed in the initial step, and then, the leader company or the SMEs complex should modelise their relationships by defining the input and output of each element in the chain. In steps 3 and 4, the new collaboration plan about how to better yield performance through the chain should be agreed upon by the key collaborators who should define the requirements (core interests) for each of them. All contents above in the new collaboration plan against better operational performance should be implemented and adjusted periodically in the last step.

What is more, three PM tools are recommended to implement the framework better.

- Partners Data: The enterprises can differentiate between two types of data;

- Key Performance Indicators (KPIs): The enterprises can differentiate between two types of performance indicators;
- Process: There are four basic steps to be followed to obtain the needed information from the individual indicators.

The public sectors are also well documented by PM literature. Since the government's mission, process, and culture is highly different from the profiting organisations, its PM framework is also highly distinctive.

de Waal and Kerklaan (2010) raise a PM readiness review (PMRR)-based PM framework to improve customer satisfaction for local governments.

- Phase 1 began with interviewing managers of licensee and extensive desk research of documents provided by the licensee.
- In Phase 2, the quality of the implementation of the PMS by licensees was evaluated.
- Phase 3 consisted of evaluation of the extant results achieved by the licensee with PM.
- In Phase 4, the final evaluation must be made. The main issue in this phase is: Does the licensee's approach to PM inspire enough confidence in the licensee's quality of management?

The scorecard methods are another representative in this category with wide application in recent years. Kaplan and Norton (1992) introduce a BSC framework for performance measurement or management (see Figure 2-8). The BSC framework guides organisations to design a proper performance measurement system by decomposing their strategies and objectives in four basic dimensions: (1) financial, (2) customer, (3) internal process and learning and (4) growth, and accordingly, to carry out proper PM.

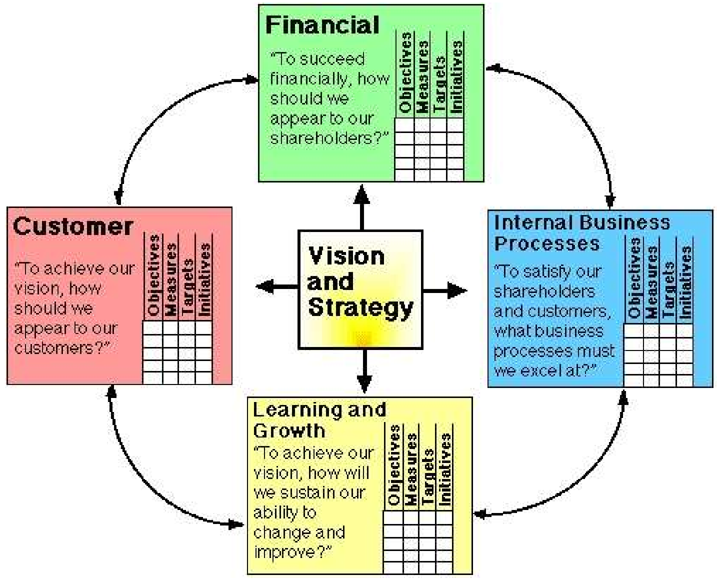
The types of scorecard methods have been widely applied in the PM domain in recent decades, and the BSC framework is one of the most representative. Generally speaking, the BSC framework is designed specifically for organisations whose operations can be explained by the four built-in dimensions of the framework. In practice, most of these corporations are in private sectors and profit purchasing.

The BSC framework assumes that the top goal of profiting enterprises is to improve their financial performance, and hence to satisfy their shareholders. To achieve that top goal, the organisations should concern the needs of their customers and improve their finance performance through satisfying the customers. Accordingly, sound operation procedures are indispensable for satisfying internal and external customers; therefore, organisations need to consider their operational systems on the third dimension. Finally, businesses should keep improving and updating their human resources to enrich their capabilities of supporting the procedures above.

The logic adopted in the standard BSC model is only suitable for the benefiting enterprises, since the financial pursuits are not the top priority for the NPOs (Kloot and Martin 2000; Kaplan and Norton 1999; Brignall and Modell 2000). Accordingly, NPOs (e.g., government, public university, and public hospital) should alter the standard model to place the customer dimension at the top, since the concerns of the NPOs are how well they meet a need in society rather than how well they raise funds or control expenses (Kaplan 2001b).

Enlightened by the philosophy of the BSC, many BSC methods alike and frameworks have been raised in these years for organisations that can hardly utilize the classic model of the BSC.

Some studies modify the classic model of BSC and extend the application scope of the method to non-profit organisations (NPOs). Currently, vast literature is documented on this approach (Brignall and Modell 2000; Wilson, Hagarty and Gauthier 2004; Kaplan and Norton 2001; Fleisher and Mahaffy 1997; Kloot and Martin 2000). However, as a managerial instrument designed for private sectors, the four-dimension structure of BSC cannot well explain and assist the performance operations of NPOs. Therefore, a brand new PM framework based on the scorecard idea is raised for them.



Source: *Kaplan and Norton (1999)*

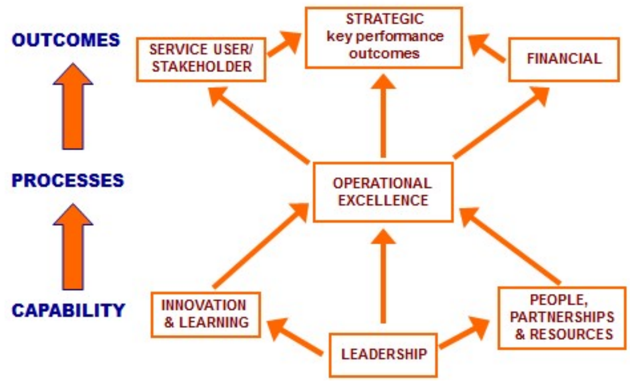
Figure 2-8 Balanced Scorecard Model

The public sector scorecard (PSSC) is the latest development of the scorecard methods for public sectors (Moullin 2009). The PSSC framework focuses on both quality and PM for corporations with public characteristics, and its essential ideas are developed from the BSC framework, considering the uniqueness of NPOs.

The nature of the PSSC framework is highly similar to the BSC, which is decomposing organisations' top strategies and objectives into performance indicators through a structured framework with interrelated conceptual factors (Figure 2-9).

It can be pointed out from Figure 2-9 that the element of performance outcomes is placed at the top of the framework, which is supported by multiple stakeholders and a well-maintained finance situation. This results-oriented design matches with new trends in public sector management (Modell 2001).

Good performance is supported by well-designed and implemented processes, which are both contained within the element of operational excellence in the framework. The author further explains that process re-design and optimisation are necessary to achieve operational excellence.



Source: *Moullin (2009)*

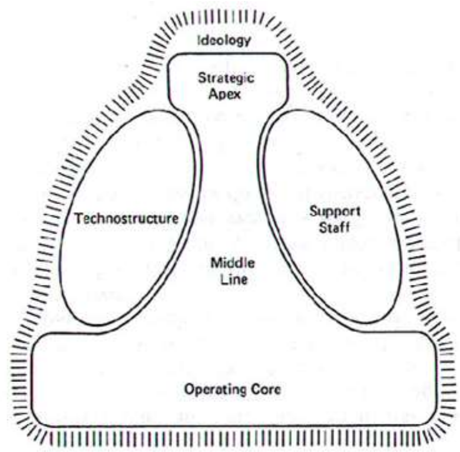
Figure 2-9 Framework of public sector scorecard

Finally, similar to the structure of the BSC, the human resources element is placed as the basis of the whole framework, since an organisation's capability and competitiveness are fundamentally decided by the competency of its staffs. The innovation and learning, leadership, and people partnerships and resources are three sub-factors on this level.

PSSC frames are a special PM tool designed with considering the uniqueness of the public sectors, and its influence has increased in the recent years.

Except for the above special frameworks building upon organisations' unique operational characteristics, some frameworks consider the characteristics of organisational structure first to premise a proper PM framework. And these studies hold an assumption that the loosely-coupled parts of an organisation (i.e., organisational structure, work flow, order chain) should be considered and truly integrated with the PMS (Malmi and Brown 2008).

There are PM framework groups that are based on Mintzberg's idea about the organisational structure. Mintzberg (1973, p.130) defined the organisational structure as "the sum total of the ways in which it divides its labour into distinct tasks and then achieves coordination among them." Based on the definition, we can point out that the organisational structure (chart) divides complex actions in an organisation into different functional segments to ensure its effectiveness and specialisation. Meanwhile, the coordination mechanism, as part of the organisational structure, compiles the above segments and ensures that they operate as a whole.



Source: *Mintzberg (1973)*

Figure 2-10 Six basic parts of organisation

Moreover, regarding divisions of an organisation, there are six basic parts (see Figure 2-10) that exist in most well-functioning organisations (Mintzberg 1980):

1. **Operating Core**: The parts consist of "operators" who yield products and services directly;
2. **Strategic Apex**: This part is specialized for developing strategies and plans, organizing and leading the whole organisation;
3. **Middle Line**: This part links operating cores and the strategic apex by aggregating bottom information and deploying upper decisions;
4. **Techno Structure**: This part is responsible for designing, planning, changing and training operating cores to improve their productivities;
5. **Support Staff**: This part serves the operating cores to get them out of the non-core operations;
6. **Ideology**: This part consists of organisational cultures, traditions, and beliefs that could make an organisation unique.

Additionally, Mintzberg catalogued what basic coordination means in organisations into six types (Mintzberg 1980), which are:

1. **Mutual adjustment**: the coordination will be accomplished through simple approaches of communication, such as face-to-face talk, daily meeting etc. (e.g.,

a micro business with one boss and three employees);

2. **Direct Supervision**: this coordination way usually leads by one supervisor who delivers orders to his subordinates based on his authority or experience. (e.g., mentor and apprentices);

3. **Standardisation of work processes**: to coordinate by written procedures and regulations about management rules and technical process, which are commonly issued by the techno structure and implemented in the operating core. (e.g., the strictly fixed actions on an assembly line);

4. **Standardisation of outputs**: this coordination is usually carried out through specifying the results of the specified working tasks, which are also commonly developed in the techno structure and obeyed by the operating core. (e.g., the quantitative criterion for a machine component);

5. **Standardisation of skills** (as well as knowledge): this is a virtual coordination way that coordinates the employees by the knowledge, discipline rules, and ethical standards they received in the education process. (e.g., a surgeon and an anaesthetist know their roles in a regular surgery even without communication ahead);

6. **Standardisation of norms**: The mind and behaviour of the members are coordinated by a strong belief (e.g., monks in a Buddhist temple).

Based on different configuration and coordination mechanisms, organisations can be categorized into several types as shown in Table 2-3 (Mintzberg 1993).

Based on the characteristics and features of a certain category of organisations described by Mintzberg (Mintzberg 1980; Mintzberg 1993), some authors carry out studies about PM frameworks specifically for each of them, and furthermore, the SSM tool is employed to decompose the strategies to add an innovation mechanism in the frameworks above. Song (2016) designed a PM framework for Chinese commercial banks, and the special needs of efficiency and risk controlling from the Chinese banks are considered in the framework. Tong et al. (2016) proposed a general PM framework for Chinese classic manufacturers, and in which, the feature of a simple operating core is fully considered. Accordingly, the six basic steps in the

PM framework are redesigned to make them in line with the typical characteristic. Moreover, similar efforts can be found in the higher education domain (Xue, Yi and Liu 2016). The six redesigned steps for carrying out PM in the Chinese higher education system are configured through the SSM tool.

Table 2-3 Different Types of Organisations and Features

Configuration	Key coordinating mechanism	Key part of organisation
Entrepreneurial	Direct supervision	Strategic apex
Machine organisation	Standardisation of work processes	Techno structure
Professional organisation	Standardisation of skills	Operating core
Diversified organisation	Standardisation of outputs	Middle line
Innovative organisation	Mutual adjustment	Support staff
Missionary organisation	Standardisation of norms	Ideology
Political organisation	None	None

Source: *Organized based on Mintzberg (1980) and Mintzberg (1993)*

The studies above consider the characteristics of a special organisational structure in building up a PMS, and further implement PM operations upon the structure. This approach helps the frameworks to be applied more efficiently, since most elements and steps in the frameworks can be matched and implemented with the part(s) in the organisational charts. However, this advantage will limit their application ranges greatly. What is more, these frameworks face up to extra difficulties to implement if the organisational charts of an organisation are keep changing.

It is clear that these general frameworks only work well for PM in organisations with level of simple or simplified operating cores and whose work flows and managerial relationships are relatively clear. On the other hand, those special frameworks utilized some of the operational characteristics of organisations, so they may work more efficiently in organisations with more complex cores. Although, their application scopes are limited to particular types of organisations. Thus, there is a need to develop a PM framework, which can be applied to a wide scope of organisations with various complexities of operating cores. Furthermore, it should be based on the performance generation structure instead of the organisational chart.

Therefore, further efforts are needed in the PM domain to address those challenging managerial issues. To this end, we will have more detailed analysis on the key elements of the existing PM models.

2.4 Basic elements in PM frameworks

In above sections, multiple PM frameworks have been reviewed by their general contents and characteristics. In this part, we will discuss some key elements in those frameworks and further analyse how these elements function in PM.

Apart from some benchmark-oriented PM frameworks, an organisation's strategies and objectives are the indispensable elements in most PM frameworks (Otley 1999; Adderley 2013; Freyburger 2013; Ferreira and Otley 2009). The initial step in a majority of PM frameworks is clarifying or setting up clear strategies and objectives to orientate the following steps (Otley 1999; Ferreira and Otley 2009; de Waal and Kerklaan 2010; Giannopoulos 2015).

The operation characteristics of organisations are the second element concerned in many PM frameworks, especially the special frameworks (Wimmer and Mandják 2002; Miciak and Desmarais 2001). The manner of operation largely influences the way an organisation carries out its PM, and further characterizes the system by setting emphasis and managerial methods in the PM implements (Wimmer and Mandják 2002; Morey and Dittman 1995).

The role and function of stakeholders are increasingly important in the enterprises that seek sustainable development (Kucukaltan, Irani and Aktas 2016; Wang, Liu and Mingers 2015; Ruf et al. 2001). On a macro level, a robust and sound PMS should embody the interests of multiple stakeholders and well balance them. Then, on a micro level, the orientation and implementation details of a PMS should be generated upon the opinions of relevant stakeholders (Kucukaltan, Irani and Aktas 2016; Wang, Liu and Mingers 2015; Kammeyer-Mueller, Liao and Arvey 2001).

Table 2-4 Elements attributed to fundamental questions of PM

Question	Element Attribute(s)	Literature
Why? (Purposes of a PMS)	· Strategies & Objectives · Stakeholder	(Ogunlana 2010; Harrison and Freeman 1999; Atkinson, Waterhouse and Wells 1997; Radnor and McGuire 2004; Davies and Downward 1996; McAdam, Hazlett and Casey 2005)
What? (Focuses and functional segments of a PMS)	· Operation characteristics · Organisational structure · Stakeholder	(Andrews 2010a; Adams and Mehran 2008; Lin and Germain 2003; Child 1972)
How? (Ways to set-up or improve a PMS)	· Operation characteristics · Organisational structure · Stakeholder	(Andrews 2010b; King and Lerner 1987; Ferri, Kalmi and Kerola 2010; Ezzamel and Watson 1993; Powers et al. 2003)
Who? (Roles and responsibilities of people involved in a PMS)	· Organisational structure · Stakeholder	(Andrews 2010a; Ferri, Kalmi and Kerola 2010; Harrison and Freeman 1999; Atkinson, Waterhouse and Wells 1997)
How about? (3E of a PMS)	· Performance measurement · Stakeholder	(Bititci, Carrie and McDevitt 1997; Bititci, Turner and Begemann 2000; Atkinson, Waterhouse and Wells 1997; Kolehmainen 2010)

Source: *Organize based on the listed literature*

What is more, the role of organisational structure in the PM framework has been documented by some researchers. In some sense, an organisation’s PMS is attached to its organisational structure. Some widely-adopted PM frameworks, such as the scorecard methods, guide organisations to set up their PMSs along organisational structures. For other PM frameworks, the key implementation steps (e.g., performance deployment, measurement, and feedback) are carried out through the formal structure of organisations. In summary, the organisation chart exerts influence on the organizing of a PMS through deciding the organisation’s division and coordinate patterns (Chenhall 2003; Youndt et al. 1996; Mintzberg 1993).

The last but not the least element, performance measurement, exists in most PM frameworks, if not all of them. In the early era of the performance research, there was a trend that equal the performance measurement with the PM, since this element indicates the performance status of an organisation straightly, and further, contributes greatly to performance improvement (Otley 1999; Evans 2004; Kolehmainen 2010; Lingle and Schiemann 1996).

The five basic elements explain well the fundamental questions regarding "why", "what", "how", "who", and "how about" of a PMS. Although these elements also exist in the literature, most of them can be categorized into one of the five parent elements substantially as presented in Table 2-4.

Then, in the section below, we will further introduce details about the functions and influences of the elements in a PMS.

2.4.1 Element of strategies and objectives

Except for the benchmark-based PM approach, most of the existing PM framework sets the strategy and objectives as the initial element in a PM process. The link between strategy and PM has been explored in dozens of normative and empirical studies (Chenhall 2003; Langfield-Smith 1997; Micheli and Manzoni 2010; Otley 1980).

It has been documented sufficiently that an organisation's strategies and objectives are the substantial driving forces for overall operations. Otley (1999) emphasizes that most rational activities yielding the desired performance are driven by an organisation's strategic factors. Adler (2011) further states that strategies and objectives not only motivate organisational outcomes, but they also exert influences on planning, budgeting, measuring, and incentive compensation. In short, most operational elements are driven by an organisation's strategic orientation. Chenhall (2003, p.287) focuses on the importance of the top targets for organisations being in a complex business environment. The author concludes that "since the target of the nowadays highly evolved PM practices is to be both low-cost producers and to provide customers with high quality, timely, and reliable delivery."

Additionally, the crucial role of the strategies and objectives in a PMS can be represented on its significant impacts on its configurations. It has been widely realized that conservative organisations featuring defender, harvest, or cost leadership strategy can be best served by a PMS, since its configurations are fairly straightforward and explicit due to the characteristics of the strategy (Adler 2011). Chenhall (2003, p.163) explains a very similar idea by stating that if an organisation can define its strategic emphasis explicitly, it usually can build up a PMS straightforwardly, since the characteristics of the system should be "centralized control systems, specialized and formalized work, simple co-ordination mechanisms, and attention directing to problem areas." Anthony and Govindarajan (2007) conducted research dedicating on matching the shapes of PMSs with types of strategy selections, and they pointed out that if an enterprise adopts a cost-oriented strategy, its PMS tends to be: formal, financially-based strategic planning; short-term, output-focused budgeting; and formula-based, frequently determined and awarded incentive compensation. On the contrary, the PMS tends to: feature informal, qualitatively-based strategic planning; long-term, outcome-focused budgeting processes; and subjectively-based, infrequently determined and awarded incentive compensation, if the organisation applies a differentiation-based strategy.

Furthermore, an organisation's strategies and objectives play a crucial role in the coordination processes of an organisation, and hence largely impact on its PM. As it has been pointed out by Anthony and Govindarajan (2007), one of the roles for a PMS is to assist corporations in planning and coordinating against their strategies.

Last, but not the least, some detailed steps in PM processes are also referenced to an organisation's top strategies and objectives, such as with performance measurement (Curtright and Stolp-Smith 2000; Ittner, Larcker and Randall 2003; Atkinson, Waterhouse and Wells 1997) and incentives system designing (Lorange and Murphy 1983; Oviatt 1988).

2.4.2 Element of operation characteristics

The PMS just like nerves spread on an organisation's operation processes to control and adjust it (Nurmi 1996). As mentioned by Locke (1968), operating systems and procedures play a role to both motivate and constrain the rest systems of an organisation. Therefore, an organisation's operational characteristics, such as industrial features (Ryan 1998; Subramony 2006), technologies and IT applications (Bourne, Franco and Wilkes 2003; Chourides, Longbottom and Murphy 2003), ownership (Westman 2014; Wendt 2014; Cassidy 2004), and organisational culture (Ottenbacher and Harrington 2007; Chan, Shaffer and Snape 2004; Henri 2006) will influence the PMS's patterns and implementations greatly.

Extensive empirical studies document this element and we can take the service industry's relevant literature as an example. Generally speaking, the emphases of PM for enterprises in the service sector are placed on the standardized actions of the employees and customer satisfaction (McLaughlin and Coffey 1990; Armstrong and Baron 2000). However, for the service enterprises focusing on the blue ocean market, standardisation often weights more, since customer satisfaction is uncontrollable to a large extent (or too costly to control) (McLaughlin and Coffey 1990). On the other hand, if the enterprises are in the high-end restaurant field, the latter issue takes an absolute critical position of their PMS, since each customer contributes much higher margin profits than the fast food (Ottenbacher and Harrington 2007). Except for the factor of market positioning, the IT and management technology factors also impact on the PM patterns of services firms, for instance, food companies who adopt E-management systems tend to apply more KPIs to monitor and measure their employees (Spremic, Zmirak and Kraljevic 2008). Furthermore, if a service company is capable of carrying out culture-based management, both PM emphasis (actions and satisfactions) can be replaced by organisational culture factors and the key of the PMS shifts to cultural interventions (Ogbonna and Harris 2002).

Most existing PM frameworks lack of some effective mechanisms to introduce innovations to operations and management during PM build-up, even for companies with simpler operational cores. For example, in BSC applications, the main trend is to use the existing business processes, although some researchers suggest using business reengineering before BSC (Van Grembergen and Van Bruggen 1997; Lichka 2005), which is very expensive and complex. In Tong, Wei and Liu (2014) there is a discussion on how to use SSM to address this issue in some particular cases.

Moreover, the professional knowledge and skills needed in the operation processes are usually in direct proportion to the difficulty of the PM (Parr 2004; Peach and Horner 2007; Chen, Chang and Yeh 2003). The current PM frameworks provide little guidance to enhance performance of complex operating cores by introducing innovation to the operational and managerial processes. They have no effective mechanism for this key issue. The PM in an R&D unit well-represents all of the above attributes in managerial contexts: R&D units consist of highly professionalized staff; however, there is no clear process ensuring the generation of the desired performance. Therefore, we will select R&D units as an example and discuss the PM operations in our study.

It can be realized from the statement above that many contingency issues in the PMS set-up and implementation are brought about by the diverse operational characteristics of the organisations.

2.4.3 Stakeholder element

The stakeholder element ensouls the PMS by defining whose voices should be included in the system's building up and managing processes.

Bendheim and Graves (1998) and Rowley (1997) point out that the stakeholders influence the whole PM and measurement system by defining their orientations, approaches, and resources availabilities.

Bryson (1995) acknowledges the fact that a key factor for the "well-functioning" PMS is that to consider the interests of multiple stakeholders in build-up and implementation. Furthermore, for an organisation to consider the needs and goals of the key stakeholders is highly crucial, to gain sustainable competitiveness continually (Wagner and Schaltegger 2003). However, as Ferlie et al. (2003) criticize, the interests and benefits of various stakeholders are ignored largely in most PM cases.

To better consider and satisfy key stakeholders interests (both internal and external), performance indicators should be multi-dimensional (Henri 2010), and their views and ideas should also be considered in PM operations (Atkinson, Waterhouse and Wells 1997).

The relevance of stakeholder theory is demonstrated by its standing as the “dominant discourse” in organisation theory (Atkinson, Waterhouse and Wells 1997) and by its application across a range of management disciplines.

Recent advances in stakeholder theory have moved from “hub and spoke” conceptions of the firm as the focal organisation to a view of the corporation and its stakeholders, as embedded in a complex network of relationships (Lozano, 2005).

Moreover, on the implemental level, it is highly important to identify key stakeholders and their corresponding interests properly in PM processes. Several approaches exist to identify and rank the stakeholders for an enterprise, such as distinguishing by their indispensability (Fletcher et al. 2003), strategic contributions (Lengnick-Hall et al. 2009), and roles in ownership (Preston and Sapienza 1990; Clarkson 1995). Wang (2015) proposes a detailed way to locate key stakeholders and further balance their interests through an SSM-based approach for the medical industries.

2.4.4 Organisational structure

The element of organisational structure exerts its influences on a PMS by both restraining and enabling employee behaviour (Adler 2011). On an organisational level, this element impacts on the PMS through deciding the mechanisms of division and coordination in an organisation (Mintzberg 1980).

Regarding job division, the nature of core works and their levels of specialisation in an organisation alter its manner of PM execution. For instance, organisations organized in a bureaucratic style tend to accentuate the measurement segment in their PMSs; the divisional enterprises employ the PMS to maintain the linkages among their branches; the organisations structured in matrix or network manners may emphasize the communication and outcome in their PM implementation but leave the process parts to the autonomies of the employee (Mintzberg 1980; Christensen, Lægreid and Stigen 2006; Mohrman, Mohrman and Lawler 1992).

Furthermore, the above job divisions always hook up the specific coordination, such as bureaucratic organisations highly value compliance against the regulations in their operation, so they may adopt KPIs reflecting both the detailed actions and outcomes. The organisation with a loose architecture (divisional, matrix and network) can hardly supervise the details in operation, due to geographic issues or job complexities. Therefore, the outcomes and training should be highlighted in the PMS (Mintzberg 1980; Mehrotra et al. 2016; Johnson 2015; Wade and Recardo 2001).

On the other hand, some organisational structure issues add extra difficulties to the PM operation. The highly complex organisational structure, such as a matrix or network structure, raises challenges for PM, since the coordination relationships, information flow, and order chain are mixed and interrelated (Armistead, Pritchard and Machin 1999; Wang and Ahmed 2003). What is more, fast-changing organisational charts also challenge the current PM frameworks, since the implementations of the current PM frameworks highly rely on stable organisational charts (Stiles 1999; Song 2016). If in an organisation, key objectives or organisational structures keep changing, PM needs to be redesigned and re-implemented, as its key performance generation processes have changed. However, more often than not, those changes in the charts are largely caused by managerial or human conveniences, not those of key objectives or structures. This situation is represented by the PM dilemma in many Chinese SMEs, which often need to adjust their organisational charts frequently (Lu 2016; Chang and Powell 1998; Alba et al. 2005). There is another important situation where Chinese banks are undertaking process banking projects (Song 2016). Then, the banks enter a period of constantly changing charts, while they also need to build up their PM.

The organisational structure element enables PM by defining roles, endowing authorities, and allocating resources in organisations. Meanwhile, individual and organisational behaviours are constrained by the segment architectures, reporting chains, and superior/subordinate relationships in organisations.

2.4.5 Performance measurement

Different from the environmental elements mentioned above, performance measurement is a built-in element of a modern PMS, since only measurable performance can be managed (Kaplan 2001a)

A comprehensive literature review for this element is unnecessary here since the core contents (orientation, approach, indicator, and implementation) of it have been discussed comprehensively before, as it is an inescapable topic for most PM studies (Amaratunga and Baldry 2002).

2.4.6 Summary

Multiple categories of PM frameworks have been reviewed in the contents previously, and it can be found that most existing frameworks with explicit details are designed for organisations that can be best, or easily, served by the PMS (Kaplan and Norton 2001). These organisations usually have characteristics of centralized control systems, specialized and formalized work, simple coordination mechanisms, and attention directing to problem areas (Chenhall 2003).

However, as for the opposite cases against the statement of Chenhall (2003), two types of challenges in PM have drawn increasing attention.

The first challenge is how to effectively implement PM in organisations with frequent adjustment organisational charts[1], which is represented by the PM dilemma in the SMEs. The current PM frameworks implement PMSs directly based on the current organisation charts, and frequent adjustments in the charts cause extra work and confusion in PM.

The second challenge is how to combine PM with innovations of business and management processes. Even for a simple manufacturer, current PM frameworks provide little guidance on how to introduce innovations during PM build-up, and an

[1] Based on a Chinese SMEs investigation carried out by Lu (2016), the organisations who change their charts significantly in every quarter (in recent two years) can be categorized as “chart changes frequently”.

SSM approach within our new PM framework is shown to address this issue in the case study in Chapter 6. This issue further causes the difficulties of managing performance in (a) complex operating core(s), which is fully represented by the difficulties of carrying out PM in an R&D unit, where suitable performance operation processes are among the keys in deriving performance of the unit. Hence, an effective PM framework should be able to enhance the performance of R&D units by providing effective mechanisms for introducing innovation in its performance generation processes through PM.

In this research, we will attempt to develop the framework and methodology against these two main challenges. As preparation, we will review the SMEs below and R&D in the next chapter.

2.5 Performance management in SMEs

In this section, we first discuss the definition and criteria of SMEs, followed by the performance management of SMEs.

2.5.1 Definition and criteria of SMEs

The diverse definitions and criteria exist in countries to characteristics SMEs, and these standards are influenced by the market environment, economic situation, and history of a country. In generally, most governmental bodies of the world define SMEs based on both objective and subjective criteria. The objective criteria for defining SMEs are usually a set of numeric standards that characterize the richness of capitals, employee scales, and market influence of SMEs. The subjective criteria are not applied as common as the objective ones, which are usually employed by the scholars or some governmental bodies to handle exceptional cases. The subjective criteria contain indictors like “independent ownership and operation,” “self-managed,” and “very limited market influence,” which require judgements of government officers or researchers based on the investigations or assessments.

More specifically, the criteria below are the most widely applied by the governmental bodies, and accordingly, the scholars.

- **Paid-up capital sum**: the capital sum is one of the most explicit indicators to define an SME, whose financial resources are usually significantly smaller than large enterprises;
- **Number of employees**: this indicator measures SME from the aspect of human resources, which is also widely adopted by many countries. However, with the emerging of new business forms (e.g., service outsourcing, virtual operation, etc.), the efficacy of this indictor is questionable especially in the high-tech industries;
- **Business turnover annually:** this indicator mainly focuses on the business influence of an enterprise. Usually, SMEs offer much fewer products and service to the market comparing with big-sized ones, correspondingly, the turnovers of SMEs are incomparable with large enterprises;
- **Independent ownership and operation:** this is a subjective criterion employed by the UK government and many studies (Gibb 1993; Fogel and Zapalska 2001; Watson and Wilson 2002) and the criterion is usually applied to handle some exceptional cases in SME defining.

In practice, most countries employ dual or triple of above indicators to filter SMEs in their policy formalisations and implementations. However, even adopting the same indicators, the numerical standard for each indicator differs from one another country according to the situations of economic development and labour market. For instance, the developed countries define their SMEs with a lower number of employees but higher capital sum. In contrast, the developing countries with big population tend to lower the bar for their SMEs' labour scale but focus on the richness of their capitals (Wu, Song and Zeng 2003).

2.5.1.1 Definition of SMEs in UK

The UK is one of the countries that realized the importance of SMEs for its national economic system very early, and hence, the character of comprehensiveness can be found in its definitions for the SMEs. Unlike some countries that define their

SMEs through quantitative indicators solely, the UK government employs both objective and subjective criteria to define the SMEs (Abor and Quartey 2010).

Table 2-5 Classification criteria for SMEs in UK

Company category	Employees	Turnover(£)	(or) Balance sheet total(£)
Medium-sized	< 250	⩽ 50 m	⩽ 43 m
Small	< 50	⩽ 10 m	⩽ 10 m
Micro	< 10	⩽ 2 m	⩽ 2 m

Source: Lu (2016)

The objective standards in the UK are very similar with those in the other EU countries, such as German and Italia, which are lower than 26 million turnovers and less than 250 staffs. Meanwhile, the subjective criteria adopted by the UK government mainly distinguish the SMEs by their market influences, formalization of operations, and ownership features. For instance, the businesses run by independent operators with unfinalized management institution are usually viewed as SMEs in the UK, and also, the enterprises in the UK can have special tax treatment for SMEs if they onlu have the very limited influence on the local market (Doi and Cowling 1998).

2.5.1.2 Definition of SMEs in US

Comparing with the UK and the other EU countries, the definitions of SMEs in the US have higher standards in the aspect of capitals — only the enterprises with annual turnover less than \$29m will be viewed as SMEs. On the other hand, according to the industry forms of US, the bar of employee scale for SMEs is placed on 1500 staffs, which is significantly higher than the EU standards. Moreover, the US government further categorizes the SMEs according to their industrial background and set different standards for them. For example, the SMEs in the general exporting service industry of US are defined as whose annual revenues are less than \$7 million, and this number is just a quarter million dollars for the SMEs in the farming industry. Out of the doubt, this more specific way to define SMEs makes the criteria more rational and feasible in applying in multiple industries. Figure 2-11 summarises the classification criteria for SMEs in the US.

	Manufacturing and non-exporting services firms[a]	Exporting services firms[b]		Farms
		Most	High value[c]	
Number of employees	< 500	< 500	< 500	< 500[d]
Revenue	Not applicable	≤ $7 million	≤ $25 million	< $250,000
Defining institution	SBA Advocacy[e]	SBA / SBA Advocacy[f]	SBA / SBA Advocacy[f]	USDA
Data source	U.S. Census	ORBIS	ORBIS	USDA

Source: *The Office of the United States Trade Representative (2016)*

Figure 2-11 Classification criteria for SMEs in US

2.5.1.3 Definition of SMEs in China

China being a command economy is very different from the western world's mixed economies. Thus, making the western world's general assumptions of SMEs definitions limited use. For example, starting from a definition standpoint, quantitative and qualitative characteristics are both used. The first dimension is the quantitative characters of the SMEs, include turnover, number of employees, and asset size. However, there are no universal value to above criteria among non-European countries, both the economic and labour market situations influence countries' answers to the question "how big the small enterprise can be?" The second dimension of qualitative characters includes ownership, control and scope of operations.

From a methodological definition approach, Europe and China are similar with both using number of employees, annual revenues and asset value. The Chinese government, like Europe, uses a dual dimension system to identify SMEs and classifies them into five types with corresponding quantitative criteria respectively. If a company meets with any one of the standards in its industry (See Table 2-6), it can be identified as an SME. A major difference is that the Chinese SMEs' scales are much larger in comparison with European standards. The majority of Chinese enterprises are SME, being more than 50 million, contributing 60% to GDP and employing 75% of the urban workforce (Zhang, 2010).

In comparison with other countries, Chinese SMEs have their unique internal and external environments. Internally, Chinese SMEs managers need higher levels of cross-department coordination and communication abilities to meet with management challenges (Tan, He and Ma 2011). The widespread family businesses ownership is another differentiated internal characteristic of Chinese SMEs. As a result, Chinese SMEs' operations rely more on nepotism and personal charisma than bureaucratic system and regulations (Song 2012). The high staff turnover rate (three times higher than average level of the other East Asia countries) is another concern for Chinese SMEs; some researchers' indicate that the lower HRM ability and inappropriate PMS are two of the most crucial factors leading to aforementioned (Wang and Wang 2012).

Apart from above internal issues, the literature shows a variety of external environmental factors that also influence Chinese SMEs' development. Some researchers state that because of the discrimination from Chinese banking system, Chinese SMEs emphasis more on their cash flow management than their western counterparts (Liu, 2008; Zhao, 2012; Shan, 2012). Wan (2012) and Lin (2014) point out that most of the Chinese SMEs set sales and marketing as their strategic priorities because of large scale and intense homogeneous competitions in all industries. Tang (2011) urges that with the acceleration of globalisation, Chinese SMEs need to set targets for institutionalisation, informatisation and internationalisation.

Table 2-6 Classification criteria for SMEs in China

Industry	**Specific standard(upper limit) (¥)**	**Medium sized (¥)**	**Small sized (¥)**	**Mini sized (¥)**
Agriculture, forestry, livestock farming, fishery	*Annual revenue <200 million*	*Annual revenue≥5 million*	*Annual revenue≥0.5 million*	*Annual revenue <0.5 million*
Heavy industry	*Annual revenue <400 million* **Or**	*Annual revenue≥20 million* **Or**	*Annual revenue≥3 million* **Or**	*Annual revenue <3 million* **Or**

	Number of employees＜1000	*Number of employees≥300*	*Number of employees≥20*	*Number of employees＜20*
Wholesale industry	*Annual revenue ＜400 million* **Or** *Number of employees＜200*	*Annual revenue≥50 million* **Or** *Number of employees≥20*	*Annual revenue≥10 million* **Or** *Number of employees≥5*	*Annual revenue ＜10 million* **Or** *Number of employees＜5*
Retail industry	*Annual revenue ＜200 million* **Or** *Number of employees＜300*	*Annual revenue≥5 million* **Or** *Number of employees≥50*	*Annual revenue≥1 million* **Or** *Number of employees≥10*	*Annual revenue ＜1 million* **Or** *Number of employees＜10*
Transportation industry	*Annual revenue ＜300 million* **Or** *Number of employees＜1000*	*Annual revenue≥30 million* **Or** *Number of employees≥300*	*Annual revenue≥2 million* **Or** *Number of employees≥20*	*Annual revenue ＜2 million* **Or** *Number of employees＜20*
Warehousing industry	*Annual revenue ＜300 million* **Or** *Number of employees＜200*	*Annual revenue≥10 million* **Or** *Number of employees≥100*	*Annual revenue≥1 million* **Or** *Number of employees≥20*	*Annual revenue ＜1 million* **Or** *Number of employees＜20*
Postal industry	*Annual revenue ＜300 million* **Or** *Number of employees＜1000*	*Annual revenue≥20 million* **Or** *Number of employees≥300*	*Annual revenue≥1 million* **Or** *Number of employees≥20*	*Annual revenue ＜1 million* **Or** *Number of employees＜20*
Accommodation industry	*Annual revenue ＜100 million* **Or** *Number of employees＜300*	*Annual revenue≥20 million* **Or** *Number of employees≥100*	*Annual revenue≥1 million* **Or** *Number of employees≥10*	*Annual revenue ＜1 million* **Or** *Number of employees＜10*
Restaurant and catering industry	*Annual revenue ＜100 million* **Or** *Number of employees＜300*	*Annual revenue≥20 million* **Or** *Number of employees≥100*	*Annual revenue≥1 million* **Or** *Number of employees≥10*	*Annual revenue ＜1 million* **Or** *Number of employees＜10*

Information transmission industry	*Annual revenue <1 billion* **Or** *Number of employees < 2000*	*Annual revenue≥10 million* **Or** *Number of employees≥100*	*Annual revenue≥1 million* **Or** *Number of employees≥10*	*Annual revenue <1 million* **Or** *Number of employees <10*
Software and IT service	*Annual revenue <100 million* **Or** *Number of employees <300*	*Annual revenue≥10 million* **Or** *Number of employees≥100*	*Annual revenue≥0.5 million* **Or** *Number of employees≥10*	*Annual revenue <0.5 million* **Or** *Number of employees <10*
Real estate development industry	*Annual revenue <2 billion* **Or** *Total assets < 100 million*	*Annual revenue≥10 million* **Or** *Total assets≥50 million*	*Annual revenue≥1 million* **Or** *Total assets≥20 million*	*Annual revenue <1 million* **Or** *Total assets < 20 million*
Property management industry	*Annual revenue <50 million* **Or** *Number of employees < 1000*	*Annual revenue≥10 million* **Or** *Number of employees≥300*	*Annual revenue≥5 million* **Or** *Number of employees≥100*	*Annual revenue <5 million* **Or** *Number of employees < 100*
Tenancy and business service industry	*Annual revenue <1.2 billion* **Or** *Number of employees <300*	*Annual revenue≥80 million* **Or** *Number of employees≥100*	*Annual revenue≥1 million* **Or** *Number of employees≥10*	*Annual revenue <1 million* **Or** *Number of employees <10*
Other unlisted industries	*Number of employees <300*	*Number of employees≥100*	*Number of employees≥10*	*Number of employees <10*

Source: *'China's regulations on the standards for classification of small and medium-sized enterprises' (2016) http://www.stats.gov.cn/statsinfo/auto2073/201310/t20131031_450691.html*

2.5.2 The PM of SMEs

There is a vast literature documented on the topic of PM for SMEs currently, but the specified PM frameworks designed for SMEs by considering their characteristics are numbered. Generally speaking, the current studies can be categorized into three types:

The first type of SME performance studies focuses on the general situation of the domain in one or multiple country(ies) with the different industrial background. A majority of researches in this type are carried out by empirical investigations. Meanwhile, some of them are implemented based on the literature research.

Gunasekaran et al. (2006) reviewed a vast literature about the operation of PM in the SMEs of UK, and the author identified that the major obstacle exists in the English SMEs is lacking well-trained line mangers who can carry out performance measurement correctly. Wiesner, McDonald and Banham (2007) reported a survey about the implementation of high performance operations in the SMEs of Australia. The conclusion of this article is that many evidence can be found to prove the ‘high performing’ scenarios have been widely accepted in management practices of Australian SMEs, but still, makeover are needed to let them benefit more from the high performance practices. Sousa et al. (2005) investigated the level of knowledge about PM and measurement in Portuguese SMEs; the “training of employees” and the “low skills to select the appropriate PM tools” were identified as two main obstacles in the PM of SMEs in Portugal. Similar studies also can be found that conducted in the countries of China (Berrell et al. 2009), Malaysia (Muhammad et al. 2010), Korean (Lee, Kim and Lee 2011), Japan (Miyamoto and Kudo 2013), and US (O'Regan, Sims and Gallear 2007). Regarding the distribution of industries, the current studies cover the manufacturing (Matlay et al. 2009), IT (Garg, Goyal and Lather 2010), service (Phillips and Louvieris 2005), non-profit (Manville 2007) and agriculture (El Makrini 2015).

The SMEs studies of the second type put efforts on applying classic PM frameworks, original or modified, to the enterprises with limited size. Some PM methods and frameworks that have been widely adopted in the large sized firms are reapplied to SMEs.

As one of the most widely applied PM frameworks, the BSC based PM research for SMEs are numerous, and its application can be found in all aspects of PM, such as overall system building up, strategy decomposition, performance measurement, and organisational diagnosis. Most of the cases documented on the application of BSC for SMEs are adopted very similar steps with those in large size firms, which starts from clarifying an SME's overall strategy and decompose its via strategy map method, and then deploy the decomposed strategic factors through measurement or supervising system (Papalexandris, Ioannou and Prastacos 2004; Manville 2007; Bhagwat and Sharma 2007; da Costa Marques, Maria da Conceição 2012). Meanwhile, there is another approach applying the BSC to SMEs by modifying some implemental details of the original framework or applying it in combined with the other methods (Tsalis et al. 2013; Biazzo and Garengo 2012; Singh et al. 2015).

However, some issues exist when applying the BSC to SMEs even its implementation details have been modified in accordance with features of SMEs. As a strategy-decomposition oriented framework, the implementation of BSC always start from a clear strategy, but the absence of the explicit strategies is not rare in SMEs, which limits the scope of application of BSC in SMEs to a large extent (Andersen, Cobbold and Lawrie 2001; Johanson et al. 2006). The quality of human resources is also a frequently-mentioned obstacle in applying BSC to SMEs since the skilled HR and line mangers are crucial in the decomposition and deployment steps of BSC (Andersen, Cobbold and Lawrie 2001; Fernandes, Raja and Whalley 2006). Furthermore, BSC requires the firms to incorporate new knowledge in the strategy implement by instant learning procedures, which also beyond the operational and resources capacity of SMEs (Andersen, Cobbold and Lawrie 2001; Taylor and Taylor 2014; Mitchell et al. 2014).

Apart from BSC, some the other general PM frameworks also can be found to be applied in the PM of SMEs. Many case studies reported to apply the EFQM model to the PM of SMEs and some of them acquired very positive results (Antony and Bhattacharyya 2010; Bayati and Taghavi 2007). Comparing with large enterprises, the best practices of SMEs are more difficult to identify since their inherent nature of rapidly-changing (Taylor and Taylor 2014), and hence, some queries about the applicability of the EFQM in SMEs exist before the first decade of the 2000s (Wang et al. 2004; Kumar and Antony 2008; Castka et al. 2004). In the latest version of the EFQM, its applicability in the SMEs was improved significantly since a SME-specific best practice was included, which focuses more on the characteristics of the European SMEs (EFQM 2016). Moreover, the PM frameworks and tools such as performance prism (Najmi, Etebari and Emami 2012), business scorecard (Kanji and e Sá 2002), and benchmarking methods (Carpinetti and De Melo 2002; Cassell, Nadin and Older Gray 2001) also can be found in the literature about PM of SMES.

The third type of PM research for SMEs holds a narrow view that focuses on the performance measurement operation of SMEs since this is usually the most pressing issues for the SMEs' PM implementation. Some scholars organize and structure the existing issues in the performance measurement of SMEs and further purpose research agendas and practical frameworks against them (Taticchi, Cocca and Alberti 2010; Hudson, Smart and Bourne 2001; Garengo, Biazzo and Bititci 2005; Hudson, Lean and Smart 2001). Meanwhile, some beneficial efforts have been placed on designing specific performance measurement systems for SMEs with considering their managerial and operational characteristics (e.g., limited resources, managerial ability, frequently-changing, etc.) (Martinez et al. 2007; Bhagwat and Sharma 2007; Taticchi, Cocca and Alberti 2010). On the instrumental level, numerous literature has also been documented on the approaches, methods, and tools for performance measurement of SMEs (Bourlakis et al. 2014; Hubbard 2009; Hervani, Helms and Sarkis 2005; Taticchi, Cocca and Alberti 2010).

Since our study will focus on the PM of Chinese SMEs, we now have a close look at PM studies for Chinese SMEs. China being an emerging economy is very different from the western world's mixed economies. Moreover, emerging economies tend to have relatively weak institutions, infrastructure and public resources to support small businesses (Zhang, et al. 2014). Thus, the western world's general assumptions of PM are of limited use.

The majority of Chinese enterprises are SMEs, being more than 50 million, contributing 60% of GDP and employing 75% of the urban workforce (Zhang 2010). In comparison with other countries, Chinese SMEs have their unique internal and external environments.

Regarding the overall PM framework for Chinese SMEs, no new theories or frameworks are found based on the literature survey; most research only applies the PM frameworks or methods designed for the larger scale enterprises to the SMEs, in which, the BSC (Cao, Foster and Watkins-Mathys 2014; Gao 2015; Davison and Ou

2010) and EFQM (Mackau 2003; Leskinen and Takala 2005; McAdam 2000) are the two most common. However, some unique characteristics in the PM operations of Chinese SMEs have been documented widely.

The unstable organisational chart is one characteristic of Chinese SMEs mentioned in many studies. Chinese SMEs' organisational charts change continually to match changing business and policy environments (Wandfluh, Schneider and Schönsleben 2012; Yu and Ni 2013), or more often, the convenience of managerial or human resources. The culture of "setting position for certain employees" further intensified the instability of the organisational charts for Chinese SMEs (Wang, Yan and Huang 2008). Moreover, more than half of Chinese SMEs do not have clear long-term strategies, and this fact strengthens the changing internal environment of Chinese SMEs (Zheng, O'Neill and Morrison 2009). The widespread family businesses ownership is another internal characteristic attributing on unstable organisational charts. According to a study by Song (2012), Chinese SMEs' operations rely more on nepotism and personal charisma than bureaucratic systems and regulations.

Accordingly, to adapt to the unstable internal environment, managers in Chinese SMEs need higher levels of cross-department coordination and communication abilities to meet with management challenges (Ye, Tweed and Toulson 2016). The high staff turnover rate (three times higher than the average level of the other East Asian countries) is another concern for Chinese SMEs; some researchers indicate that lower HRM ability and inappropriate PMS systems are two of the most crucial factors leading to the aforementioned (Xue Cunningham and Rowley 2007).

Apart from the above internal issues, the literature shows a variety of external environmental factors that also influence Chinese SMEs' development. Some researchers state that because of the discrimination from Chinese banking systems, Chinese SMEs emphasize more on their cash flow management than their western counterparts (Ye, Tweed and Toulson 2016). Huang (2009), Wang and Yang (2014) point out that most Chinese SMEs set sales and marketing as their strategic priorities because of large-scale and intense homogeneous competition in all industries. Tang and Tang (2012) urges that with the acceleration of globalisation, Chinese SMEs need to set targets for institutionalisation, informatisation, and internationalisation. More recently, Parnell et al. (2015) stated that the high failure rates among Chinese SMEs are not difficult to understand, due to the information asymmetry in the market, abrupt and changing government policies, and difficultly accessing capability.

In most recent studies on PM characteristics of Chinese SMEs, two pressing issues can be identified. One is frequent adjustments of organisational charts causing PM implementation difficulties as SMEs find it is difficult to handle the subsequent changes in the KPIs and performance plans themselves. However, existing PM frameworks provide little help on this. Another is staff management, especially for the new-generation staffs, which is addressed in Lu (2016).

In this study, we will mainly address the first issue in our new PM framework (Chapter 5) and corresponding case study (Chapter 6).

Chapter 3 Literature Review of R&D Management and Relevant Topics

Determining how to manage R&D performance properly is always a big challenge for managers. On the one hand, the importance of modern R&D activities is drawing increasing attention, since these activities constitute the main source of product and business innovation for modern enterprises. On the other hand, some managers view R&D management as a work of embracing a likelihood of failure, due to the inherent complexity, uncertainty, and difficulty of measuring the outcomes of the R&D process.

These issues add extra challenges to performance management (PM) in R&D units. In fact, most widely-used, generic PM frameworks are limited in terms of their ability to guide R&D PM, since very few of them take into account the unique nature of R&D operations. Thus, managers can only obtain limited help from the current PM frameworks when faced with critical issues in R&D PM, such as forming R&D performance generation processes tailored for the R&D strategies and business environment, which often require thorough studies of the R&D management; and properly assessing and managing the competency of R&D staff, as mentioned in Chapter Two and to be discussed later in this chapter.

Thus, we believe that it is unnecessary to draw a clear boundary between R&D management and PM when seeking to establish an effective performance management system (PMS) in R&D units. Therefore, in this chapter, we review R&D management and PM in R&D units together.

3.1 Definition of R&D

The term R&D stands for research and development, also known as RTD (research and technical development) in Europe. It refers to activities of corporate or governmental innovation (Tirpak et al. 2006).

R&D can be described from two perspectives – macro and micro. The definitions constructed from the macro view regard R&D as activities driven by a certain social structure; hence these definitions mainly emphasize the role of governmental bodies in the R&D process. The micro definitions, on the other hand, treat R&D as a series of technology and/or product innovations that occur in organisations. As a consequence, micro definitions focus on the mechanism or procedures of R&D in the organisational context.

A representative definition of macro R&D is given by the Organisation for Economic Co-operation and Development (OECD); it is the most widely-used definition, with international influences.

The OECD first attempted to define R&D activities in 1963, with its Frascati Manual (1st edition). After a half-century's worth of revisions, the definition has been adopted by many scholars, corporations and government organisation, including the National Science Foundation (NSF), United Nations Educational, Scientific and Cultural Organisation (UNESCO) and the European Commission (EC). In the latest Frascati Manual, R&D activities are defined as follows:

> *Research and development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications. (OECD 2005, p.116)*

Apart from defining the concept, the OECD also classifies R&D into three basic groups:

- ***Basic research*** *is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view;*
- ***Applied research*** *is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective;*
- ***Experimental development*** *is systematic work, drawing on existing knowledge gained from research and/or practical experience, which is directed towards the production of new materials, products or devices; the installation of new processes, systems, and services; or the substantial improvement of those already produced or installed. R&D covers both formal R&D in R&D units and informal or occasional R&D performed in other units.*

The OECD defines R&D in a very general sense, and many studies point out that related concepts, such as science and technology (S&T), engineering and innovation are also included in the OECD definition to a large extent.

Micro R&D definitions focus on the mechanisms or procedures of R&D in the organisational context. Common perspectives din such micro definitions include R&D's function (Roman 1968), role (Gupta and Wilemon 1996) and process (Gassmann 2006). Although these definitions reveal some features and characteristics of R&D, they only explain parts of the whole.

The definition of R&D put forward by the System of National Accounts (SNA) is a relatively comprehensive effort on the micro level. It states the following (The Organisation for Economic Co-operation and Development 2002, p.176):

> *R&D is an activity undertaken for the purpose of discovering or developing new products, including improved versions or qualities of existing products or discovering or developing new or more efficient processes of production.*

The SNA definition takes a perspective that includes proper abstraction to explain R&D activities – it both interprets R&D activities in an organisational context and covers all main factors on the micro R&D level.

Comparing the two classes of R&D definitions, micro R&D is more in line with the purpose of this research, as it can be applied to explore an R&D PM framework on the organisational level. Therefore, SNA's R&D definition will be adopted in the present research.

It must be noted that even micro R&D activities can show significant internal diversity, depending on whether they are carried out in the public or private sector.

The clarity of aims is one difference between public and private R&D. Rainey et al. (1976) outline how the aims of public projects are more ambiguous compared to the private sector because such aims always refer to general public needs instead of specific customers' demands. Ring and Perry (1985) further argue that: low degree of market exposure, strict legal and formal constraints, influences from interest groups, and complex objectives, are main reasons for ambiguity in the objectives of public projects. Guellec, Pottelsberghe and Potterie (2003) strengthen this point by analysing R&D projects funded by the U.S government in the 1990s. They conclude that the lack of clarity in the aims of U.S. public R&D funding is caused by the belief that government should foster the propensity to invest in R&D rather than conduct it directly.

The level of market exposure is another perspective mentioned by several studies. Foray, Mowery and Nelson (2012) state that public R&D tends to foster diversity and competition in the national innovation system, which runs opposite to market principles due to their high costs and uncertainties. National security concerns and international competition needs also push public R&D away from the market side (Jaffe and Lerner 2001; Mowery 1998). In a stark contrast with public R&D, high market exposure is a critical factor that enhances the competitiveness of private R&D (Barreto and Kypreos 2004), and such exposure can be reflected in the location of markets (Rothwell 1994), the identification of customer needs (Cowan and Jonard 2004), the control of R&D time cycles (Roman 1968) and the on-time adjustment of products (Foray, Mowery and Nelson 2012).

Moreover, due to the otherness of market exposure, public and private R&D further differ in terms of resources utilisation (Whorton and Worthley 1981), pricing (Griliches 1991) and performance evaluation (Coccia 2001).

In accordance with our research purposes, we will focus on the literature regarding R&D activities in profit-making organisations.

3.2 Generations of R&D management

R&D management is a very broad concept that can be defined as a combination of the tasks of innovation management (i.e., creating and commercializing inventions) and technology management (i.e., external and internal creation and retention of technological know-how) (Coombs 1996; Meyer and Mizushima 1989; Gassmann 2006).

In practice, the topics regarding R&D management include but are not limited to:

1) Basic & applied research;
2) New technology development;
3) New product development;
4) Prototyping;
5) R&D portfolio management;
6) Management of R&D operations;
7) Technology transfer;
8) R&D related activities in functional departments (i.e., R&D HRM, R&D PM, etc.).

A comprehensive review of these topics is beyond the scope of this Ph.D. thesis. Therefore, only the literature on the topics relevant to this study will be covered. Since we will later be studying suitable R&D operation procedures for classic Chinese manufacturer SMEs, we will concentrate on the driving force, management approach, and dominant structure of management of R&D operations, and their relationship with strategy. These topics will be presented based on the timeline of their appearance.

3.2.1 Types of generation classifications for R&D management

R&D operation and management have gained increased attention since the end of WWII, following the trends of the Cold War and the Information Revolution. In the past century, a vast number of theories and frameworks regarding R&D management have arisen, and a trend can be observed in which the emphasis of R&D management has been moving from a focus on technology to the interactions between R&D processes (Rothwell 1994).

R&D management can be classified into several generations based on characteristics such as driving force, management approach, dominant structure, and relationship with strategy (Rogers 1997; Rothwell 1994). Dramatic changes in scope, role, and process in R&D management can be identified in terms of different generations (Akhilesh 2014), which have been widely accepted and referenced in the literature.

Rothwell (1994) divides R&D practices and research since the 1950s into five generations based on the motivations and strategic roles of R&D in organisations. The practices and managerial patterns in different generations were introduced in this research.

Rogers (1997) adopts the five-generation framework to further analyse the differences between generations from multiple perspectives. The author concluded that some tendencies can be identified by looking at the progression of the five generations:

- The core of R&D operations shifts from information to knowledge;
- The structures of R&D units shift from bureaucracies to networks;
- The way to manage R&D talent shifts from training/development;
- The scale of R&D shifts from local/nation to transnational;

- R&D strategies shift from competitive to collaborative.

Although four-stage and three-stage frameworks (Roussel, Saad and Erickson 1991; Miller 1981) can also be found in the literature, these simply combine several generations that only have minor differences.

Since the five-stage classification and corresponding standards stated by Rogers (1997) and Rothwell (1994) have been widely accepted in the literature, we will adopt them in our research and discuss them below.

3.2.2 Stage of swing between science and market

According to Rothwell (Rothwell 1994), the first generation of R&D started in the 1950s in the Western countries. In this early stage, the necessity of research had been widely realized in private enterprises, but how to manage it properly was still unclear. Some pioneers of industrial research, such as Xerox and GE, established advanced laboratories, emulating how government agencies carried out giant public research projects. Accordingly, the typical structure and bureaucracy of government R&D were also inherited by the industrial R&D in this era.

During this period, industrial R&D was still in an ‘ivory tower’ (Rothwell 1994), meaning that it was largely independent of enterprise strategies and customer needs, only being pushed by the objective of technological progress. Strictly speaking, the D (development) part of R&D was still missing to a large extent, since the partnership between research departments and the other market-oriented departments was weak and occasional.

Until the mid-1960s, defects in the first-generation R&D were pointed out by many researchers; these defects included low efficiency, low profit contribution and being far from market needs (Roman 1964; Roman 1968). Such shortcomings, however, were corrected in a radical way in the second generation R&D.

Due to fiercer business competition, market needs played a crucial role in the R&D practices of the second generation (Akhilesh 2014). The highly competitive environment led industrial R&D to change radically from being pushed by science to being pulled by the market. At the same time, R&D staffs were also thrown out of the ivory tower and begin to establish tight and regular partnerships with internal and external customers. Indicators like "customer satisfaction" entered R&D staffs' daily work, along with stricter performance appraisal (Roman 1964; Farris 1973). Undoubtedly, the above changes led to tighter integration between R&D departments and overall operations, as well improved R&D efficiency in most industries. However, the scattered market needs also made R&D activities discrete and led to chasing immediate benefits, the ill effects of which were evidenced by many immature products catering to customers' short-term needs during this period (Dunwell, Pitfield and Savill 1971; Clark and Fujimoto 1991).

3.2.3 Stage of balance and flexibility

After swinging between two extremes (science and market needs) in the first two generations, industries tried to find a balance point, leading R&D activities to enter the third stage.

This trend started in the mid-1970s in the Western countries, where most enterprises attempted to cut unnecessary R&D budget to improve productivity due to high rates of inflation and demand saturation at the time (Gupta and Wilemon 1996; Meyer and Mizushima 1989). As pointed out by Baker and Green et al. (1986), a strategic balance between R&D and the other businesses operations was pursued at this stage. Roussel and Saad et al. (1991) describe the process of achieving balance from two sides. Under the pressure of budget controls and brutal market competition, R&D departments began to care about the needs of the organisation's current and future businesses, and marketing and sales staffs also started to consult R&D before setting their objectives. However, the balance in this stage was still hard to come by and fragile due to the lack of corresponding managerial tools. Although some R&D management tools had already emerged in this stage, their influences were still very limited. A dispute happening in the managerial context, as recorded by Erickson (1993, p.34), reflects a typical tension between R&D and marketing departments:

> *The marketing people say, "If you can tell us what you expect to achieve, we can tell you what the market might be." R&D people say, "If you can tell us what the market will value in five years, we will be*

in a better position to give the market what it wants." The gap frustrates everyone but still cannot be filled.

The fourth generation of R&D emerged in the early 1980s and can be viewed as a continuation of the previous period. Some widely used R&D management ideas and tools were developed in this generation under the pressure of time-based competition driven by Japanese enterprises. Gupta and Wilemon (1996) remark that the focus of business R&D in this generation was the shift from isolated technologies or product innovations to placing them into the total business concept. Niosi and Jorge (1999) further state that R&D philosophy in this stage was changed from a linear view to a flexible one. Based on the related literature, such flexibility can be reflected in following aspects:

1) The knowledge owned by different bodies could be exchanged and shared more frequently and flexibly (Håkanson and Zander 1988).
2) The fixed research chain was replaced by a flexible strategy-based research and development process (Roussel, Saad and Erickson 1991).
3) The partnerships between R&D and market-related departments were more flexible. The traditional separation between the R&D, marketing and producing divisions gradually vanished (Souder 1988).

In addition, some R&D frameworks and tools corresponding with this new R&D philosophy also came into being. The Stage-Gate System (SGS) in general R&D operation and the Spiral Model in the IT industry reflect the themes of “flexibility” and “balancing” in this era (Cooper and Kleinschmidt 1993; Cooper 1990; Boehm 1988; Kydd 1997).

3.2.4 Stage of globalisation and digitalisation

The fifth generation of R&D began in the mid-1990s under the trends of globalisation and digitalisation. As rapid globalisation has brought greater uncertainty to the business environment, firms have needed to adapt their R&D to this new situation. Accordingly, many efforts in R&D practice and research have been put into answering the following two questions (Rogers 1996; Rothwell 1994):

1) How can R&D processes be made faster?

2) How can international knowledge and resources be utilized in the R&D process?

R&D in this generation is also largely characterized by digitalisation. Since the end of the 1980s, IT companies, which rely highly on intelligence resources instead of assembly lines for their operations, have come to be benchmarks for business R&D. In this stage, the R&D department does not only interact with the marketing or sales divisions, but additional stakeholders (e.g., competitors, distributors, suppliers, etc.) become involved in R&D activities (Akhilesh 2014). As a result of these broad interactions, the boundary between research and development is also blurred, since separations between functional modules (e.g., research, production, sales) gradually disappear and the entire organisation is united under a singular strategy. Moreover, the new managerial technologies and tools brought by digitalisation also promote R&D practices in this era. For example, cloud-based customer management systems allow staff from the R&D, sales and production departments to form project teams at any time.

In terms of R&D structure in this generation, the matrix structure evolved into its new form – the network structure. The network structure emerged in response to a more heterogeneous modern market, whose customers require diversified and quickly updated products (Tsai 2001). With this background, the task team (sometimes even a virtual team organized online) replaces the division as the basic managerial unit. In a task team, the staff members come from multiple functional modules to cover all issues related to the team's mission, which can range from potential needs identification to mass-produced model design to marketing strategy (Snow and Miles 1993; Rice 1994). Once the task is accomplished, the team will be dismissed and its manpower reallocated to a new team. Due to the high mobility of human resources and formal structure, the clear boundary that used to exist between functional matrixes in the previous stage vanishes and the network emerges. The figure below explains how organisations evolve from a regular style to a random network with growing connections among functional nodes (Cowan and Jonard 2004).

3.2.5 Generations of R&D operations and their associated business environments

We have introduced three main stages in the development of R&D operations. However, we need to point out that the general conclusion that "the latest generation of R&D operation is the best" cannot be drawn here. The reason that the R&D operation can be sorted into generations is that the general market and business environments have changed, each showing its own features (e.g., the "Tech rush" in the 1950s, stagflation in the 1970s, and the IT revolution in the 1990s). Therefore, organisations should analyse the overall environment they are facing and then select a proper R&D operations approach or method to guide their practices.

In the three stages and five generations described above, specific dominant preferences can be observed (Rothwell 1994), such as technology or market enthusiasm in the first stage and the endeavours of linking local R&D ingredients with an international R&D network in the last stage. Accordingly, the modes for organizing and configuring an R&D unit match with those operational preferences; these are often referred to as R&D structures in the relevant literature (Allen and Hauptman 1990; Zhang, Baden-Fuller and Mangematin 2007; Argyres and Silverman 2004; Tirpak et al. 2006).

3.3 R&D structures

Based on the R&D operations models introduced above, some internal features and characteristics can be extracted from the stages of R&D operations. Therefore, in this section, we will introduce four basic R&D structures that are applied sequentially in the above stages.

As has been pointed out by many authors, there are four basic perspectives from which to explain an R&D structure: organisation chart (organisational structure), coordination mechanism, strategic orientation, and culture for innovation (Argyres and Silverman 2004; Badir, Büchel and Tucci 2009; Tirpak et al. 2006).

- **R&D chart** informs both members and outsiders as to how the organisation is inbuilt. Meanwhile, it also determines how R&D activities are directed toward the achievement of organisational aims (Akhilesh 2014). It was widely believed that an R&D organisation chart is the same as the organisational configuration of the R&D department since clear boundaries exist between R&D and non-R&D departments (Tirpak et al. 2006). However, when the matrix or network structural forms emerged in recent decades, those clear boundaries disappeared, and the concept of the R&D organisational chart took on a wider connotation. Nowadays, the R&D organisational chart is not defined by the name of the division; instead, it refers to all organisational components and their partnerships necessary to accomplish R&D activities (Tirpak et al. 2006; Argyres and Silverman 2004). From the aspect of the concentration of authority in management, an R&D organisational chart can be centralized or decentralized. More precisely, the structure can be characterized morphologically into bureaucratic, divisional, functional, matrix and network styles.

- **Coordination mechanism** is another important variable that characterizes an R&D structure; it is defined as a mechanism for managing the interdependencies between activities performed to achieve an R&D goal (Malone and Crowston 1990). If we view the R&D organisational chart as a system dividing an overall R&D activity into components, the coordination mechanism acts to bring them together and ensure that they can run smoothly towards fulfilling the R&D strategy's aims. Depending on the basic managerial unit present in an organisation, the R&D coordination mechanism can be departmental, project-based, product-based or task team-based (Ghosh 2007; Daft and Marcic 2013).

- **R&D strategic orientation** reflects the primary expectation of an organisation with regards to its R&D. Organisations tend to have different expectations for R&D when they experience various competitive contexts. Rothwell (1994) summaries five basic R&D orientations from the 1950s to the 1990s:

    1) Scientific progress;

    2) Customer needs;

    3) Budget control;

4) Time cycle;
5) Wider R&D elements integration.

- **R&D culture** is an overall atmosphere of innovation in the new product development (NPD) and new business development (NBD) processes. As the only virtual element in R&D structure, R&D culture interacts with the physical and operational elements mentioned above and drives R&D staffs internally to accomplish targets. Depending on the concentration of decision-making power in R&D activities, the culture can be classified as follows:

    1) **Power culture**: In this culture, the formal power granted by the organisation is the dominant factor. Since such power is held by a limited number of people, this culture is also known as “authoritarian culture.” Decision-making power is highly concentrated in this type of culture, and as such, regulation and procedures are not that important;
    2) **Role culture**: This is a very typical culture in bureaucratic organisations. Instead of granting power to the certain individual, impersonalized job positions hold power. Therefore, the role and corresponding power granted by the job position are the dominant factors in this culture;
    3) **Task/achievement culture**: This is a culture of low power concentration since all staffs in a job unit share decision-making power equally, and the difference between leaders and non-leaders is not significant. In this culture, the power is owned by the job task itself; hence, all power and resources should be dynamically allocated towards accomplishment of the job task;
    4) **Person/support culture**: this culture has the lowest power concentration level, and the development of individual persons takes the central role in the operation of the organisation.

With various configurations of factors described in the four culture types above, more typical and specific R&D structures can be drawn; these are bureaucratic (divisional), functional, matrix and network.

3.3.1 Bureaucratic R&D structure

Under a bureaucratic R&D organisational chart, the chief of the department plays an absolutely crucial role; almost all important scientific and managerial decisions are made by the top-level manager. The advantage of this structure for R&D is the shortening of decision-making time since fewer individuals are involved in the process. Because of this, consistency can be guaranteed.

However, the disadvantage of the bureaucratic structure is obvious. Creativity and innovation are suppressed in departments organized this way, going against the nature of R&D behaviour. Moreover, it is difficult to find a person who can always make the right strategic and scientific decisions.

In terms of the coordination mechanism, the departmental or project-oriented method is the most commonly employed under the bureaucratic structure. Since the department as a whole is the basic R&D managerial unit, all R&D activities are conducted by following information delivered through formal chains of authority. When simultaneous R&D tasks carried out in the department become too many to be managed by a limited of persons, project-oriented coordination is adopted. By dividing a holistic authority into parts through R&D projects, the department header can have a wider and deeper management scope. However, the information asymmetry and distortion that accompany power decentralisation are common reasons for project failure under this mechanism.

Usually, the strategic orientation of a bureaucratic structure is single-dimensional, following, for example, the intentions of top leaders, science per se or market needs, since too many strategic orientations will lead to chaos and inefficiency in the bureaucratic structure. Accordingly, the typical R&D culture in the bureaucratic structure is the role culture, because formal power is granted to a job position rather than a person.

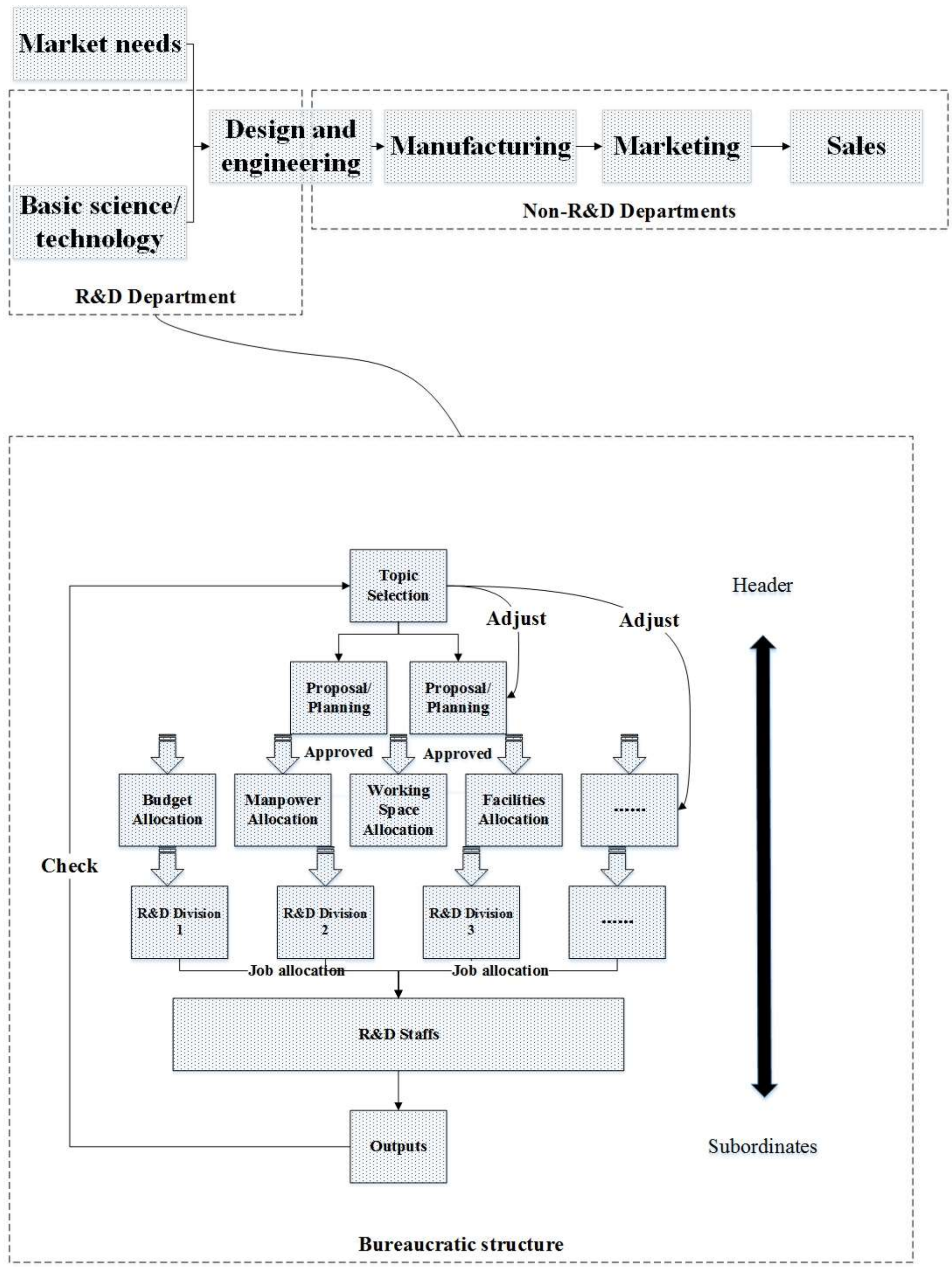


Figure 3-1 Typical R&D processes in a bureaucratic R&D structure

A typical R&D process in a bureaucratic R&D structure is illustrated as in Figure 3-1. We can find linear relationships among all the R&D activities since the power transmission mechanism is linear as well as single-dimensional. The R&D

staffs who actually carry out the R&D activities exist at the bottom of the pyramid; they need to follow orders delivered from technical and administrative managers.

The divisional structure is derived from the bureaucratic structure with the background of a growing business scale and product line. This structure is a combination of several different geographic or specification-based R&D units, which are self-sufficient and equipped with their own resources (see Figure 3-2). However, the characteristics of a divisional structure are largely decided by its sub-structures, since they can be bureaucratic, organic or mixed.

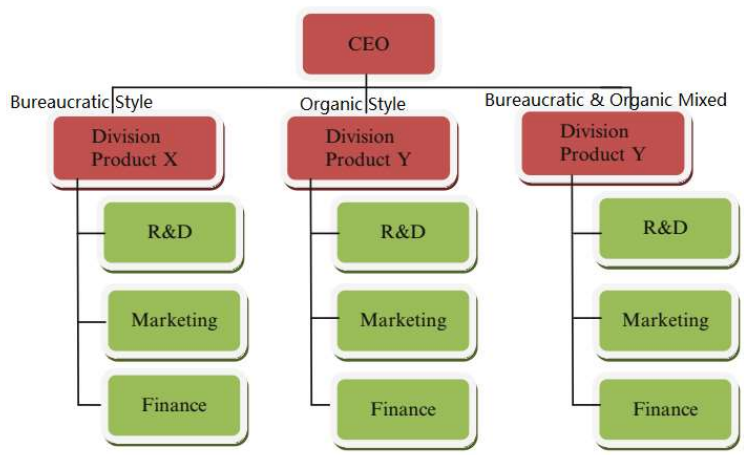


Figure 3-2 Organisation structured in divisional structure

3.3.2 Functional R&D structure

The fundamental idea behind a functional structure is that it divides overall R&D activities into segments based on specialisations in order to promote R&D efficiencies. Under the functional structure, R&D staffs' skills can be improved through long-term practice and training in a particular functional field (Figure 3-3).

Compared with the bureaucratic organisational chart, the control levels in a functional organisation are reduced significantly, since the vertical chain of authority is not the main way that information is transferred. Moreover, most of the divisions under this organisational chart have the same authority level and are linked by the procedure used to accomplish a certain R&D task. The independence of the R&D

department is weakened, largely because it needs to establish wider partnerships with the other functional blocks (Figure 3-4).

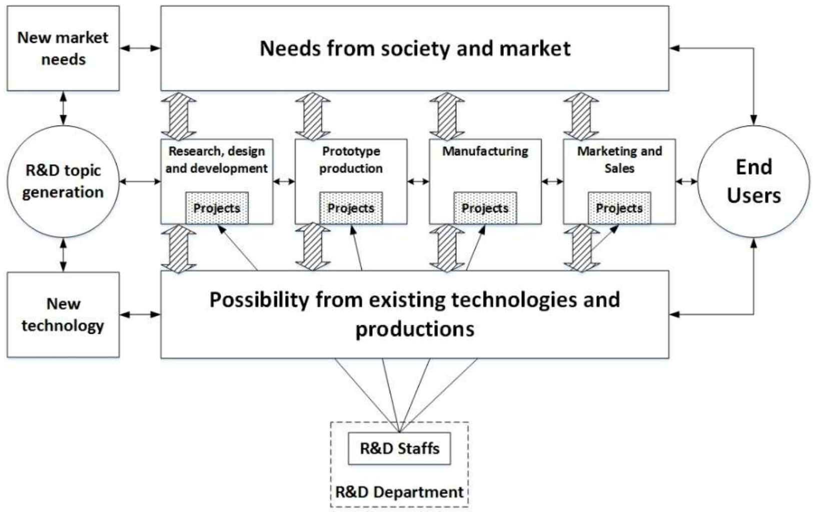


Figure 3-3 Typical R&D processes in a functional R&D structure

The functional structure also brings with it new challenges in terms of coordination of R&D activities. Time control, resource allocation, information communication and even office politics are all potential stumbling blocks that can lead to failure. Accordingly, it is very difficult, if not impossible, to manage all functional units in a bureaucratic way – i.e., by letting a top manager handle all decision-making and coordination. Therefore, project-based R&D operation is the main coordination mechanism used under this structure. Distributed authority can reduce the risks brought about by decision-making errors or coordination failures.

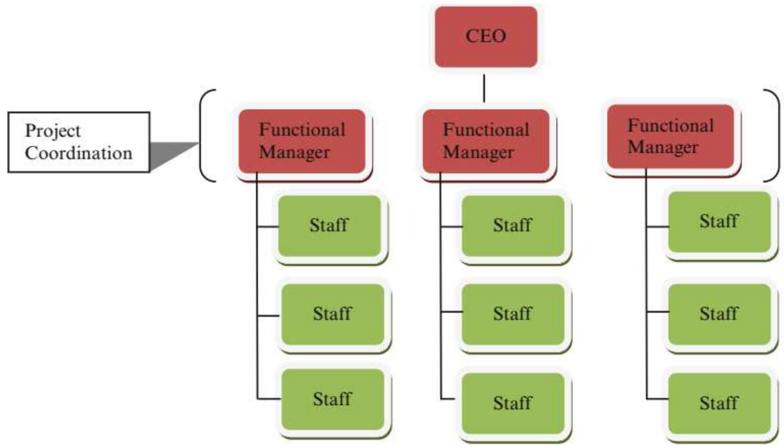


Figure 3-4 Organisation structured in functional structure

There are several implementation frameworks used to create functional R&D units. The two most representative ones are the linear and nonlinear frameworks, which will be discussed in Chapter 7, where we discuss how to build a functional R&D unit for classic Chinese manufacturer SMEs.

3.3.3 Matrix R&D structure

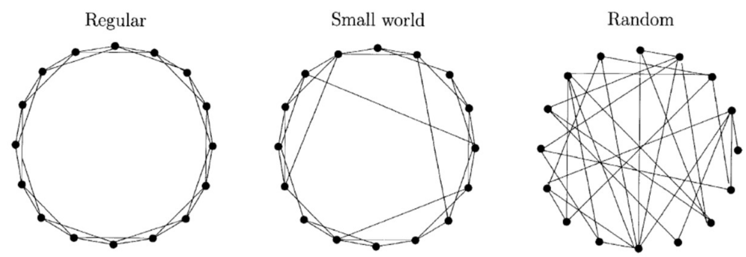
If we say specialisation is the only crucial factor to consider when forming a functional structure, an organisation needs to take both specialisation and product into account to build a matrix structure. In a matrix-structured firm, "team" replaces "project" as the basic managerial unit, and the team is organized toward accomplishing a strategic target instead of a technical or scientific aim. The matrix idea deconstructs R&D staffs' solid identities, which means they can no longer simply call themselves scientists or engineers – practical and theoretical knowledge about marketing, sales and producing all enter into the core of their daily work.

However, the matrix-based structure also brings the challenges of multiple sources of authority and how to function cohesively. Gerstner Jr (2009) points out that the matrix structure requires an organisation to have very high management capability to improve staff commitment, coordination, and ability. This may explain why very few successful cases of matrix structure (e.g., IBM) are reported for this generation. It was not until a decade later when managers were equipped with more powerful theories and technologies, that this structure became really widely applied.

3.4 Network R&D Structure

There are two types of sub-networks in a network R&D structure: internal and external. An internal network is made up of members who were selected based on the needs of the task to be accomplished; they have various horizontal and vertical specialisations (Snow and Miles 1993; Akhilesh 2014). External networks, on the other hand, consist of several legally and economically independent corporates aiming and cooperating to optimize resources in their R&D processes. Both networks are decentralized to a large extent since they are organized by the logics of task accomplishment or resource optimisation, rather than bureaucracy (Snow and Miles 1993) (see Figure 3-5).

Similar to the other structures, the network structure has its pros and cons in practice. Within-team communication and work independence are two significant advantages of the network structure and these advantages further contribute efficiency and flexibility to the organisation (Reagans and McEvily 2003; Schilling and Phelps 2007). As has been pointed out by several researchers, members of small teams tend to feel more responsible and accountable, as they directly contact different nodes or people to seek information and solve problems (Schilling and Phelps 2007; Gandal, King and Van Alstyne 2009; Tröster, Mehra and van Knippenberg 2014). Moreover, operational budgets can be better focused on core workflows instead of administration by lessening the role of fixed departments (Gassmann and Von Zedtwitz 1998; Achrol and Kotler 1999). Lastly, a performance-oriented culture is deeply rooted in this structure, since each member's performance can be evaluated and rewarded more easily based on importance and contributions (Hanisch and Wald 2011; Jansen, von Görtz and Heidler 2015).



Source: *Watts and Strogatz (1998)*

Figure 3-5 Process of transition from a regular structure to a random collaboration matrix

Like a double-edged sword, the potential problems of the network structure accompany its merits; the independence of each unit makes coordination on an organisational level difficult since no one person can represent the whole team to make a decision. Here, the team leader is more like a technical supervisor than a duly authorized manager (Miles and Snow 1992; Snow and Miles 1993).

At the same time, a team leader without formal authority can do very little to push his staff, even if the job is seriously delayed or has very urgent status. A temporary or weak leader also negatively impacts subordinates, since they usually work without any guidance or feedback (Miles and Snow 1992; Akhilesh 2014).

Moreover, the flexibility and mobility of manpower make skilled workers feel overloaded all the time since the constant allocation of human resources is mandatory (Gandal, King and Van Alstyne 2009; Tröster, Mehra and van Knippenberg 2014).

3.3.4 Summary of four basic R&D structures

One interesting phenomenon that can be observed in the history of R&D development is that enterprises have tended to adopt a certain R&D structure, like a “fashion,” in any given historical period – such as the bureaucratic structure in the first R&D stage or the matrix structure in the second R&D stage. However, we cannot simply conclude that an R&D structure that has emerged later is superior or more advanced than the earlier structures.

Table 3-1 Features and characteristics of the four basic R&D structures

Organisation chart	Main coordination mechanism	Strategy orientation	R&D culture
Bureaucratic	*Department-oriented management*	*Single dimension (Science or Marketing)*	*Role culture*
Functional	*Project-oriented management*	*Balance and flexibility*	*Task/achievement culture*
Matrix	*Team management*	*Integrating of multiple operational factors*	*Task/achievement culture*
Network	*Task-group management*	*Integrating of multiple operational factors and stakeholders*	*Person/support culture*

On the contrary, the above stated facts support the idea that the R&D structure should be chosen to fit with the practical situation of an organisation. The macro-economic and market situations, plus the constraints of the management technology and method in certain historical periods have led to the dominant R&D structures in those periods.

Table 3-1 summarises the features and characteristics of the four basic R&D structures.

3.4 Competency and the competency model in R&D

As mentioned above, measuring performance properly in an R&D unit is always a big challenge for HR and R&D managers, due to R&D's nature of uncertainty, fuzziness, and people-orientation. Nonetheless, the emergence of the competency theory and the competency model methods offer a new way to manage and improve R&D performance. By involving competency factors in R&D PM, the above challenge of performance assessment can be largely relieved, since the emphasis of measurement shifts from R&D outcomes to their producers. Moreover, carrying out PM using competency factors is in line with the people-oriented nature of R&D operations, and the systems of PM and people management become well-integrated.

Thus, we will concentrate on the research relevant to the competency model in the analysis below.

3.4.1 Introduction to the competency model

The concept of competency is continually evolving with changes in social environments and the understanding of researchers.

McClelland (1973, p.241) first defined competency from the perspective of Giant Theory as "*the necessary knowledge, skill, ability and traits for high-performance employees*." Mclagan (1980, p.288) then redefined the concept from the perspective of "people-job matching" as "*the necessary knowledge, skill, and ability for employees to satisfy their job requirements.*"

In the 1990s, with significant progress in the domain of psychology, scholars and practitioners realized that it was impossible to exhaust all competencies or competency factors, even in the most generalized manner. Accordingly, the definitions in this era changed from being absolute (i.e., trying to list all key competencies underlying good individual performance) to relative. Spencer (1993) thus defines competencies as the measurable underlying characteristics that can separate high performance employees from the rest. Mansfield (1996) further defines the competency model as a detailed, behaviourally specific description of factors that employees need to be effective in a job.

In different research fields, the roles and functions of competency model (CM) given by researchers also differ. For instance, some researchers devote to explore measuring ways to quantify a person's underlying capacity (Burgoyne 1993); another some try to help organisations to benefit from evaluating and managing the traits and occupational capacity of their staffs (Burgoyne 1993).

In the initial stage of CM research, this theory is viewed as a tool for human resource development through the identification of a portfolio of key characteristics for a certain job position. Such general characteristics or competencies include aspects like key knowledge, skills, individual characteristics and work behaviour patterns (Sanchez and Richard 1990). With the development of CM research in terms of depth and breadth, additional roles that CM can play in the organisational management process have been pointed out. Mclagan (1996) argues that all individual-level human resource decisions can be made based on the CM method because compared to the traditional job description approach, the CM model better matches individual characteristics with organisational needs. Furthermore, Mclagan and Michell (2002) state that with the help of CM model, it is possible to construct a "hologram" containing all key information about the individual, and then to construct an "individual-based" human resource management system for organisations. In addition, the CM model can help firms enhance their individual performance (Boyatzis 1982), carry out more individualized management activities (Mansfield 1996) and offer individual information to the HRM system to improve the effectiveness of all HRM steps (Patterson et al. 2000).

3.4.2 Methods for competency identification

A variety of methods can be applied to construct the CM model, and the choice of method in the CM research is related to the focus of the competency dimensions. For instance, the behavioural event interview (BEI) method, which will be introduced in detail below, is more suitable if the CM model is based on working behaviour. Similarly, the generic model overlay method should be used when constructing a comprehensive CM model. Generally speaking, the following three methods are the most widely-used methods in the CM research field.

- Behavioural Event Interview Technique;
- (Modified) Job Competence Assessment Method;
- Customized Generic Model Method;

3.4.2.1 Behavioural event interview technique

The BEI technique is the most common used method for competency identification. It requires the participants to represent working scenes they had experienced, and the answers are not necessary to be well-organized. Nonetheless, the emphasis of the interviewers is the competency information delivered from the participants, which causes positive or negative performance of them. Comparing with the other similar tools, BEI has a wider scope in gathering competency factors since not only behavioural information but also inherent factors motivate these behaviours will be flagged (Draganidis 2006).

The basic steps for constructing a CM model via BEI are as follows:

a) Select the standard performance level in the organisation and determine the sample range based on above performance standard line;

b) Carry out the BEI and collect performance-related information for the individual;

c) Analyse the collected information and find causal relationships. Then construct the initial CM model;

d) Collect more information via BEI and use this information to test and improve the model until it is sufficiently validated.

3.4.2.2 Job competence assessment method

The Job competence assessment method (JCAM) consists of a serial of strict procedures to extract performance relevant factors based on the participants' structured descriptions (Dubois 1993). The essence of JCAM is differentiating performance-promoting behaviours from the normal ones under a certain managerial environment or context. Once the potential performance-promoting behaviours have been clarified, the other methods will be applied jointly with JCAM to develop specified competency factors (Dubois 1993). The modified JCAM method is similar, but critical behaviour stories are written down rather than told in a face-to-face interview.

The JCAM is not a comprehensive method that can develop competency factors by the sole application. However, it can locate and extract working behaviours relevant to competency, and further help the other tools (such as BEI) to develop competency factors for organisations.

3.4.2.3 Customized generic model method

The Customized generic model method (CGM) is a method that helps organisations to develop specified competency factor in accordance with their needs from general ones. Usually, the competency factors listed in the literature are too general to be applied directly in business, therefore, the CGM alike methods are needed to further specify these factors.

The CGM starts from asking users to identify a number of generic competency factors that contribute to good individual performance in their firms. Furthermore, the operational and managerial context of the organisation will be taken into account to generate more explicit and pertinent factors through refining and interpreting those generic ones. Next, the customized competency factors will be testified and adjusted in the operation and management of the organisation until they are valid and effectively enough (Dubois 1993).

3.4.3 General competency model

In the 1970s, the American Management Association carried out a five-year investigation of 1,800 senior managers and found that the key factors for high-performance managers are knowledge, motivation, traits, self-recognition, social role and skills (Hayes 1979). This investigation is viewed as the first attempt to apply CM theory to practice.

Boyatzis (1982) investigated more than 2,000 managers across the public and private sectors using BEI and Perceptual Learning Style Preference questionnaire (PLSPQ). The author then constructed a CM model with six aspects (managerial target, leadership, HRM, underling direction, other-regarding and professional skills) and 19 detailed factors.

Spencer (1983) surveyed 216 managers with a cross-cultural background and found that the factors distinguishing high-performance managers from the rest can be divided into four types: achievement, sophistication, control and monitoring, and synaesthesia.

Since the 1990s, large-scale investigations like the above have become rarer. Instead, more specific CM research conducted in certain industries or with certain types of employees has increased.

Carless and Allwood (1997) looked at the managerial activities of several consultation company heads and found that the competencies of professional firms' managers include decision making ability, interpersonal relationships, planning ability and organisational capability.

Herbert (1999) carried out a seven-year survey of senior managers in British and Irish companies. In this research, the managers' bosses, instead of the researcher, recorded the managers' performance on 12 competency factors. Then, using principal component analysis (PCA), the researcher identified 12 competency factors.

The CM theory was introduced in China in the mid-1990s, after which some interesting studies on Chinese cultural characteristics emerged.

Wang and Cheng (1999) extracted ten competency factors for managers in state-owned enterprises. Yao and Wang (2004) pointed out five basic factors that are the core competencies for managers in Chinese IT companies. Zhang and Wei (2005) analysed the job contents of managers in Chinese commercial banks by the work analysis method and identified five character dimensions that lead to high performance of these companies. For clarity of presentation, the competency models discussed above are summarised in Table 3-2.

Table 3-2 Summary of some general competency models

	Methodology	Sample	Competency factors
AMA (1970)	Work Behaviour Inventory	1,800 senior managers	· knowledge · motivation · traits · self-recognition · social role · skill
Boyatzis (1982)	BEI PLSPQ	2,000 managers in both public and private sectors	· managerial target · leadership · HRM · underlings direction · other-regarding · professional skills

Spencer (1983)	BEI	216 managers with cross-cultural background	· achievement · sophistication · control and monitoring · synaesthesia
Caress and Allwood (1997)	BEI	13 Australian consulting company heads	· decision making ability · interpersonal relationships · planning ability · organisational capability
Herbert (1999)	Self-evaluation sheet PCA	senior managers at British and Irish companies	· strategic thinking · analysis and judgment · planning and organizing · management of underlings · persuasion · decisiveness · sensitivity · oral communication · adaptability · energy · motivation
Wang and Cheng (1999)	Job analysis	220 managers in 51 Chinese state-owned companies	· achievement · sophistication · social relationship network
Yao and Wang (2004)	BEI	332 managers in the Chinese IT companies	· charisma · adaptation · strategic thinking · social relationship network · character and morals
Zhang and Wei (2005)	Focus Group Interviews BEI PCA	Middle-level managers in 23 Chinese commercial banks	· information collection · idea presentation · professional knowledge · cooperation · self-motivation · communication

3.4.4 Competency models designed for professionals

The competencies of R&D staff are some of the most important factors for determining the performance of R&D units. However, the competency factors of R&D staff are much more complex, and very difficult to measure. Monk (2001) used the repertory grid technique and work profiling method to identify the competency factors for auditors in South Africa. First, the repertory grid technique was used to summarize the core individual factors of successful auditors. Then, with the help of the work profiling method, the crucial working processes were summarized and categorized into four types. In the conclusion, Monk states that intellectual, interpersonal and communication skills, plus several individual character factors, lead to high performance of the auditors.

Kagaari and Munene (2007) used a 32-item competency interview guide to interview junior staffs of several universities' engineering departments. In this interview guide, the essential working contents of engineering school lectures were self-described by behaviour such as "I keep reading the latest research in my field and try to follow and improve the interesting ones." Such behavioural descriptions were then summarized using short phrases such as "focus on the latest research trend" and "do follow-up research." Finally, all information collected from the interview was used to construct a competency model for extraordinary lectures in the engineering schools.

Fouad et al. (2009) stress the importance of the benchmark method in research on professional employee competency. Based on the competency cube model, the researchers developed a five-dimension model including competency benchmarks for the identification of professional competency factors.

Tripathi et al. (2010) constructed a CM model for researcher performance assessment using the Personality, Ability, Knowledge, Skills (PAKS) model. Unlike most of the competency research, a literature-based competency abstracting approach was employed, and a 14-factor CM model for the researchers is stated in the conclusion of the research.

Liao (2012) also employed the PAKS model to study innovation researchers' competencies in R&D organisations. In this research, besides using the BEI method, the autobiographies of extraordinary Chinese researchers were also viewed as a source of secondary information. In the end, the author identified 43 CM factors. Table 3-3 summarises the competency models designed for professionals.

Table 3-3 Summary of competency models designed for professionals

	Methodology	Competency factors	
Monk (2001)	· Repertory Grid Technique · Work Profiling method · Critical Incident Technique	· Technical skills · Information gathering · Problem analysis · Management control/objective setting · Execution · Initiative · Building and maintaining relationships · Team work · Providing direction · Flexibility · Self-motivated · Attitude toward work · Image · Confidence	
Kagaari and Munene (2007)	· 32-item interview guide from Munene et al. (2003) · OCB test instrument	· Assess and evaluate · Design and implement · Plan, organize and Supervise · Set admin and mark · Career guidance and counsel Organisational citizenship behaviour	
Fouad et al. (2009)	· Competency cube · Benchmark method	Foundational competency	· Integrity-honesty · Personal responsibility · Adherence to professional values · Accountability · Concern for the welfare of others · Professional Identity
		Personality	· Reflective practice · Self-assessment · Self-care
		Knowledge	· Scientific mindedness · Scientific foundation of professional practice
		Skills	· Interpersonal relationships · Affective skills · Expressive skills
Tripathi et al. (2010)	· Literature research · PAKS Model	Personality	· Assertiveness · Competitiveness · Self-sufficiency · High emotional stamina

			・High Energy Level
		Ability	・Mental ability ・Divergent thinking ・Quantitative research
		Knowledge	・Technical ・Practical knowledge on the subject ・Latest trends and research related to the subject
		Skill	・Communication ・Problem Solving Skills ・Presentation Skills ・Coaching and Training Skills
Liao (2012)	・Thematic Apperception Test (TAT) ・BEI ・Autobiography Analysis	Professional Knowledge	5 factors
		Thinking Pattern	8 factors
		Ability	12 factors
		Character and Motivation	17 factors

3.4.5 Summary of current research

From above literature review, we can see that there are three approaches to CM model construction.

The first approach is performance oriented, and can be represented by McClelland (1994)'s works. In this approach, the organisation's expectations of employees are placed in the fundamental position and the implicit assumption of this approach is that "we know the exact meaning of 'performance." The job of CM is just to determine what kind of employees can best achieve this performance. For R&D units, whose performance attributes are not clear, use of this approach alone will not solve the problem.

The second approach is based on the vision and mission of the organisation, and the research question under this approach is What kinds of employees can best support the accomplishments of the vision and missions? However, the linkages among vision, mission and operations are not always explicit, and under some circumstances, the generated competency factors cannot fully support operations, since they may be either inexplicit or too general.

The third approach is based on matching the employee, job position and organisation. Here, the key success factors are the intermediary variables between employees and the organisation. Thus, the key research steps under this approach are 1) finding the key competency factors for a certain job position by looking at the organisational strategy, 2) measuring the employee's competency factors, and 3) checking the degree of match between the employee and the position.

In the studies described above, several professional competency dimensions were identified to describe the core perspectives of professionals' work. Different from other job types, professionals' works performance aggregation processes are highly complicated, so it is difficult to describe these jobs using performance-oriented models such as the iceberg competency model or by behaviour-based models like the four-ability model. In comparison, the PAKS model is the most commonly-used competency assumption for research related to professionals, because three of its four dimensions are on the individual level, matching the highly individualized character of professional work. However, from the research of Monk (2001) and Liao (2012), we can still find inadequacies of the PAKS model, the most obvious one being the ignorance of ethnic and professional interest factors.

3.5 R&D performance management

In the preceding sections, we have conducted a comprehensive survey of the operational characteristics, organisational features, and competency models of R&D units. However, as a purposefully designed segment within an organisation, the R&D unit functions by yielding the performance desired by the organisation. Thus, in this section, we will review the literature regarding PM in R&D units.

Aroused by the changing business environment of the last decades, topics relevant to R&D PM have drawn increasing attention (Li and Yue 2005; Stock and Reiferscheid 2014). The following environmental factors have motivated the boom in R&D PM the most (Stock and Reiferscheid 2014; Lee, Kim and Lee 2011; Chiesa and Frattini 2007; Tirpak et al. 2006; Von Zedtwitz 2006; Li and Yue 2005):

- Strengthening market competition;
- Faster-changing customer requirements;
- Highly differentiated products;
- Growth of adoptable technologies;
- Increasing government regulations.

Although the critical role of R&D PM has been realized progressively, frameworks specifically designed for R&D PM have not been fruitful.

Mwita (2000) constructed a general PM framework to be used mainly for R&D management in the public sector; it consists of the following:

- The employment of professional managers;
- Explicit standards and measures of performance;
- Greater emphasis on consistency of services;
- Decentralisation;
- Increased competition between organisations and sub-units;
- Emphasis on private-sector management styles;
- Increased accountability and parsimony in resource use.

Chiesa et al. (2007) developed a comprehensive R&D PMS with six basic steps. The authors state that measuring the achievements in these steps is the main challenge in the implementation of the framework. The steps are as follows:

- Diagnostic activity supporting resource allocation;
- Motivating personnel;
- Enhancing communication and coordination;
- Learning;
- Reducing R&D risks;

- Improving R&D performance.

The above frameworks assume that well-functioning R&D procedures exist and in the organisations. However, such frameworks can deliver very limited help for rebuilding or improving problematic R&D operations, except when applied with business reengineering steps (Salimifard, Abbaszadeh and Ghorbanpur 2010; Aremu and Ayanda 2008), which cost extra resources and time.

Masella and Chiesa (1996), and Chiesa, Frattini and Lazzarotti (2009) conducted a series of works to develop a performance measurement-oriented framework for R&D units. Some characteristics of R&D operations are taken into account in the system, and its efficacies are also proofed in multiple case studies.

Although it has been well-known that performance measurement is the central challenge in managing R&D performance, the design of PM frameworks has been widely criticized in recent years (Procurement Executives' Association (US) and United States. Dept. of Commerce 1998; Amaratunga and Baldry 2002).

Mintzberg (1993) describes the following characteristics of organisations with highly complex working contents:

- Highly complex and crucial operating core;
- The "pigeonhole mechanism" exists in the coordination of the core;
- The suitable coordination ways are the standardisation of skills and norms.

Inspired by Mintzberg's (1993) work, Wang (2015) and Xue, Yi and Liu (2016) designed PM frameworks for research organisations based on the six general steps of PM. The key points of each step of R&D PM are shown in Table 3-4.

Table 3-4 Key points of R&D PM in six-step framework

Step	Key Points
Strategy positioning	1. The R&D staff in the core operations should be involved 2. The headquarters and core operations should have rounds of discussion in the positioning process
Strategy decomposition and deployment	The "bottom-up" style of decomposition and deployment means that the core operations may lead the processes.
Performance planning	R&D staffs initiate the planning, and line managers discuss and finalize

	the performance plan based on the staffs' proposals.
Performance guidance	This step is highly crucial in an R&D organisation (or unit), and the guidance should be given by the senior technicians instead of line managers or HR managers
Performance measurement and appraisal	The performance appraisal should focus on both the 3E indicator of R&D staff and the accumulation of the human capital on an organisational level.
Performance feedback	The appraisal is not the end of in R&D organisations, since feedback and improvement of the results of the appraisal are even more important. The feedback can be given by senior technicians and technical managers in the R&D organisation or unit.

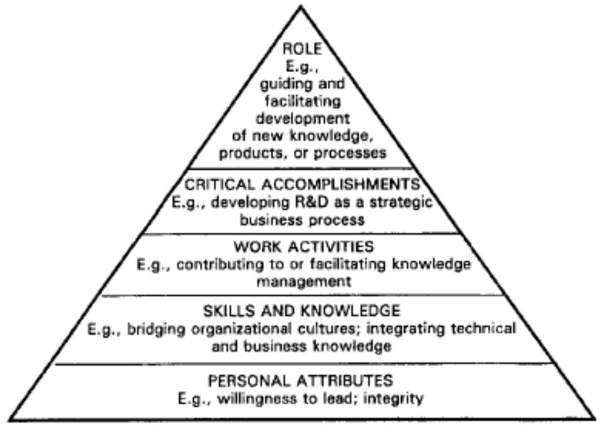
The competencies of R&D staff are another highly weighted factor in many frameworks. Baldwin, Sabourin et al. (2003) looked at the relationships between numerous competency factors and R&D performance in the food industry, and identified 12 competency factors that most contribute to R&D performance as shown in Table 3.5.

Table 3-5 Twelve key organisational competencies for R&D performance

Variable
Markets - introducing new products in present markets - introducing current products in new markets - introducing new products in new markets
Technology - using technology developed by others - developing new technology - improving existing technology
Management/Human resources - continuously improving quality - introducing innovative organizational structure - using information technology - continuously training staff - introducing innovative compensation packages - recruiting skilled workers

Source: *Sabourin et al. (2003)*

Rifkin, Fineman et al. (1999) present a PM approach design for technical managers, in which a pyramid-shaped competency model is drawn to guide PM for R&D managers (see Figure 3-6).



Source: *Rifkin, Fineman et al. (1999)*

Figure 3-6 Pyramid-shaped competency model for R&D managers

Furthermore, the competency factor is placed at the heart of the framework in the studies of Hurmelinna, Peltola et al. (2002), Hoang and Rothaermel (2005, 2010), and Tsai and Wang (2004).

These competency-based frameworks shed light on the importance of the staff competency in R&D operations, but the instrumental details of the frameworks do not reflect the latest developments in the domain, such as the subjective and time-consuming approaches for competency measurement introduced by Rifkin, Fineman et al. (1999) and Hoang and Rothaermel (2010).

Apart from the handful of PM frameworks designed specifically for R&D operations, the more common situation is that R&D PM is reported as a subordinate in general PM studies (Brentani and Kleinschmidt 2004; Chen and Huang 2009; Wood 1999; Bassioni, Price and Hassan 2004; Mohrman and Mohrman 1992; Bose 2006). Subsequently, a vast number of PM framework architectures for generic managerial contexts are adopted in R&D PM.

The balanced scorecard framework is one of the most widely-adopted PM frameworks for R&D operations in the current literature. Gough et al. (1994) designed a BSC-based performance framework for R&D organisations, and specific elements in the framework were crafted based on the four dimensions of the BSC. Similarly, Liang (2011) created a BSC-grounded strategic PM toolkit for the research context, and the performance diagnosis and improvement stages of the toolkit are carried out according to the dimensions of the BSC. Furthermore, García-Valderrama (2008), Sartorius, Trollip and Eitzen (2010), Soderquist and Godener (2004), and Amaratunga et al. (2010) also apply the BSC to R&D PM, but in these frameworks the emphasis is placed on the dimensions of strategy accomplishment, profit management, internal operations, and HR development, respectively.

To a large extent, the BSC framework can guide PM operations in R&D units using formed and stable procedures for performance generation; the top objectives of the units can be smoothly decomposed layer-wise. However, the effectiveness of the BSC framework is questionable if the units are in a changing environment or the existing procedures need further improvement, since the decomposition cannot carry on if the procedures are altered.

In the current field of research, the EFQM framework is also often adopted for R&D PM. Tarí and Madeleine (2010) present an R&D PM framework developed from the EFQM framework, in which the self-evaluations conducted by R&D staffs are the main vehicle for carrying out the PM. Afterwards, the framework was further modified four dimensions were extracted for PM in R&D units: procedures, difficulties, benefits, success factors and management evaluation (Tarí 2012).

No strong conflicts exist between the benchmark frameworks and R&D operations, but these frameworks can only deliver very limited help to R&D units in building up a PMS or carrying out comprehensive PM. Helping R&D units to compare their operations to the best practices is the main function of these frameworks.

Some widely used generic PM frameworks, such as the performance prism (Neely et al. 2003; Adams and Neely 2000) and the performance matrix (Griffin and Mahon 1997; Yin, Qin and Holland 2011) can also be helpful in guiding R&D PM. Similar to the generic PM frameworks described above, conflicts exist between their implementation approaches and the unique nature of R&D operations.

In addition to the issues mentioned above, generic PM frameworks pay equal attention to all the PM steps, and hence, some key steps for R&D performance generation are not emphasized enough, such as training, performance planning, and performance feedback.

In summary, the existing R&D PM frameworks have not considered a very important issue: how to create the R&D performance generation processes tailored to R&D strategies and the business environment, which often require deeper knowledge of R&D management. The generic PM frameworks assist R&D units in carrying out PM to some extent, though they often conflict with the inherent characteristics of R&D operations. These universal frameworks can rarely enhance the performance of an R&D unit significantly.

Furthermore, some implementation details of the frameworks do not fit very well with R&D managerial needs. Importantly, the competency assessment methods currently used in most frameworks are subjective and time-consuming (i.e., subjective assessment, questionnaires, and psychology scales). Although an objective and timely competency assessment is not the only key to ensure the success of a competency management system (e.g., the art of how to implement the assessment results or the competency training is also important), it is still a pre-condition to the success of competency management.

Chapter 4 Introduction of Some Research Methods

In this chapter, we are going to review the overall research methodology, and some operational and statistical research methods, which will be frequently used in this thesis.

4.1 Critical Realism (CR)

In the theory of CR, the events are classified into three layers as aforementioned (see Figure 4-1). The layer of empirical consists of palpable events in our daily life, which means all sensible things, such as appearance, voice, and feeling, exist in this layer (Archer et al. 2013; Niiniluoto 1999). It can be pointed out based on our experiences that the empirical events are changeable, sometimes even irrational, therefore, this layer is the farthest from the traditional meaning of reality. However, CR theory further explains that all scattered phenomena in the empirical layer actually are caused and ruled by the events or non-events in the actual layer (Niiniluoto 1999). Comparing with the empirical contents, the stability degree of the matters in the actual layer is much higher. The layer of real is viewed as the highest since all events and non-events occur in both aforementioned layers are fundamental ruled by the mechanisms and structures in this layer (Archer et al. 2013).

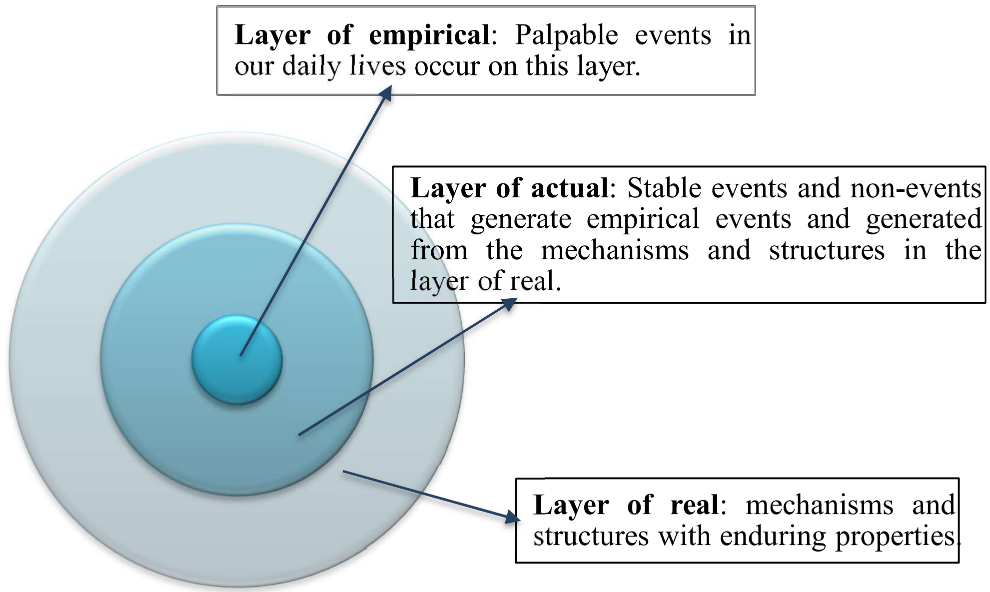


Figure 4-1 Three layers of reality

According to the three-layer classification, the critical realist believes that cognition starts from the empirical layer and continue to the higher layers through exploring the underlying and enduring mechanisms and structures continually (Archer et al. 2013; Collier 1994). Specifically speaking, the cognition process under CR can be summarized as a DREI model, which are description(D) of empirical phenomena, retroduction(R) and elimination(E) of the phenomena for exploring the mechanisms and structures, and identification(I) the enduring mechanisms and structures (Collier 1994).

Considering the context of this thesis, the empirical layer is reflected by the operational and managerial events existing in organisations and literature (Fleetwood 1999). By comprehensive literature review and specific case research, the enduring mechanisms and structures underlying those phenomena can be partially realized, and hence, summarized in the form of new PM framework.

Under the research paradigm of CR, the general methodology adopted in this thesis is action research (AR). As stated by Bradbury and Reason (2008, p.31):

Action research is an interactive inquiry process that balances problem solving actions implemented in a collaborative context with data-driven *collaborative analysis or research to understand underlying causes enabling future predictions about personal and organisational change.*

The definition of AR suggests that the dynamic is one of the main characteristics of this methodology. Unlike the methodologies with a one-dimensional nature ("assumption-justify" style), AR aims to relax the tension between an initial research agenda and research objectives and the environment (Huxham and Vangen 2003; Coghlan and Brannick 2014). The nature of AR requires an initial theory to keep adjusting and perfecting until it explains personal, organisational or societal transformations (Coghlan and Brannick 2014; Coughlan and Coghlan 2002). This methodology matches with the CR paradigm on an ontological level (Reason and Bradbury 2001). Under that paradigm, entities are not only material things but also embodied in relational and processual manners with stratified, emergent and transformational essences (Collier 1994).

More specifically, due to the nature of this thesis, a modified AR methodology was adopted for the organisational research. The organisation development (OD) methodology is an important branch of AR in the organisational and business research domains, in which the general research processes are broken down into three steps (Huxham and Vangen 2003; Coghlan and Brannick 2014; Reason and Bradbury 2001) (Figure 4-2):

Step 1 - Unfreezing

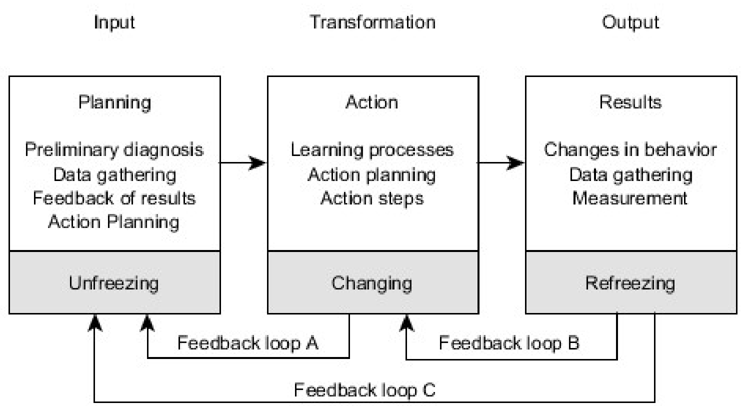
In this step, the managerial dilemmas or problems of organisations should be highlighted and clarified, and the original theory or method of the research should be prepared for the dilemmas and challenges. Meanwhile, the preliminary diagnosis, data gathering, preliminary feedback of results, and project planning should also be implemented in this step (Huxham and Vangen 2003; Reason and Bradbury 2001).

Step 2 – Changing

The situation of the dilemmas and problems should be diagnosed and explored in an actual managerial context. Next, the initial theory or method should be applied, and the corresponding reactions and behaviour of the organisation should be recorded and tested. The above actions should be carried out jointly by the consultant (researcher) and members of the client organisation (Reason and Bradbury 2001; Huxham and Vangen 2003).

Step 3 – Refreezing

Depending on the actual changes in the organisation (if any) resulting from corrective actions in Step 2, the initial theory or method should be modified, then reapplied. Before finalizing the theory or method, the above process may be looped several times until the operation or performance of the organisation is strengthened (Reason and Bradbury 2001; Huxham and Vangen 2003).



Source: *Reason and Bradbury (2001)*

Figure 4-2 System model of the OD research process

In this thesis, we will firstly propose a new PM framework. Then, we will explore approaches to apply the framework to SME and R&D units by action research. In doing so, we aim to explore mechanisms about organisational performance to guide PM and enhancement operations in the real world.

4.2 Soft System Methodology (SSM)

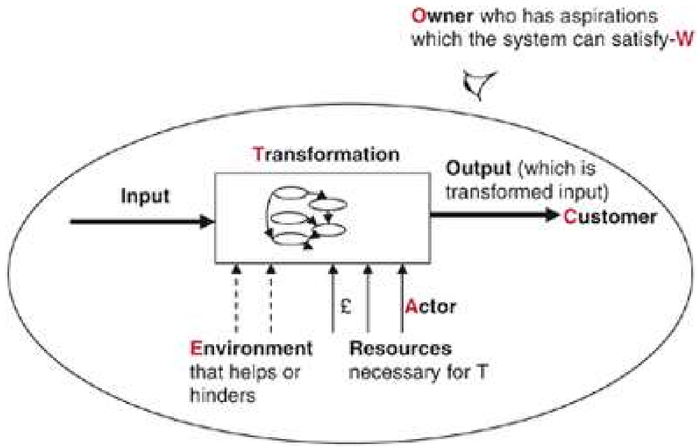
Soft systems methodology (SSM) is a systematic methodology for structuring and planning actions to solve soft, complex, and social problems. It was first introduced by Checkland (1972) in his article 'Towards a Systems-based Methodology for Real-World Problem Solving'. According to Checkland and Poulter

(2006), the essence of SSM can be described as:

> *'an organized, flexible process for dealing with situations which someone sees as problematical, situations which call for action to be taken to improve them, to make them more acceptable, less full of tensions and unanswered questions.' (Checkland and Poulter 2006).*

Systems science was initially developed in the domains of engineering and biology. These domains aim to process complicated "hard problems", which have clear described goals in essentially a design role (Zexian and Xuhui 2010). Nevertheless, the traditional "hard system" methods of analysis are unhelpful in processing "soft problems", which are highly unstructured and characterised by multiple (sometimes even conflicting) value standards and objectives (Checkland 1972; Checkland and Poulter 2006). The field of PM is a perfect example, full of typical soft factors, such as satisfaction, motivation, appraisal, and conflicts, which are all low-structured and highly subjective (Wang, Liu and Mingers 2015). Therefore, given the characteristics of PM, SSM can play an important role in assisting shareholders and managers in structuring and illustrating the managerial problem situation from a holistic viewpoint (Mingers, Liu and Meng 2007; Wang, Liu and Mingers 2015).

The SSM analysis starts from the assumption that an organisation is a system composed of purposeful designed actions, and these actions cause constant changes and transformations in the organisation. In this system, the actors conduct actions to generate outputs, which can be tangible (products) or intangible (service or information). The actions of the actors are ordered or guided by the owners (i.e., possessors, shareholders, and key stakeholders), who have the powers of creating, adjusting, and terminating the system within certain environments. Moreover, SSM assumes that the different stakeholders of the system may hold different faiths (Weltanschauungs) about the value and objectives of the whole or particular parts of the system, so the models of SSM should reflect these diverse standpoints. All of the above elements are collectively known as the "Customer, Actors, Transformation, Weltanschauung, Owner, and Environment (CATWOE)" system of SSM (Mingers, Liu and Meng 2009; Liu et al. 2012; Wang, Liu and Mingers 2015) (Figure 4-3).



Source: *Mingers, Liu and Meng (2009)*

Figure 4-3 Primary concepts of SSM

Generally speaking, SSM has a seven-step implementation framework (Mingers, Liu and Meng 2009):

Step 1: Identifying the problematic situation that needs intervention;

Step 2: Researching the situation and building up a detailed picture of it;

Step 3: Selecting perspectives and building root definitions (RDs);

Step 4: Developing a conception model (CM) based on the RDs;

Step 5: Comparing the model with the real-world situation;

Step 6: Defining feasible and desirable changes to be implemented;

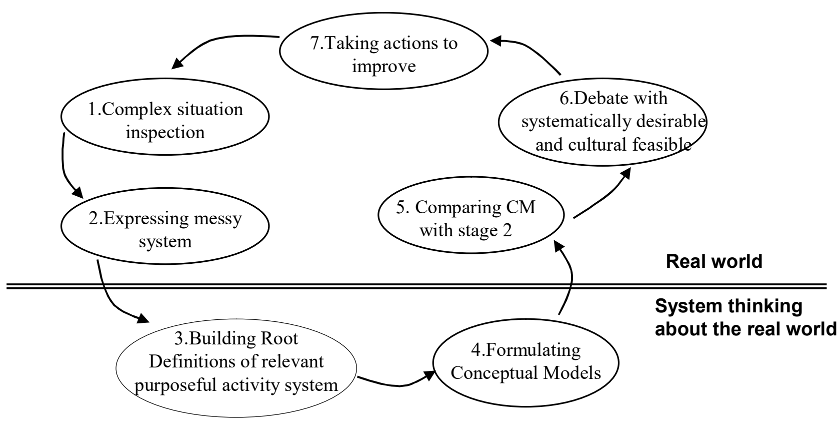
Step 7: Taking action.

To carry out an SSM analysis in organisational research, the overall situation of an organisation should be considered first. This includes recognizing the unstructured problems and exploring detailed information about the issues, cultures, and political factors of the organisation.

Next, the purposeful actions of the organisation must be identified and articulated through a CATWOE analysis in the form of hierarchical and interconnected root definitions (activity models). The activity models should illustrate the process of how these actions attribute to the goals and objectives stated in the root definitions. In developing the activity models, apart from the operational actions, the monitoring and controlling actions should also be taken into account by applying the 3E framework (efficacy, efficiency and effectiveness).

The level of detail of the actions in the model depends on the managerial needs and capacity of the organisation. For instance, the actions can be decomposed to a personal level if the organisation plans to carry out individual-based PM. Similarly, the decomposition can stop at the departmental level if the performance management system (PMS) is department-based.

Finally, to bring organisational innovation into the SSM implementation, the model developed in steps 3 and 4 should be compared with the current situation (reorganisations in steps 1 and 2) to propose necessary actions for organisational improvement. The key stakeholders of the organisation should be involved in the innovation process through rounds of dialogue. When an agreement about the organisational changes has been achieved among key stakeholders and the feasibility of the changes has also been confirmed, the organisation can implement the agreed upon changes. The flowchart of this process is illustrated in Figure 4-4.



Source: *Song (2016)*

Figure 4-4 Seven-step implementation framework of SSM

To date, SSM has been widely applied in organisations with various characteristics, such as non-profit organisations (Sinn 1998; Por 2008), highly professionalized organisations (King 2011; Mingers, Liu and Meng 2007), and small and medium-sized enterprises (SMEs) (Watkin et al. 2012; Krishnan and Ganesh 2014). Meanwhile, multiple studies employing SSM report on performance management (PM) topics, such as general PM framework development (Liu et al. 2012; Wang, Liu and Mingers 2015), performance decomposition (Dulaimi, Khalfan and McDermott 2006; Ardakan and Mohajeri 2009), and the extraction of key performance indicators (Liu et al. 2010).

In this study, SSM will be used to undertake performance decomposition and deployment for organisations with simple operations core(s) that also require organisational innovation. To introduce the detailed steps in establishing an SSM-based performance measurement system, a brief case is presented below.

Institute ZLY is a subordinate unit of the Chinese Academy of Sciences (CAS) committed to basic research in physics. To ensure the efficiency of research performance and public budget allocation, ZLY needs a performance indicator system to measure and further manage its research performance. Considering the ambiguous and highly complicated nature of research performance, SSM will be adopted to develop indicators for the performance measurement system.

Step one: The primary goals of the institute should be clarified initially since these will be the starting point of the SSM decomposition. Considering ZLY is a sub-unit of CAS, both the global strategies from CAS and the local strategies of ZLY inherited from CAS should be taken into account in this step. There are various ways to implement this step: reviewing the strategic files and documents will be enough if an organisation has clear statements about its levels of strategies; if not, rounds of discussions among key stakeholders will be indispensable in extracting and developing explicit strategies.

Table 4-1 Statements about the strategies of CAS and ZLY in "*what-how-why*" form

Strategic statement of CAS	
What?	To keep yielding innovative, cutting edge, and revolutionary research outcomes in the natural sciences.
How?	By improving the quality and quantity of human capital, infrastructure, facilities, and resources.
Why?	For benefiting the social and economic development of China, and further, human society.
Strategic statement of ZLY	

What?	To enrich innovative knowledge in physics research through original, cutting-edge research.
How?	By identifying the promising research areas in the domain, and conducting research and disseminating it via prestigious channels (e.g., academic journals, research projects, industrial collaboration projects etc.)
Why?	For promoting the prestige, resources, and sustainable development of CAS and ZLY**.**

The organised and structured statements about the strategies of CAS and ZLY are listed in Table 4-1 (in the form of *what-how-why*):

Step two: The implementation details on how to achieve the objectives stated in the "what to do" part should be considered in this step. In the case of ZLY**,** the questions will be "*How do we identify promising research areas in physics?*" "*How do we conduct effective research in this domain?*" "*How do we disseminate the research outcomes to maximize impact?*". The answers to these questions should be stated in the form of sequentially connected actions. Several methods are possible in generating the answers.

If ZLY is largely satisfied with their current operational and managerial procedures, they can simply seek the answers by following existing practices and deploying the actions to the existing organisational segments. Otherwise, the possibility of organisational modification and procedure innovation can be introduced into the answer-seeking processes by generating the best actions theoretically, instead of practically. The feasibility and necessity of those theoretical best actions will be further discussed by the key stakeholders of ZLY to reach an agreement about the actual implementation plan for the organisational modifications and procedure innovations.

All of the actions (actual or theoretical) and their connections can be illustrated through the rich map tool of SSM. The rich map of top strategies of ZLY is presented in Figure 4-5.

Generally speaking, to keep the logic of rich map clear, the number of elements in each level of the rich map should be less than nine. On the rich map above, the general logic of ZLY for accomplishing its top strategies has been clarified, but the implementation details of each element are still blurred. Therefore, further levels of decomposition are needed in the next step.

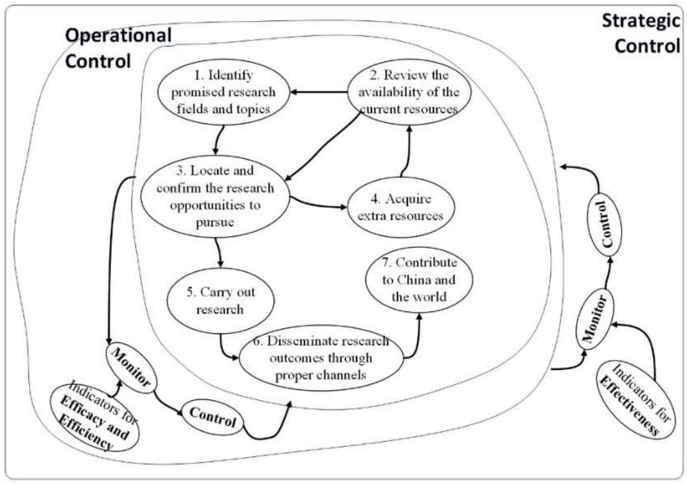


Figure 4-5 Rich map for the general strategy of ZLY

Step three: More action details about the elements in the rich map above should be defined in this step by developing levels of root definitions. For instance, the sub-level root definition for the element "Identify promising research topics" can be listed in Table 4-2, again in the form of "*what-how-why*" statements:

Table 4-2 Sub-level statement about the action *"Identify promising research topics*" in "*what-how-why*" form

Identify promising research topics	
What?	To identify promising research topics for ZLY that lead to original cutting- edge research while considering resource availability.
How?	By wide external scanning for research opportunities and by promoting internal discussion.
Why?	To promote prestige, resources, and sustainable development by selecting promising research topics.

The contents under “How” are the essential part of the root definition since they state clear actions to accomplish the higher-level objectives. Similar to the manner introduced above, the communication among key stakeholders is needed here to enrich implemental details to draw rich maps for the sub-objectives. Below is the rich map for the action “*Identify promising research topics*” as an example (Figure 4-6):

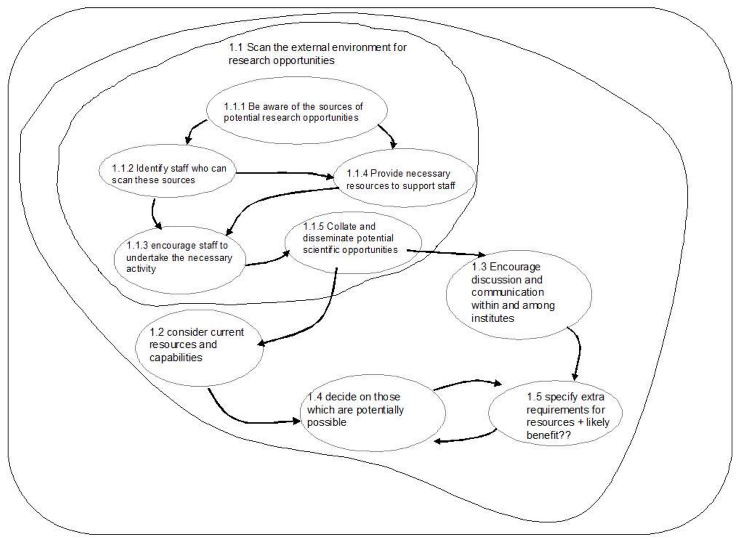


Figure 4-6 Rich map for the action “Identify promised research fields and topics”

The level of detail in the root definitions and rich maps depends on the managerial needs of organisations. In the case of ZLY, its performance is generated by individual researchers, so a key-individual based managerial style is adopted. Accordingly, we can find many individual based actions in the rich map (e.g., “identify WHO can…”, “encourage STAFF to undertake…”). On the other hand, if an organisation is carrying out department-based management, the decomposition work above can stop at the departmental level with less action details.

Step four: When all levels of root definitions have been clarified with the desired implementation details, the key performance indicators (KPIs) can be extracted from them via the 3E framework. It should be kept in mind that the discussions among key stakeholders are still crucial in this step, since only they can properly decide what KPIs will be employed in the operations.

As an example, some general KPIs are listed in Table 4-3 for Action 1.1 to 1.5 in Figure 4-6.

Table 4-3 General KPIs for actions generated from SSM step 1.1-1.5 for ZLY

Efficacy (Quantity of promising research topics identified)	**Efficiency** (Input-output ratio)	**Effectiveness** (Do the identified research topics actually lead to good research outcomes)
· Number of promising fields proposed from each research unit · Number of promising topics proposed from each research unit · Number of conferences attended · Number of conferences organized · Number of new overseas collaborative organisations · Number of invited speeches ……	· Average investigation costs for each confirmed future research topic · Average overall costs for each confirmed future research topics ……	· Number of high-quality publications in the newly identified research topics · International reputation of ZLY in the promising fields proposed by each research unit · Satisfaction of CAS relating to ZLY ……

Step five: When the KPIs have been finalized, corresponding managerial procedures and regulations should be addressed to develop a performance measurement system, such as the time cycle of the measurement, data sources of each KPI, the performance appeal procedures, and so on.

The SSM also has its limitation. As it has been pointed out in Mingers (2000), the idea of "system" in SSM should be understood on an epistemological basis (e.g., a method to conceptualize an organisation), instead of an ontological one (e.g., reflect all the physical details of an organisation). Therefore, in managerial contexts, the details of a SSM model and its effectiveness highly rely on the expertise and experiences of the people (e.g., management experts, technology experts, and key stakeholders) who designed and constructed it. After realizing this limitation, we paid extra attentions in the case studies below on selecting suitable candidates to participate rounds of SSM discussions. By doing this, we want to make sure the final SSM models are feasible and reflecting the strategic needs of the companies to a large extent.

4.3 Principal Component Analysis

In organisational research, a large number of correlated and overlapping variables may be involved, especially in highly complicated managerial contexts. However, the significant number of variables raises challenges in processing them. It is extremely helpful for scholars and practitioners to have a method that can reduce the number of variables while keeping most of the useful information.

Principal Component Analysis (PCA) is the method developed to fit the needs above. PCA was initially introduced by Pearson (1901) as a sub-method of his principal axis theorems. Later on, Hotelling (1933) further developed this method and made it an independent method. Today, PCA is widely applied in many disciplines as a method for exploratory analysis and predictive modelling. In general, PCA converts a series of correlated variables into a set of linearly uncorrelated variables, which are the principal components. The newly generated principal components contain most of the information within the original samples, but the number of new components is usually significantly less than the number of the initial variables. Accordingly, there are three main assumptions of PCA. The linearity assumption assumes the input data set can always be converted into linear combinations of the variables (Kakkar and Narag 2007). The second assumption presumes the importance of mean and covariance in the computing of PCA, and hence, it is not impossible that the max variance's directions contain good features for discriminations (Kakkar and Narag 2007). The third assumption in PCA is that larger variances have more important dynamics (Kakkar and Narag 2007).

The transformation process of PCA is conducted such that firstly, the component with the largest possible variance is identified as the principal one. Each of the other components is then sequentially found, starting from the highest possible variance under the constraint that is orthogonal to the preceding components. Therefore, the vectors generated by PCA form an uncorrelated orthogonal basis set. This leads to an important feature of PCA, that, it is highly sensitive to the initial variables' relative scaling.

In general, a PCA-based analysis should be applied according to the steps below:

1) **Original data process**: The collected data should be pre-processed before the analysis. In other words, the order of the input data should be checked before implementing PCA, and data with reverse order must be adjusted before the analysis. Moreover, normalization is also a necessary step before carrying out the analysis. It can be implemented in multiple ways, such as zero-mean normalization and min-max normalization. The sample-to-variable ratio is another issue that should be kept in mind. Currently, there is no agreement on the best ratio for PCA-based research, but based on Ford, MacCallum and Tait (1986), the majority of research tend to have a ratio greater than 1:5.
2) **Calculate the correlation coefficient matrix of the input data, the eigenvalues and eigenvectors of the correlation coefficient matrix, and then the variance contribution rate of each component:** In most organisational research, these calculations are completed with the help of mathematical software such as SPSS and Matlab.
3) **Components selection**: Based on the variance contribution rates, the extracted components are ranked in descending order. The researcher decides how many components should be retained. Most literature point out that an 85% cumulative variance contribution rate is the threshold value for components selection, since a lower value cannot guarantee the adequacy of the original information. Moreover, the rationality of the new components is another consideration in selecting the components; the new combinations of the original variables should also be rational and nameable.
4) **Principal component scores calculation**: When the components have been selected and retained, their principal component scores need to be calculated based on their eigenvalues. The scores can be used to generate a variable, or simply applied to weight the variables.

In the current organisational research literature, PCA can be found to apply in many ways. Indicator extraction is one main function of PCA in this domain. Many scholars employ this method to filter indicators for specified organisational measurements or overall organisational evaluations (Lovaglio 2011; Ferguson and Reio Jr 2010; Ittner et al. 1999). In addition, PCA is also used to identify new particulars to measure and manage organisations by naming new combinations of the original variables (Kakkar and Narag 2007; Ogunro et al. 1979; Martins 2003). Furthermore, PCA is also reported to carry out management modelling (Zaim, Tatoglu and Zaim 2007; Rodriguez, Saiz and Bas 2009; White et al. 2003) or performance forecasting (Singh et al. 2009; Han, Kim and Kim 2007).

On the other hand, several well-known limitations exist in PCA. The risk of losing key information is the first limitation pointed out in multiple literatures (White et al. 2003; Kakkar and Narag 2007; Lovaglio 2011). Therefore, the users should balance the gain from reducing the dimension of information and the corresponding loss carefully before applying PCA. The second limitation of PCA is rooted in its non-parametric nature, which means a-priori knowledge about a data set is very different to be incorporated into analysis (White et al. 2003; Kakkar and Narag 2007).

4.4 Evidential Reasoning rule

Multiple attributes are usually involved in complex business and management decisions, where each attribute reflects part of the essence of the business and management problem. Thus, it is very crucial for the decision makers to adopt a proper method that takes all the attributes within the problem into account in making aggregation (Yang and Singh 1994; Belton and Gear 1983; Belton and Stewart 2002). Evidential Reasoning (ER) rule is a widely-applied method for handling complex decision problems through combining various independent evidences with their weights and reliability scores to assist decision makers to conduct fully informed choices. Meanwhile, its comprehensive and probability-based outputs exactly match the needs of managers especially in complex managerial contexts (Zhu et al. 2015). The ER rule evolves from the original ER framework, which was first developed and reported by Yang and Singh in 1994 based on the Dempster-Shafer (DS) theory (Yang and Singh 1994; Yang 2001; Lowrance, Garvey and Strat 2008).

To carry out a ER rule-based decision making project, the first step is usually to clarify the structure of the problem by defining elements such as the criteria, options, source of information, and decision makers. Next, a discernment frame Θ needs to be established in the form of L pieces of evidence e_i $(i = 1, \dots \dots, L)$ with N mutually exclusive and collectively exhaustive proposition θ_n $(n = 1, \dots \dots, N)$ (Yang and Xu 2014; Yang and Xu 2013). Commonly, the evidences are structured hierarchically, which means that the ground levels criteria define the decision objective and further attribute to it. In other words, this hierarchical structure is dispensable in conducting a ER rule-based decision, to a large extent, the hierarchy is formed to simplify the problem by transparentizing its internal logic.

Furthermore, the belief distribution should be defined on a power set through assigning belief to singleton propositions and the subsets of the discernment frame. The power set P(Θ) consists of 2^N subsets of the overall discernment frame as given in Equation (1) (AbuDahab, Xu and Chen 2016).

$$P(\Theta)=\{\emptyset, (\theta_1), \dots, (\theta_n), (\theta_1, \theta_2), \dots, (\theta_1, \theta_n), \dots, (\theta_1, \dots, \theta_{N-1}), \Theta\} \quad \textit{(1)}$$

Next, the belief distribution for each independent evidence can be obtained in the following equation:

$$e_i = \{(\theta, \beta_{\theta,i}), \forall\theta \subseteq \Theta, \textstyle\sum_{\theta\subseteq\Theta} \beta_{\theta,i} = 1\} \quad \textit{(2)}$$

In Equation (2), the evidence points to proposition θ has a belief degree $\beta_{\theta,i}$, and $(\theta, \beta_{\theta,i})$ refers to the focal element of e_i if $\beta_{\theta,i} > 0$ (Yang and Xu 2013). It is worth noting that, the belief distribution equation in the ER rule considers both global and local ignorances, which is different from the ER approach that only acknowledges the global ignorance (Yang and Xu 2013).

Regarding the applicability in managerial contexts, another highlight of the ER rule is that considers the reliability of each piece of evidence separately, since most of the decision technologies assume the input information is fully trustworthy, which is not always true in management circumstances (Yang and Xu 2013; Zhu et al. 2015). For instance, due to the complexity of a managerial problem or the issue of data accessibility, some information may be generated or collected from novice or inexpert stakeholders. Under this circumstance, the reliabilities of the information vary substantially, which further affect the quality of the final outcomes significantly. In the equation of the ER rule, the reliability of an evidence is reflected by the reliability score r_i between [0,1], where $r_i = 1$ indicates a fully reliable information (Yang and Xu 2013; Yang and Xu 2014).

In addition, taking weights into account is also very helpful for managerial decisions since different evidences vary in terms of their importance. In the equations of the ER rule which will be explained next, w_i represents the weight of evidence *i* and $\sum_{i=1}^{L} w_i = 1$.

Furthermore, the weighted belief distribution with reliability (WBRD) can be calculated based on the weight and reliability of the evidences. Before that, $\widetilde{m}_{\theta,i}$ which represents the support degree for θ from evidence e_i with the associated r_i and w_i is first calculated. The equation of basic probability masses for e_i is given in Equation (3).

$$\widetilde{m}_{\theta,i} = \begin{cases} 0 & (\theta = \emptyset) \\ c_{rw,i} m_{\theta,i} & (\theta \subseteq \Theta, \theta \neq \emptyset) \\ c_{rw,i}(1 - r_i) & (\theta = P_{(\Theta)}) \end{cases} \qquad \textit{(3)}$$

It should be kept in mind that the normalized factor $c_{rw,i} = \frac{1}{(1+w_i - r_i)}$ requires $\sum_{\theta \subseteq \Theta} \widetilde{m}_{\theta,i} + \widetilde{m}_{P_{(\Theta)},i} = 1$, meanwhile, $m_{\theta,i} = w_i \beta_{\theta,i}$ and $\sum_{\theta \subseteq \Theta} \beta_{\theta,i} = 1$. Next, assuming that r_i is not equal to w_i, the unreliability of e_i is denoted by 1-r_i. Then, when $r_i = 1$ and $\widetilde{m}_{P_{(\Theta)},i} = 0$, we eliminate any θ by e_i if $\widetilde{m}_{B,i} = 0$ for any $B \cap \theta = \theta$, i.e., whatever support θ may receive from other evidences (Yang and Xu 2014). Accordingly, Yang and Xu (2013) rewrote an equivalent equation:

$$\widetilde{m}_{\theta,i} = \begin{cases} 0 & (\theta = \emptyset) \\ w_i \beta_{\theta,i} & (\theta \subseteq \Theta, \theta \neq \emptyset) \\ 1 - r_i & (\theta = P_{(\Theta)}) \end{cases} \qquad \textit{(4)}$$

Now, a piece of evidence can be denoted by the WBDR with the basic probability masses presented in Equation (5).

$$m_i = \{(\theta, \widetilde{m}_{\theta,i}), \forall \theta \subseteq \Theta; (P_{(\Theta)}, \widetilde{m}_{P_{(\Theta)},i})\} \qquad \textit{(5)}$$

Three focal elements in the ER rule are considered in Equation (5) to measure the degree of support for θ from e_i, which are: belief distribution, reliability scores, and weights. It is worth pointing out that the unassigned support $\widetilde{m}_{P(\Theta),i}$ is now allocated to the $P_{(\Theta)}$ for redistribution (Yang and Xu 2013).

Based on Equations (1) — (5), the ER rule can be adopted to calculate the combined degree of belief $\widetilde{m}_{\theta,e_{(2)}}$, in which, two independent evidences e_1 and e_2 support proposition θ jointly, leading to $\beta_{\theta,e_{(2)}}$ as presented in Equation (6) and $\widehat{m}_{\theta,e_{(2)}}$ in Equation (7) (Yang and Xu 2013).

$$\beta_{\theta,e_{(2)}} = \begin{cases} 0 & (\theta = \emptyset) \\ \frac{\widehat{m}_{\theta,e_{(2)}}}{\sum_{D\subseteq\Theta}\widehat{m}_{D,e_{(2)}}} & (\theta \subseteq \Theta, \theta \neq \emptyset) \end{cases} \quad \textbf{\textit{(6)}}$$

$$\widehat{m}_{\theta,e_{(2)}} = \left[(1-r_2)m_{\theta,1} + (1-r_1)m_{\theta,2}\right] + \sum_{B\cap C=\theta} m_{B,1}m_{C,2} \quad \forall\theta \subseteq \Theta \quad \textbf{\textit{(7)}}$$

Equation (7) consists of two parts, which are the bounded sum of the evidence individual support degree ($\left[(1-r_2)m_{\theta,1} + (1-r_1)m_{\theta,2}\right]$) and the orthogonal sum of the collective support degree ($\sum_{B\cap C=\theta} m_{B,1}m_{C,2}$) (Yang and Xu 2013; Yang and Xu 2014).

In the following part of this thesis, we will mainly employ the equation of combined degree of belief to aggregate multiple pieces of managerial evidences to assist the managers to forecast the performance of their subordinates.

The general limitations of ER rule have not been widely discussed in the existing literature yet, but one limitation still can be located particularly for the research in this thesis. The ER rule requires criteria dependencies and variable correlations in the analysis, which eliminates the possibility of combining ER with the other some common methods (i.e., simple regression). A modification was suggested by Yang et al. (2015) recently to unlock this limitation, but the application of this idea are still to be implemented.

Chapter 5 Performance Tree: A New Performance Management Framework

Based on the issues and problems identified in the former chapters, a new performance management (PM) framework, namely as the performance tree (PT) framework, that developed around performance generation procedures of organisations will be introduced in this chapter. The chapter starts from rethinking some basic concepts in the PM domain, and then those new concepts and comprehensive conceptual model of the PT framework are introduced latter. This chapter ends with discussions about some contingency issues in the implementation of the PT framework.

5.1 Performance and performance network

In order to introduce our framework of PM, some basic concepts will be discussed here firstly.

As discussed before, there are still no universally agreed definitions of performance, although there have been many different definitions (Otley 1999; Al-Turki and Duffuaa 2003; Cordery and Rowena Sinclair, Carolyn, Payer-Langthaler and RW Hiebl 2013). In summary one can say that performance includes purposeful activities (actions) and their consequences (results and impacts) related to the purposes (objectives), as illustrated in Figure 5-1. Let us emphasize that impacts are long term consequences and often unclear at the time of counting the results, and thus need to be estimated. For example, performance of sale may include: visiting customers (actions) → sale value (results) → influence to the sale of next year (impact). Clearly the impact is not all clear yet but one can use this year's customers' satisfaction to estimate it as a measure of sale performance.

Figure 5-1 Relationship of intended action and consequence

In practice often people think performance just includes the consequences (Thomas, Clark and Gioia 1993), while some people argue that sometimes the consequences are not clear to define (Cordery and Rowena Sinclair, Carolyn, Payer-Langthaler and RW Hiebl 2013), and thus one has to include the intended actions (McMann and Nanni Jr 1994). It is now very common to adopt them both as performance (Alfred et al. 2012). For example, Al-Turki and Duffuaa (2003) state that there are three basic dimensions to describe an organisation's performance, which are outputs, processes to achieve the objectives and (potential) influences. In practice it is measurement of performance that matters, which is decided by a company and usually only measures some of the actions and consequences such as those positive to, or planned by the company, see below for the details. Thus clearly one should include both the actions and consequences in the definitions of performance.

Let us further examine a set of performance. In the existing approaches of PM like BSC, PSC, SSM and BSM, a sequence of logically connected actions or processes are considered in setting up performance management system (PMS), such as action chain for the purpose of research: do research → write paper → publish paper → get citation. Extended from the action chains, we now include consequences into the chains so that we have now performance chains. The reasons are that i) we need to measure performance later and ii) actions are often connected by consequences: If we look into action chain above, it is clear that in order to write a paper one needs to use research results from the action "do research". Therefore, the chain actually should be as: research → (results) → write paper → (draft) → publish paper → (key ideas in the paper) → get citation → (research impacts).

Thus we add those in brackets and the action chain become the performance chain: [do research, results] → [write paper, drafts] → [publish, key ideas] → [get citation, research impacts], all of which are logically connected and will form a performance network.

Furthermore it has been realized that the stakeholders play a central role in creating and enhancing the performance of an organisation (Kammeyer-Mueller, Liao and Arvey 2001; Weerakoon 1996). We argue that even at a micro level, performance is closely linked with stakeholders: for example, to make performance network above to work, it needs stakeholders to do research and write papers. First of all, the purposes of activities and actions are defined by some of the stakeholders. More importantly, without specifying the actor and planner of purposeful actions, it is unrealistic to identify the intended actions as there may be many activities going on according to different purposes by different people. In any company there are some planned activities to achieve the objectives (e.g., sales, or customer relations) but there may be many individual actions towards the same purpose. Thus the company can, for example, either include only the planned activities into performance or all the activities intended by the staffs, depending on the governing policy of the company. However, in practice, one has to specify the stakeholders as otherwise it may not be realistic to know which actions are intended or not. Last but not the least, the impacts (good/bad/none) are to be expected by some stakeholders. Therefore, the role of stakeholder is indispensable in performance, and stakeholder and performance interact as illustrated in Figure 5-2:

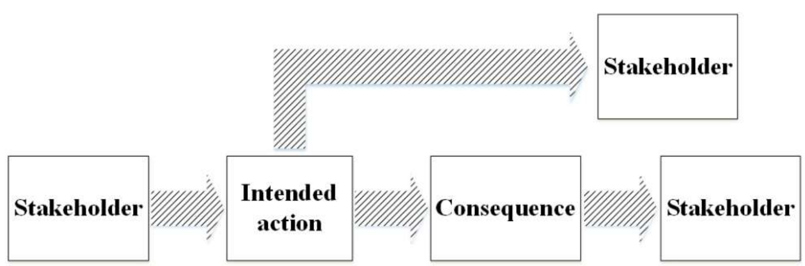


Figure 5-2 Relationship of stakeholder, intended action and consequence

Thus the chain of stakeholder → performance → stakeholder is an essential interaction between stakeholder and performance. Such an interaction is actually a base of SSM – key actions in an organisation relate key stakeholders (Wang, Liu and Mingers 2015). Below we will examine the role of stakeholders in connections of performance at a micro level.

1) The fundamental connection chain is the above "stakeholder → action → consequence". Further in this chain, the stakeholders may own, plan and directly execute the actions. The stakeholders and actions can often be further decomposed into sub-actions intended by some stakeholders. For example, for purpose of research, let us say that the intended action is to carry out innovative research, intended by actors and planners. In some cases, this action may be decomposed further as follows:

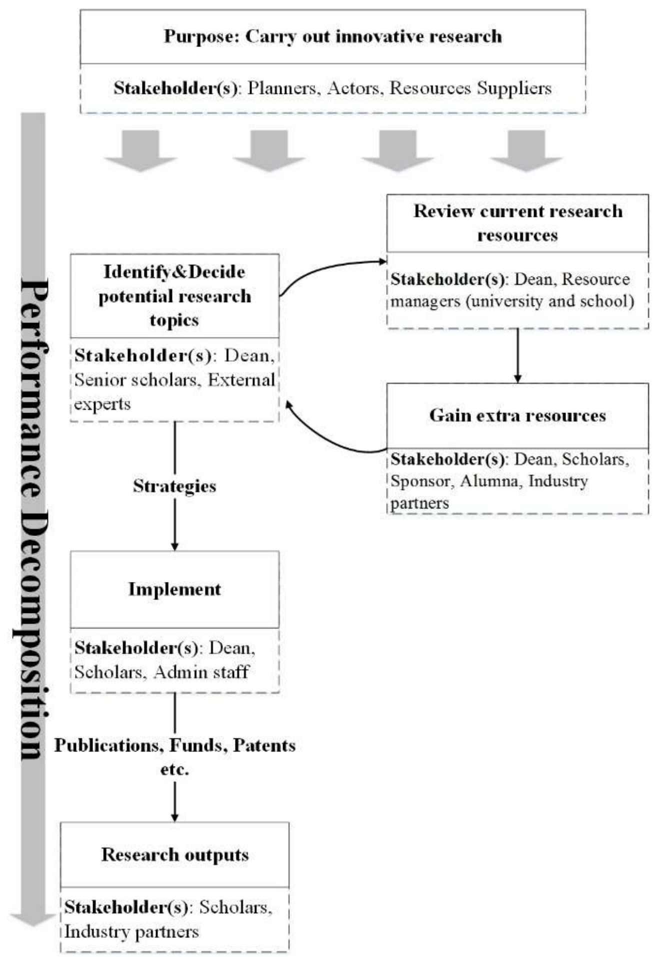


Figure 5-3 Performance decomposition of research actions

This decomposition process is associated with labour division in management, and is widely used in theories and practices of PM. Such decompositions can mainly be guided by the existing business or operation processes such as in BSC, PSSC; or can be based on more innovative processes as in SSM and BSM (Wang, Liu and Mingers 2015). Besides, other stakeholders can affect this chain by influencing the purposes of the actions.

2) Connections of performances, which need interactions with stakeholders. Clearly from the left of the chain (in Figure 5-2), the stakeholders can directly affect, or be affected by, different performances through some consequences or actions of the performance (Wang, Liu and Mingers 2015). More importantly for the right of the chain, the actions or consequences can directly affect, or be affected by, some stakeholders and consequently directly aggregate or affect other performances (Wang, Liu and Mingers 2015), as showed in Figure 5-4 for a process of two separate performances aggregating into a joint performance.

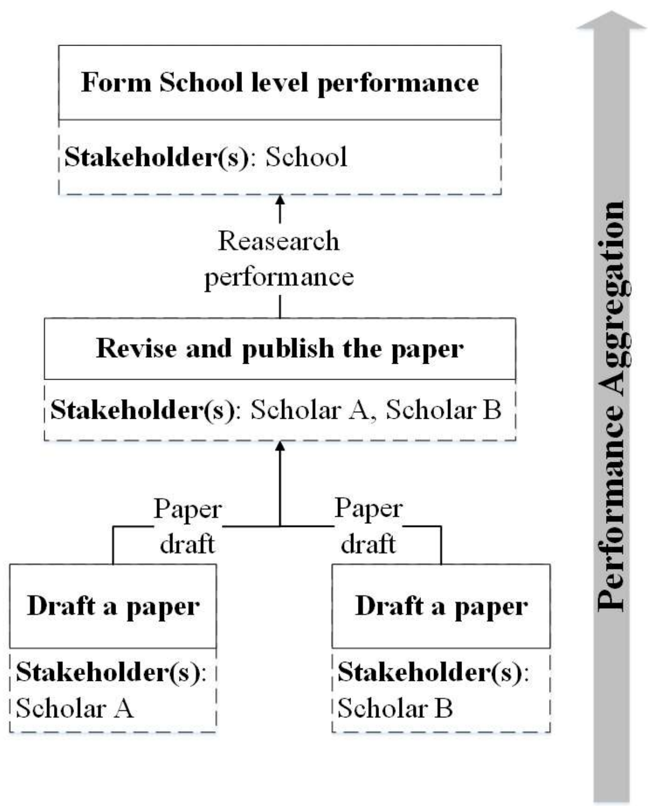


Figure 5-4 Performance aggregation processes in an university

Thus here these stakeholders in points 1 and 2 belong to the direct class introduced in (Wang, Liu and Mingers 2015). This way of performance connection is associated with coordination in management.

3) Connections of performances, which do not need stakeholders. These are often connected through some automatic processes, for example, assemble lines, robots, inter-processes connect, etc. These ways of connections can be action-action, consequence-consequence or consequence-action. These connections are, however, not the main concerns of management. In this work, we will not study such connections as anyway management is concerned with people.

In summary at micro level different performance is connected through stakeholders (those need no stakeholder are not our concern), and form a stakeholder and performance network: on one hand, performance in an organisation directly connect stakeholders through its actions and consequences, on the other hand, stakeholders directly connect performance of the next level by its actions (e.g., actors or planners of the actions of the performance), as shown below (Figure 5-5).

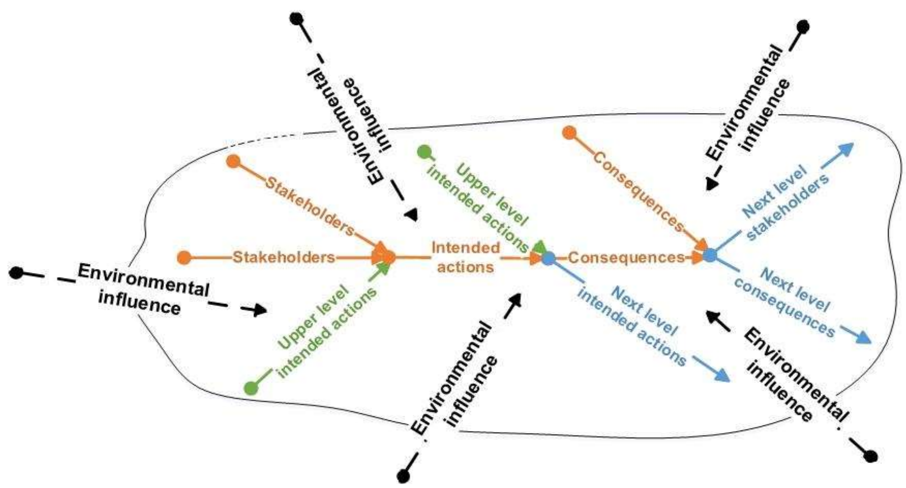


Figure 5-5 Performance-stakeholder network

At the macro level, it is clear that in an organisation stakeholders play a central role in performance decomposition and aggregation through the mechanisms, to convert individual performance into organisational performance and therefore form the performance stakeholder network of the organisation, which consists of the chains of "stakeholder → performance → stakeholder" as discussed above. Similar but different ideas have been used in SSM, where actions (not performance) and stakeholders are sought in turn in the process of action decomposition (Mingers and Taylor 1992).

Essentially there are two ways to depict a performance stakeholder network: either stakeholder orientated, where the nodes represent stakeholders and the connection arcs represent performances; or performance orientated, where the nodes represent performances and the connection arcs represent stakeholders, as depicted in Figure 5-6:

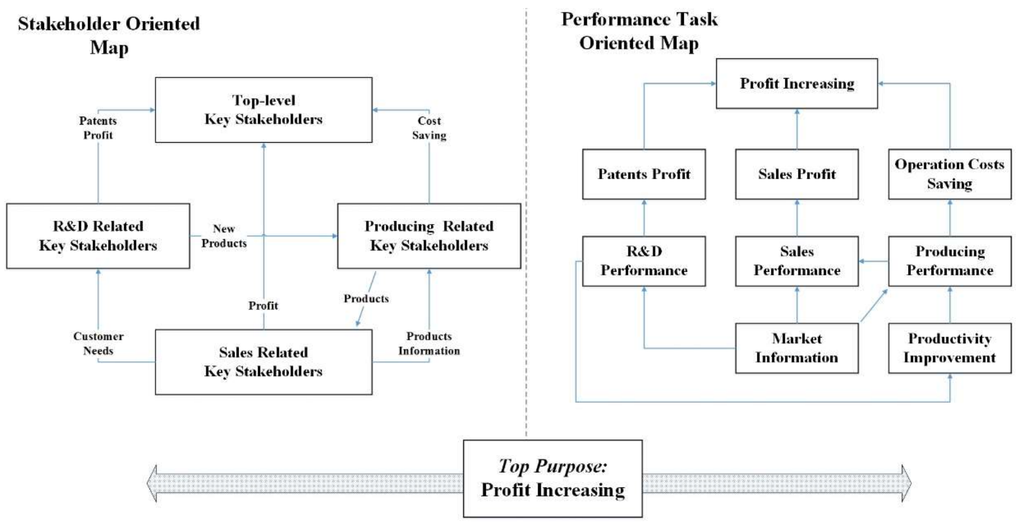


Figure 5-6 Stakeholder-performance network

Although stakeholders connect performance, often in PM and SSM literature (e.g., Strategy Map in BSC, and what-why-how sequence in SSM), one only concentrates on the network of the performances and thus the above structure is simplified into a performance network, where performances and their aggregation paths are retained but the stakeholders are omitted actually, just like the right part of Figure 5-6. The performance network will be discussed in detail in the next section.

In our framework, PM works on the performance network of an organisation. In classic PM theory, PM is carried out using the existing performance network of an organisation. In our framework, we do not just follow the existing processes. In the context of management, normally the actions are planned and acted by some stakeholders from the objectives (as purposeful activities), and they may not be the best ways to achieve the objectives, e.g., due to limitations of the stakeholders. In this regards SSM has an innovative procedure to plan and execute the actions. By adopting the idea in SSM, our framework includes rebuilding the performance network as a basic mean to improve performance. In this process we follow the logic: from the objectives of an upper level we identify potential stakeholders to decide possible actions or activities to achieve the objectives; we further need to measure the performance, and then manage them through stakeholders and resources (Wang, Liu and Mingers 2015), and those constitute of PM, and will be discussed in details in the next section. In developing the performance network, either actions can be further decomposed or the performance connect to further stakeholders and performance; which ways to use depend on organisational configuration–specialisation and coordination. For example, for an organisation with a simple-work operational core, performance decomposition from the top level will be mostly used. This will be further discussed in the next section.

5.2 Performance structure and performance tree in organisation

An organisation has its key stakeholders to decide its key objectives and strategies, and then has or plans a set of activities (action sets), which (with the stakeholders) carry out the strategies, and hopefully lead to the satisfactory completion of the objectives (Tsang, Jardine et al. 1999). Clearly, the resolution of these activities and their sub-activities largely depends on the organisational strategies and the level of details in PM. Let us note that the internal and external stakeholders, objectives and the activities are closely linked (Wang, et al 2015).

5.2.1 Performance network, performance structure and performance Tree

For each of the activities, there is the corresponding performance, owned, planned or executed by, or directly affecting some of the key stakeholders. Any part of the performance, and its logic connection paths form a performance network, and all the performance networks form the performance structure of the organisation. It describes how the organisational performance is aggregated and decomposed. Furthermore, an organisation often has some key performance, and then we can identify the key performance network, which is necessary to achieve the key performance. We call it the performance tree (PT) since it often has a tree structure.

Let us emphasize that the direct stakeholders are important in building an organisation's performance generation and management processes, which provide indispensable resources and form environmental factors for performance networks. Consequently, the crucial internal managerial and operational elements (i.e., management pattern, key success factors, organisational culture), and the key external elements (i.e., relationship with suppliers and/or customers) of an organisation can be reflected in the PM process through getting the stakeholders involved. Furthermore, we can add the stakeholders into the performance networks, and introduce performance-stakeholder networks and performance-stakeholder structure. However, they are similar, and we will further discuss the roles of stakeholders in developing PMS based on performance structure in great details later. To this end we often will need more than just the involved stakeholders. In some circumstances, specific methods and tools are needed to locate indispensable stakeholders in an organisation, such as the approach introduced in Savage et al. (1991) and the tool (The Balanced Stakeholder Card) discussed in Wang, Liu and Mingers (2015).

In an organisation the lowest level performance (usually personal performance) converts and aggregates into sub-level performance, then finally integrates to the top organisational performance through its performance structure and the stakeholders. Here we will depict performance as a node, and the aggregation paths indicate the logical relationships between each of the activities in the process of performance generating as discussed in section above. The top nodes of the performance structure should be its organisational performance, and the bottom nodes often represent the performance of the activities to the finest level of resolution that the management wish to achieve.

Our PM approach is to enhance the performance of organisations by designing, developing, implementing and managing the whole or a part of PT, which will be explained later on. The PT is the crucial part of the performance structure, where PM concentrates mostly. In fact, a PT likely consists of not only physical business processes, but also key management processes. Performance structure and tree in an organisation can be designed and developed in different ways: one is to follow the current organisation's strategies and the operation processes. For instance, the scorecard methods can develop a performance structure according to some pre-fixed logical frameworks. The other way is to rebuild business procedures by applying some approaches (like SSM) and discussing with key stakeholders (Liu, Meng et al. 2012). In practice, the two approaches can be mixed.

For the convenience of the users, a performance map tool will be introduced here. A performance map is a graphical representation of a performance network. In a performance map, each of the nodes (linked by bold lines if on the PT, otherwise a narrower line) represents a performance, and the bond-arrowed-lines connecting the nodes express that they are part of a PT. Their logic connections are displayed in Figure 5-7.

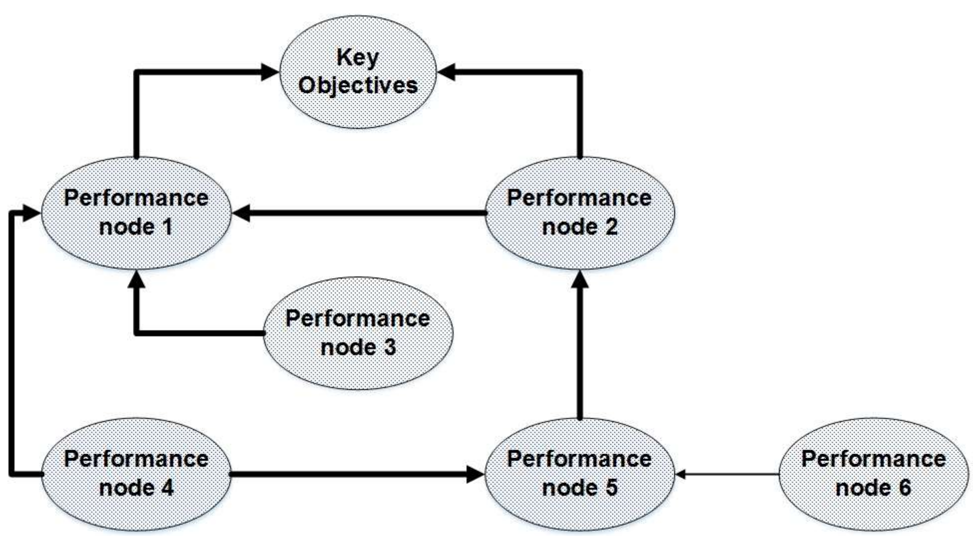


Figure 5-7 Performance map with on-tree and not-on-tree performance node

Let us take a company as the example to elaborate, assuming one of the company's critical objective is to improve the profit rate by product innovation. Under the above objective, the performance-generation actions from the R&D and production departments are critical, because they determine whether the top objective is accomplishable or not. However, some of the other actions, such as market information collection, HR support, even workplace cleaning, also contribute to the top performance indirectly. All the performance of the above actions, with different degrees of importance, form a performance network. However, considering the resources constraints (such as time and resources), the management will only focus on the indispensable part of the above network to ensure the top objective being met, and this indispensable part forms a part of the company's PT as shown in Figure 5-8.

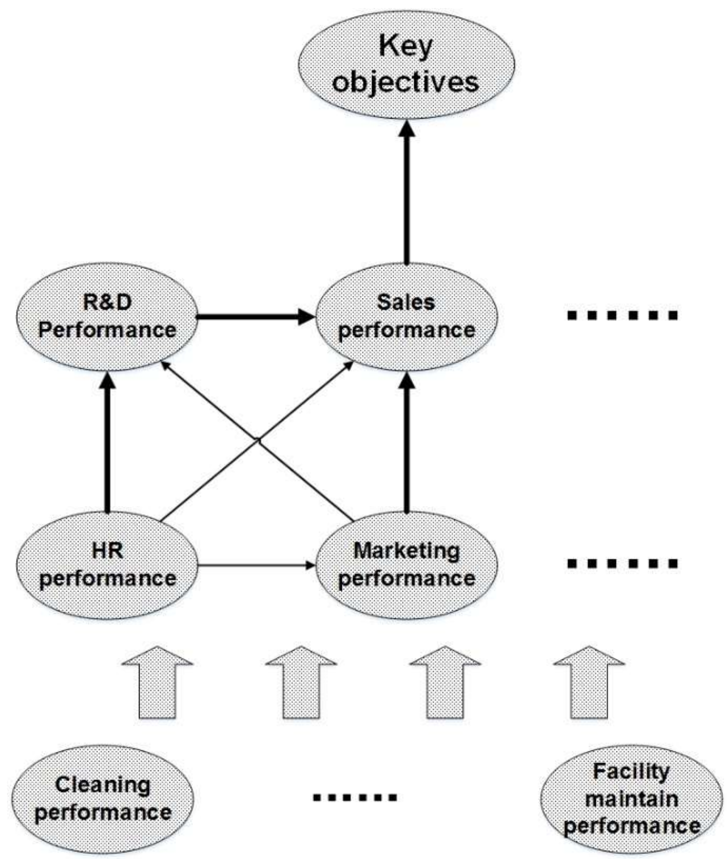


Figure 5-8 Indispensable and dispensable parts in a performance map

Performance networks are dynamically updated with the technology, operation and strategy of a company. For instance, if the company added another key objective: "improving the products quality by strict dust controlling in the workplace", then the performance of cleaning, a marginal performance in the former case, will be brought into the PT.

5.2.2 Performance set and unit

Now we introduce two more concepts in the PT framework: performance set and unit.

There are two basic managerial tools for managing a PT: One is the departmental structure (or organisational chart) and one is their key performance indicators (KPIs) to measure their performance.

A performance unit contains a sub-performance network of the whole organisation, key stakeholders, and resources to achieve certain performance goals that are defined and measured via performance set. A performances set of a performance unit consists of its objectives and corresponding metrics to convey managerial goals and measure its performance. Moreover, if a performance unit only contains the indispensable sub-performance network and stakeholders for its objectives, it is referred to as a "lean performance unit".

Let us emphasize performance sets and units are formed and operated by managers, and should match with the basic performance structure. However more often than not, KPIs and departments are wrongly designed in real organisations. In practice performance sets often only have KIPs (Kerssens-van Drongelen and Cooke 1997).

Each performance inside a performance unit has its own objectives, and further its performance metric can be designed via the 3E theory introduced in Liu et al. (2010). However, in general a performance set of a unit does not include all sub-objectives and metrics of the performance inside. Managers of an organisation also have their own ideas to run and measure their units, so often only select some from, and add some to, the whole set. Under ideal conditions, the contents of performance sets have a hierarchical structure: The contents of a higher level performance set should be included by its immediately lower level sets to a large extent. But the lower sets always contain their own contents that cannot be included into the higher one. For example, some local managerial requests that are not coming from upper sets can be added into the lower level sets to reflect local managerial preferences.

A performance unit could be coincident with a department of an organisation's existing organisational chart. When this happens, it is an actual performance unit, otherwise it is a virtual one (see Figure 5-9). In practice, virtual performance units can shed lights on the organisation's other possible configurations, thus presenting scenarios for organisational structure changes.

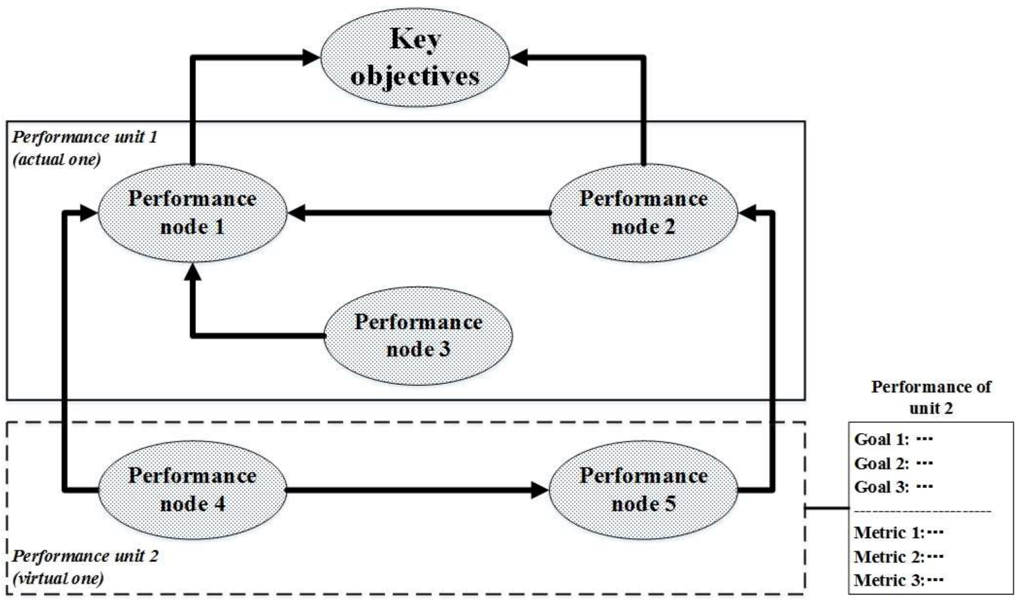


Figure 5-9 Actual and virtual performance units in a performance map of an organisation

Here we will give another example to further explain the above concepts. Still, let's take above company as the example, whose top objective is "increasing 15% profit rate through products innovation". Obviously, the R&D and production performance are the crucial ones under the current objective. Therefore, the related part of the PT should be developed around the nodes related to achieving these particular performance criteria. This production-oriented performance map is illustrated in Figure 5-10.

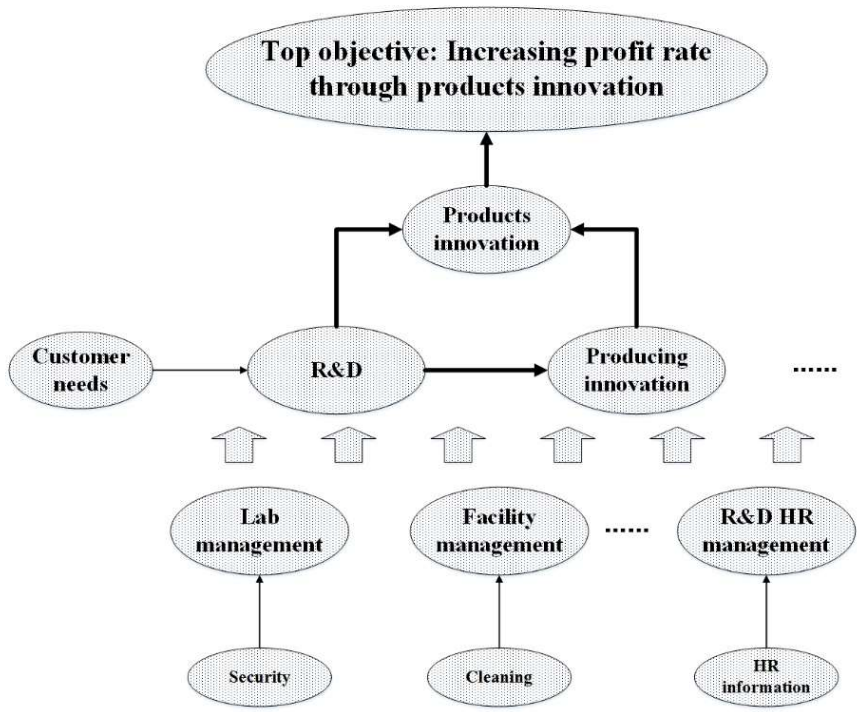


Figure 5-10 R&D and production-oriented performance map

It is can be seen that the above PT is mainly made from the R&D and production related nodes. Accordingly, the performance set of the unit contains performance objectives and metrics under the same themes. There are two main sources of the set's contents: objectives/metrics inherited from the upper level and requests from local management needs, as shown in Figure 5-11.

Let us emphasize here that a performance unit can be actual or virtual, in the latter case it may not coincidence with current practices of an organisation. Virtual performance units however shed light on an organisation's potential reformations, and hence they are very useful for organisations with structure reformation intentions, which will be elaborated later.

Interactive relationships exist among the performance network, set and unit, which mean that if one of them changes the rest may need to change accordingly. For instance, if the company reallocates the "Producing process innovation" node to the "producing unit", its corresponding performance set may change too – the focus of objectives and metrics may shift from R&D project to production-process.

Moreover, the configuration of above three elements is determined by an organisation's objective and strategies fundamentally. For example, if a company's key objectives are modified, the networks, sets and units' configuration may have revolutionary changes too. For instance, Figure 5-12 shows the above company's performance map under the key objective of "increasing the profit rate through innovative sales methods".

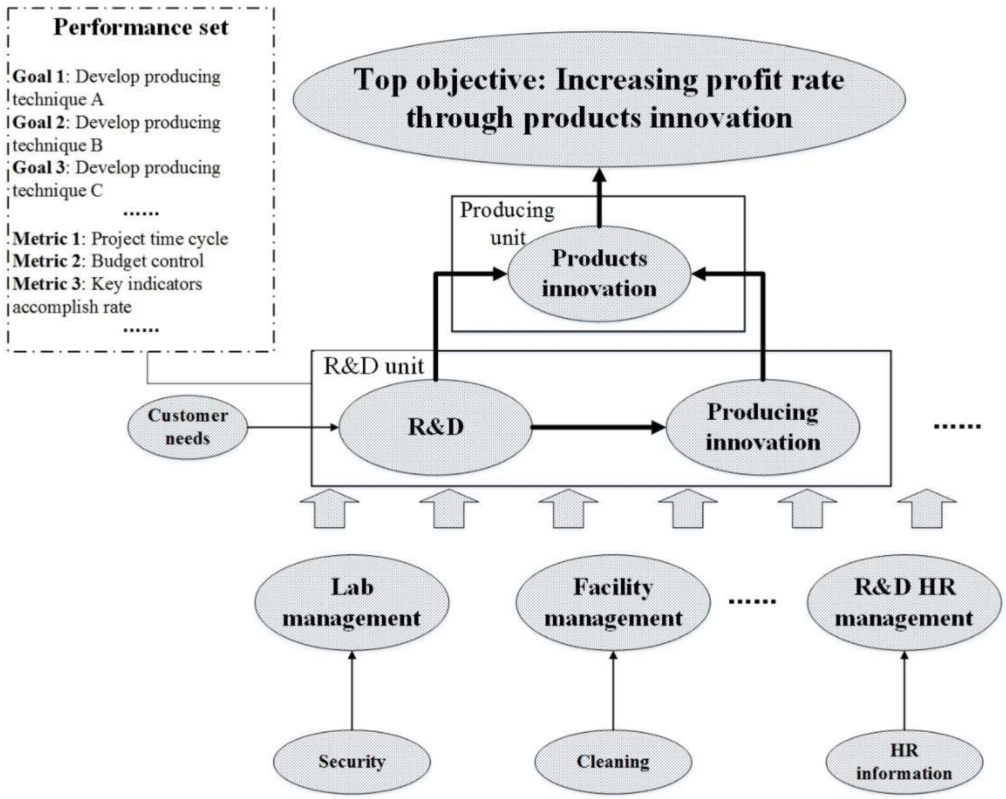


Figure 5-11 Performance set for the R&D unit

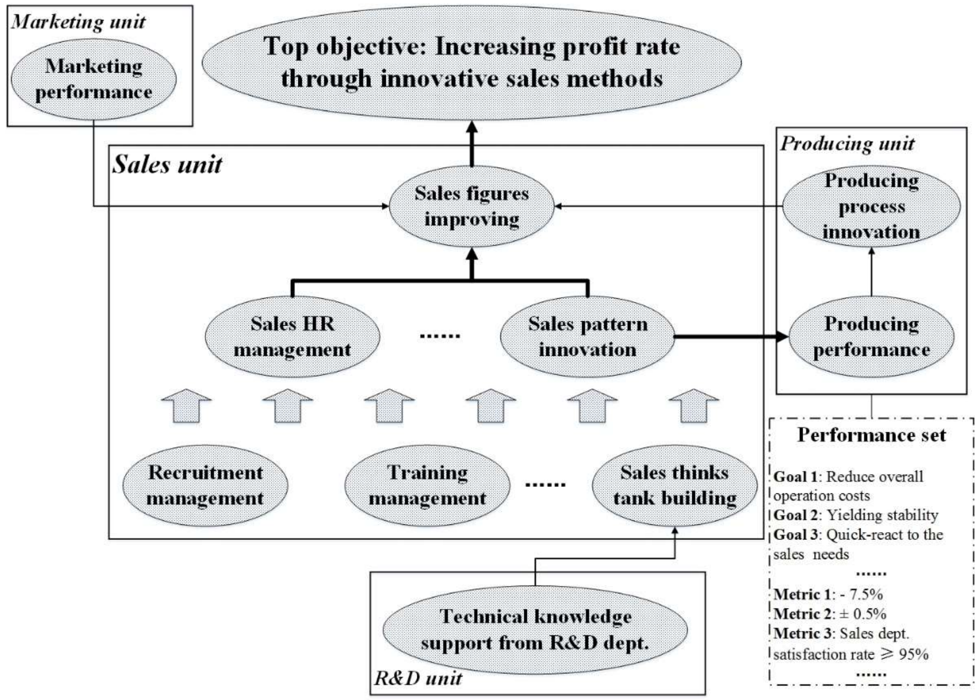


Figure 5-12 Performance map under the changed top objective

Comparing with Figure 5-11, emphasis of the whole PT shifted from R&D performance to the sales performance, and the performance nodes in the PT were changed accordingly to support the modified objective. Moreover, the ranges and internal connections of the performance units were changed significantly too – the range of sales unit on the PT was extended greatly. The last difference is the contents of the performance set, the new metrics listed can better fit with the coordination needs from the new objective.

Furthermore, the roles of stakeholders can be added into the performance map to form a performance-stakeholder map to reflect more contingency factors (Figure 5-13), but it will increase the complexity of performance maps dramatically. Therefore, in practice, we only use the performance map to assist organisations to carry out PT based PM.

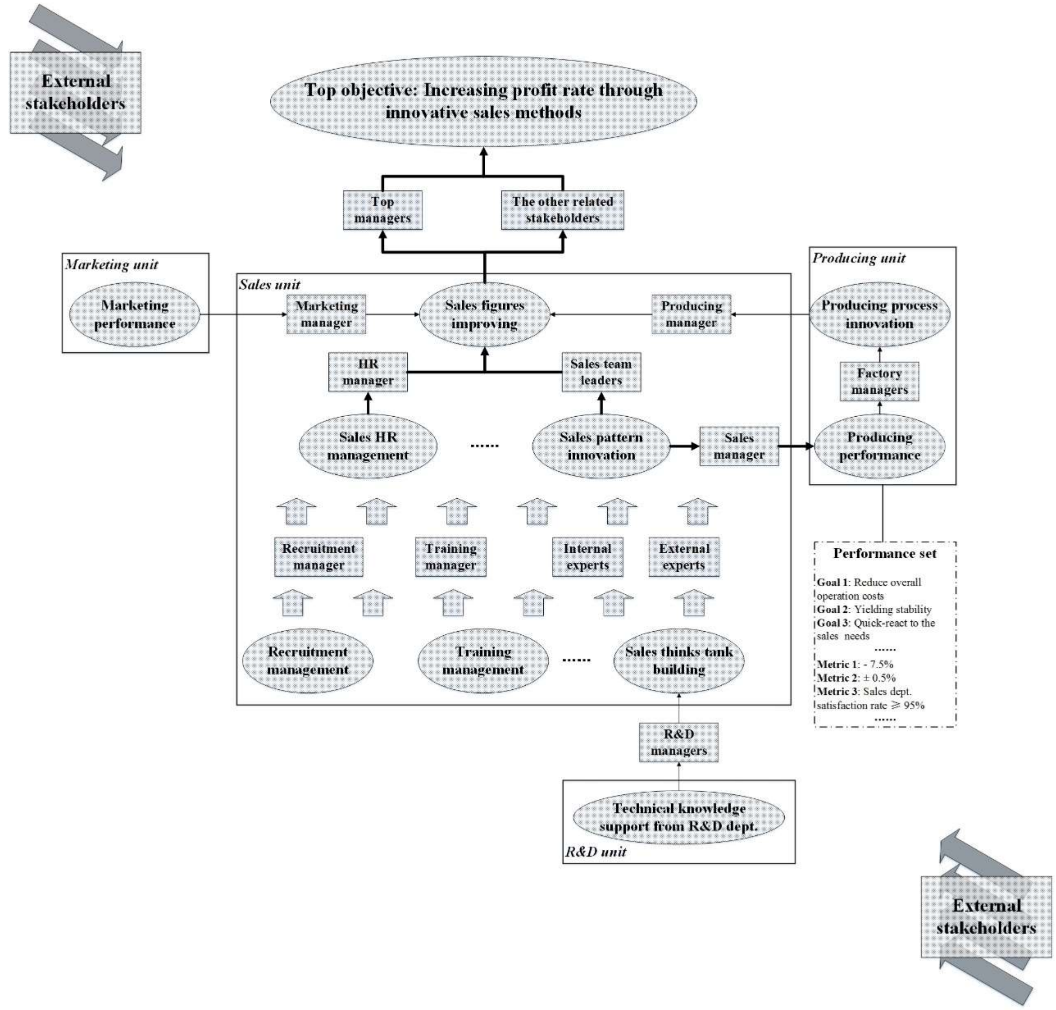


Figure 5-13 Performance map under the changed top objective

The Figure 5-13 illustrate the connections of each PT element in a real managerial context. Furthermore, the conceptual model of the five basic elements in the PT framework can be depicted as Figure 5-14

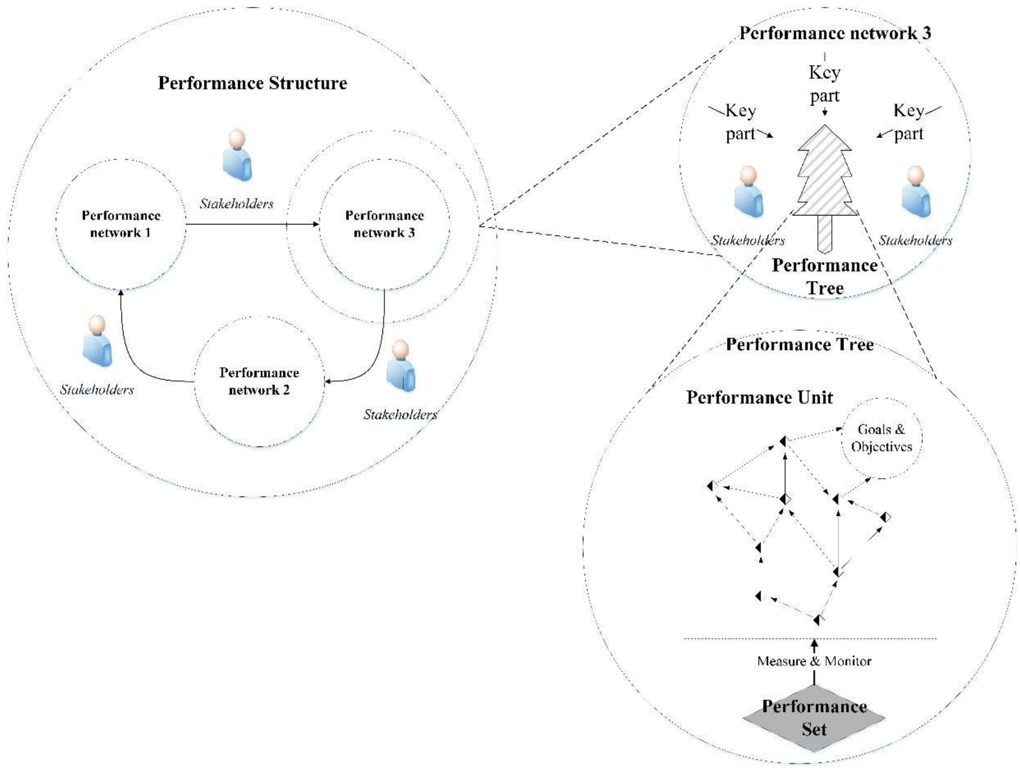


Figure 5-14 Conceptual model of five elements in PT framework

5.3 PT performance management framework

As discussed, various attempts are made to develop framework for PM, at one end, very abstract frameworks exist, such as "a holistic process that ensures employee contributes to business objectives (CIPD 2015)" or "a systematic process that a manager applies to involve employees in accomplishing a unit's mission and goals (Watson 2014)", which apply to all organisation although they do not provide any details for its actions. Similarly, although the PM frameworks such as EFQM can be used to build performance benchmarks, they cannot be used to set up a PMS in a particular company as they are not associated with objective/strategy or operation of an organisation. On the other hand, the widely used six-step framework (Otly 2003) and the scorecard-based approaches such as BSC and BSM rely heavily on strategy decomposition and organisational charter in setting up and running PMS. From the literature they work well for mechanical organisations (Tong, Wei and Liu 2014), but for more complex operations like universities and rapidly changed charts (like SMEs), they normally need much adjusts or alternations to apply (Aremu and Ayanda 2008). In our opinion, the key of setting up PMS for an organisation is not necessarily to decompose its objective/strategy but to build its performance network based on them, although strategy decomposition may be a good approach to build its PT in mechanical organisations (see Tong, Wei and Liu 2014).

Based on the introduced new concepts, we can describe our PT PM framework as: ***Enhance organisations' performance by firstly developing the performance tree with its key stakeholders according to its key objectives/strategies, and then properly managing performance tree through performance sets and units.***

Comparing with the existing frameworks, our PT framework's network view is more focused on the generation of performance, which ensures its advantages as discussed above compared with the existing linear frameworks (such as six-step framework (Otly 2003)). Our PT performance framework contains the following five key elements: ***objective/strategy, stakeholder, performance tree, performance set, and performance unit.*** Their functions and connections are explained below.

The first part of the framework is to construct a PT according to key objectives and strategies. Since performance consists of intended actions, we build a PT by firstly identifying its objectives and then deciding possible actions to achieve them with key stakeholders iteratively, according to relevant strategies set by the organisation:

(i) If the objectives can be largely achieved through the existing operation processes, one can just apply the BSC or PSC to decompose the objectives and strategies; to decompose its top strategies/objectives straightforward in a top-down manner as the local stakeholders can accomplish the given objectives based on their knowledge and experiences.

(ii) However, the operations may need some improvement to achieve the objectives. In this case one may apply (e.g., EFQM, BSM) to diagnose and improve the existing actions.

(iii) An organisation may need to rebuild a part of its operations and in such a case, the methods such as the SSM, are very useful. For a simpler case like a traditional manufacturer, combinations of BSC and SSM seem to be effective, see Tong, Wei and Liu (2014) (to be seen in the HB case). For complex cases, e.g., R&D operations, further knowledge (such as theory of research generation and structure, see Chapter 3) may be needed. In such a case often combined efforts from top managers, base staff and even external experts are needed -– the top managers can describe overall objectives and directions that are echoed and supported in details (or rejected) by the base staff through their research and expertise, and several iterations may be needed from top to bottom and back to top. The helps from base staff and external experts are highly crucial in this case, since they hold most of the technical details about how to achieve the objectives.

Here the objectives often come from discussions or decompositions of the top ones or a need of upper level PT building up. In practice, above three situations may exist in the different parts of PT building of an organisation. For example, the PT of manufacturing department can be built up in the first way, while that of sales department may use the second way, and for the R&D department, whose working flows are very technical, its PT needs the help of the third way to build.

Meanwhile organisations need to consider formulation of performance units – which can be virtual or real, as discussed before. In practice forming performance units is a very complex task (Mintzberg 1980) and often they come from adjusts from the existing organisational charters. Different types of organisations have different emphasis in the organisation structure rebuilding process. However, the following principles are very useful for forming performance units:

(i) In effectiveness-oriented organisations represented by government and university, relatively independent performance unit is the emphasis in the structure rebuilding (Reeves, Duncan and Ginter 2000). To take a university as an example, schools are core performance units that generate and aggregate performance in the university, which are fairly independent. Making core performance units operating independently is a key in designing a virtual performance unit for the effectiveness-oriented organisations.

(ii) The efficiency-oriented organisations care more about “doing things right”(Kwon and Armstrong 2002). The efficiency-oriented organisations usually have highly dependent core performance units, which means the organisational performance can be guaranteed only by improving both the units’ and their cooperative efficiency at the same time (Wojciszke and Abele 2008). The emphasis of rebuilding organisation structure for the effectiveness-oriented organisations is the cooperative structure linking these units.

(iii) The difference of PT emphasis is also reflected in the contents of performance sets. The effectiveness-oriented organisations may prefer contents reflecting customers’ satisfactions and the efficiency-oriented organisations trend to select contents casting light on their operation efficiency.

Thus the logics of building up a PT system are from its intentions to construction actions and then set units for management and measurement for results. Once the PT system has been built up, the second part carries out PT-based management through performance units – for example by applying the KPI and performance plan. The KPIs in performance sets are metrics used to evaluate factors that are crucial to the success of an organisation. And the tool of performance plan is a work plan for how to accomplish their performance tasks between a line manager and subordinates, which including details of their key works, resources, performance appraisal, potential problems in the work and rewards. The proper approach to carry out performance plan-based management is depending on the characteristics of an organisation. For instance, the performance plan of a university staff should be generated through detailed bottom-up communication to clear its technical contents. However, the performance plan for an assembly line worker can be assigned from a line-manger directly, since there is very limited flexibility in the assemble-line works.

The KPIs' approach enables a company implementing its strategies/objectives effectively. And the performance plans help staff accomplish their performance targets with clearer path and stronger supports.

Building up a PMS by our PT framework is an iterative process. In practice, because of interactive relationships between performance sets and hierarchical performance units, their configurations will be adjusted several rounds by stakeholders before its finalisation, to be seen later in detail. Let's emphasize here that building up of the PMS can be made independent of the organisation's existing formal structure, and therefore to promote potential organisation structural innovations.

In summary the PT framework can help organisations building up a tailored PMS around building up its PT to implement its strategies/objectives effectively and effectively. The existence of the "virtual performance unit" in the framework helps the organisation building up/reforming its formal structure and objective system interactively, which further ensures they are mutual-supportive. Moreover, most of the current PM tools can be integrated in our PT framework, which proves a way to build a unified framework for PM.

In the recent two decades, the most widely used existing PM frameworks (or approaches) are represented by the scorecards, such as BSC and PSC. The BSC is by far the most widely applied framework, it helps organisations to "align business activities to the vision and strategy of the organisation, improve internal and external communications, and monitor organisation performance against strategic goals (BSI 2016)". Comparing with the BSC, our PT PM framework has following four advantages:

1) The BSC highly relies on an organisation's existing operations and formal structure to carry out top compositions, so it hinders the potential structure reformation in the organisation. However, in the PT PM framework, the existence of virtual performance units enables organisations to redesign their operations and structures in the decompositions, and organisational reformations are promoted at the same time.
2) The BSC guides organisations to build up their PMS through fixed four-

dimension in a top-down way, so it may neither suit for non-profit organisations since the profits are not their first concern, nor for hi-tech enterprises that top objectives/strategies are formed in an up-bottom-up way. In our PT PM framework, both top-down and bottom-up ways are applicable, which means an organisation's PMS can be oriented on its top objectives/strategies or on the professional staffs' ideas.

3) The BSC's fixed four-dimension makes it difficult to apply locally, such as departmental or divisional level. However, the PT PM framework only requires objectives or tasks, which do not have to be top ones, to start the developing of the PMS. What is more, even without a clear objective or task, the PT PM framework can also form the system in the bottom-up manner.

5.4 Preparation works for applying a PT framework

The preparing stage is indispensable for all situations. The important things of the preparing works include to establish a performance promotion team (hereinafter referred to as "the team") to handle contingency issues and to gather comprehensive information to review the company's existing objects and strategies, as shown in the cases studies to be presented later. Usually, the team consists of external consultants and the representatives of key stakeholders of the company.

Furthermore, to construct a tailored PT PMS, users should pay a great attention to clarify three principal questions before carrying out a project.

Question 1: The organisation will largely maintain the formal structure status quo or carry out significant structural transformation (and to what extent)?

For users who wish to establish a comprehensive PMS without reforming its current formal organisational charts, it is not necessary to take virtual performance units into account in the project.

Other organisations may prefer improving their performance process through transforming current organisational charts, and in this case, the virtual performance units (especially lean units) will be fairly critical.

The virtual performance units help the organisation reviewing its current structure to optimize its PM procedures. Organisational structure transformations reorganize the company's current performance generation and management procedures. Therefore, the virtual performance units should be considered from the initial stage of the construction -- virtual departments could be added, departmental boundaries could be adjusted and cross-department performance collaborations could be established. In this way, the five elements in the PT system will be reconfigured following the optimized performance generation procedures. However above subversive changes rarely happen in an enterprise, instead, some limited changes are more common. The PT framework can also meet these minor improvement needs by applying the approach of virtual performance unit locally.

Question 2: What is the stakeholders' role in the PT performance management?

The PT framework can assist organisations with different setting of stakeholder to construct their PT systems. In the PT PMS, the stakeholders' influences can be limited or comprehensive. In the first case, only limited parts or/and levels of the stakeholders are involved in building the system. For example, one can concentrate only on companies and their external customers as in the BSC. The comprehensive way is commonly seen in the public sectors or private organisations with complex operating cores. In this case, interests of each key stakeholder will be balanced at all levels. For instance, the levels of stakeholders are balanced stepwise in the Balanced Stakeholder Scorecard for hospital (Wei, 2015; Moullin et al. 2007). According to ownerships and managerial capacities, PT users should adopt a suitable way to handle the stakeholder factors, since more managerial challenges will emerge with increasing stakeholder considerations.

Question 3: What are the user's preferences to contents of performance sets (balanced contents or those emphasizing certain aspect)?

Depending on the organisations' ownerships and preferences, they will adopt unique ways to achieve their key objectives and strategies. The most obvious embodiment about above differences is the organisation's performance sets. For instance, because of the profiting impulse, private enterprises tend to configure more financial related objectives and metrics in their sets. In contrast, the public sectors do not have strong earning motives, so they prefer balanced contents of performance sets to satisfy multiple demands from stakeholders. Therefore, it is necessary to take above features into account in constructing a PT.

In practice, users' answers to above three questions are tightly related: a company with strong short-time profiting impulse may pay extra attention on its customers, and set them as the core stakeholders. Correspondingly, under the short-time pressure, the company would avoid turbulence in operation, so the organisational transformation is a less likely choice.

In the following chapters of this thesis, we are going to further address specific approaches to the PT framework for the sake of improving its feasibility in organisations with various characteristics. The first case will be addressed on the issue of PM dilemma in SMEs, which have fast-changing organisational charts and high demands on organisational innovation. Furthermore, the second case will focus on the PM in R&D unit, which is the representative of complex operating cores.

Chapter 6 Case Study of HB Company

Based on the new PT framework introduced in the former chapter, a tailored implementation approach addressing the pressing PM issues in the Chinese classic manufacturer SMEs will be developed in this chapter.

6.1 Project summary

The HB Company was founded on June 1997 as a small and micro enterprise. After 20 years of development, the HB Company has become one of the leading enterprises in the Chinese industrial paints field. Nowadays, HB owns three manufacturing bases distributed in different provinces, and the major businesses of the company include industrial paints, construction paints, military purpose paints, and painting project construction. As of 2016, HB has 556 full time staff members; its manufacturing capabilities have reached 10,000 tonnes of general paints and 400 tonnes of water-based paints. Moreover, its construction capability growth is to 10,000,000 square metres for metal coating, 2,000,000 square metres for construction coating, and 1,000,000 square metres for terrace coating.

The rocketing of the manufacturing and projecting capabilities brings large profits to the company – its net profits reached GBP 30 million in 2015 and are expected to be GBP 46 million in the fiscal year 2016.

To sustainably achieve the strategies and increase its core competitiveness, HB Company invites the performance management (PM) consulting group of Kent business school to carry out a management diagnosis and improvement project. They wish to solve the existing managerial problems and reform its management system through building a comprehensive performance management system (PMS) in the company.

6.2 Information gathering and diagnoses

A performance working group is set up in the first stage to guide and implement the whole project. The group consists of external performance experts, the headquarters of HB (CEO and deputy CEOs), senior managers from the key departments (sales, marketing, R&D, manufacturing, customer service, and administrative office), and some key staff in key departments.

After confirming the members of the group, semi-structured interviews are carried out in layers of managers, supervisors, and subordinates of HB. The questions of the in-depth interviews focus on the daily work content, emphasising local and global operation objectives, managerial procedures, and existing managerial issues. The questions are asked per the five basic elements in the PT framework, as introduced in Chapter 5, such as:

- What are the strategies of your department?
- What are the key objectives of your position?
- What are the main collaborators of your job inside and outside the company?
- Could you briefly describe the procedures of accomplishing your job?
- What are the main performance criteria you are currently facing?
- Do you think the current organisational chart can support your work well?

The in-depth interviews are carried out along the organisational chart of HB in a top-down manner, which means the headquarters are interviewed first, and then the departmental managers and line managers, and finally the core staff in the departments. The information gained from the levels of staff will be cross-checked until a widely-agreed conclusion has been generated regarding the current situation and issues in the management system of HB.

Moreover, the secondary data are also collected in this stage from the Internet, internal files, and industrial documents to support the team to form an overall picture about the status and issues in the PM of HB.

The essence of this stage is to perform a collaborative analysis of the social and economic situation of HB. This data collected during the primary and secondary research data-gathering exercise is essential to developing the proposed PMS. Many existing approaches can be integrated in this step to help identify, visualise, and link the key processes from tangible and intangible resources to strategic objectives.

After analysing the primary and secondary data and rounds of discussions in the working group, the situation and issues of HB can be identified as discussed below.

6.2.1 Current performance control system of HB

The HB Company has a very flat organisational chart, which consists of only three managerial layers (Figure 6-1).

The board of directors and the CEO form the top level of the organisational chart, and they not only focus on the strategic topics of the company but also participate in the detailed first-line management (the CEO is also the expert on manufacturing management), which is not unusual in Chinese small and medium enterprises (SMEs).

Next, the department managers are on the second layer of the organisational chart and receive direct orders from the top and deploy them in their departments. The situation is similar for the top management, as some of the department managers also have dual roles as managers and practitioners. For instance, the manager of the R&D department is the most accomplished researcher, and the director of the sales department should accomplish the sales target, which is 2,000,000 pounds.

The front-line employees are at the bottom of this organisational chart, and a hierarchical system can also be found among them. However, the leaderships and powers in that system are informal and temporary; the most common situation is that five to 10 employees form a working group and one of them will be elected as the group leader based on informal powers.

Because the top and middle managers are highly involved in the first-line operations and the most organisational charts of HB are short, the company has adopted the idea of management by objective (MBO) to control its performance.

In summary, the HB performance control system operates as follows:

1) The headquarters confirm the top objectives of HB in the beginning of each fiscal year, and these objectives usually focus on the financial performance of the company (e.g., sales volume, net profits, debt to assets ratio, etc.). The departmental managers become involved in the setting of objectives to a limited extent, which means the objectives are generated largely depending on the information and plans of the top management.

2) The CEO and deputy CEOs further break down the top objectives into operation targets belonging to different departments. In this step, a cross-department meeting will be held to discuss the overall competitive strategies of HB to achieve the top objectives. In the end of the meeting, the core departments (usually the sales, marketing, manufacturing, and R&D) will be assigned several very clear (usually numerical) operation targets, such as ‘increase the sales volume of the Product A by *x*%’ and ‘finalise the R&D of Product B no later than X month’ for sales and ‘increase the yield of Product A by *x*%’ for manufacturing.

3) The department managers will hold very similar joint meetings on the departmental level to clarify specific competitive strategies. The objectives will be further divided into the sub-divisions of the departments according to the specific competitive strategies. For instance, the sales department may set its competitive strategies ‘to increase the sales volume by *x*% in the southern China market and civil construction market’, and then, these increments will be further assigned to each sales division and sales team.

4) The CEO monitors the progresses of the key objectives, and if some of them are behind the plan, the CEO will push the department managers to solve the issues and catch up with the plan.

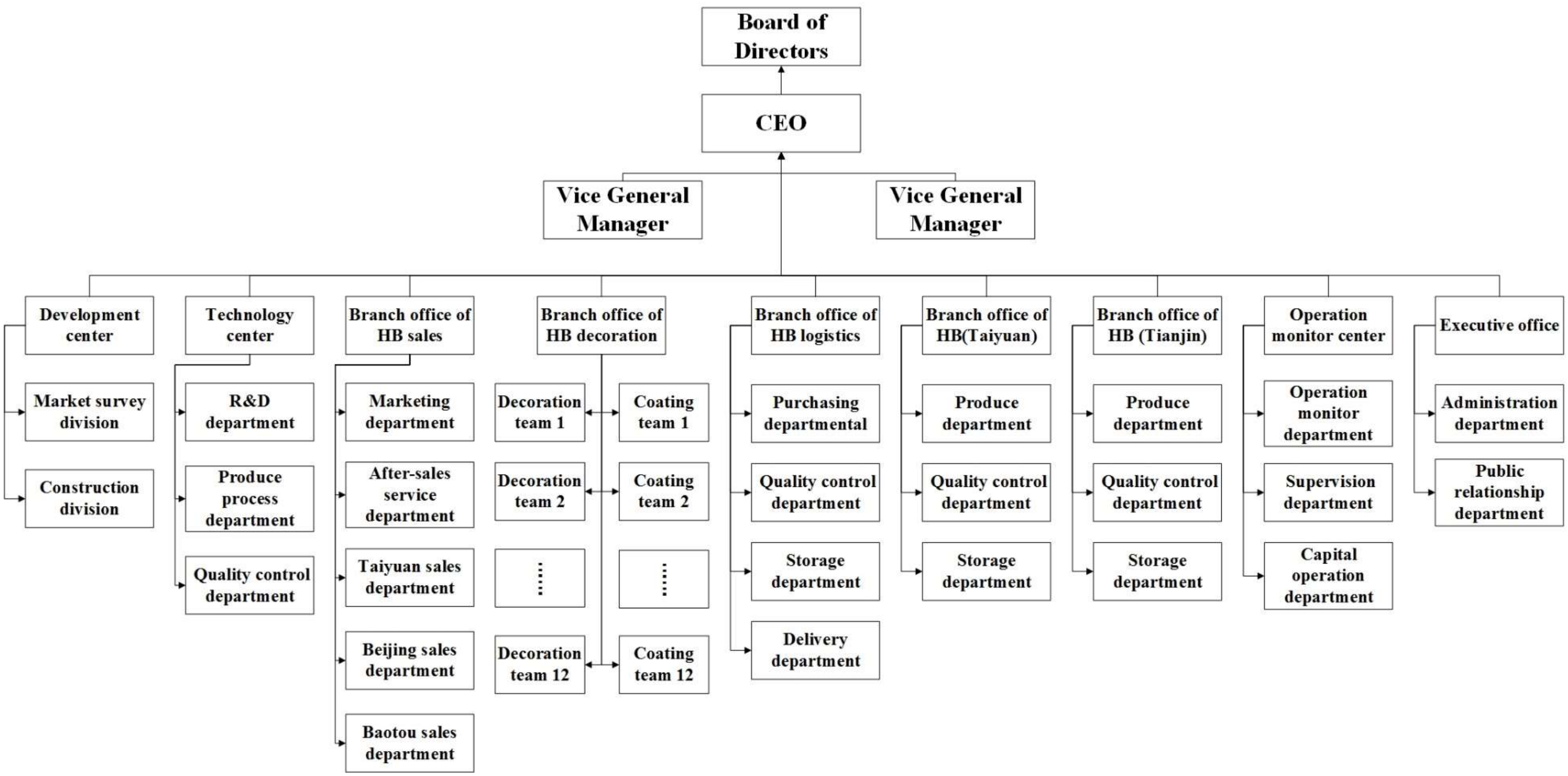


Figure 6-1 Organisational chart of HB

Based on the descriptions above, we can hardly call the current performance operations of HB a PMS since several important factors of a PMS are missing (such as comprehensive performance measurement, performance guidance, and performance feedback).

The MBO-based performance control system drove the company well in the initial stage of the business since most of the necessary performance coordination can be accomplished through face-to-face communications among the department directors in a small business. However, with the expanding of the scale of HB, the side effects of this incomprehensive and informal system are increasingly obvious (will be discussed in Section 6.2.2).

6.2.2 Key issues in current performance management system of HB

After rounds of in-depth interviews for levels of staff of HB, several main issues in the daily operations of HB have been identified. After summarising and communicating with the headquarters of HB, the key issues of HB are confirmed as follows:

1) **The current performance control system over-emphasises performance outputs. The management of the performance generation processes is largely ignored.**

The current MBO-based performance control system of HB puts most efforts on ensuring the performance output. However, the department coordination, sustained competitiveness of the company, and long-term positioning of HB are ignored.

The department managers report many cases concerning the side effects of the system. For example, some salesmen accomplished their performance targets at the cost of the brand reputation of HB. The department managers refused to collaborate under the pressure of performance competition.

2) **The current performance control system is difficult to alter to match the fast-changing organisational chart of HB in time.**

The performance target division of the current performance control system is based on the current organisational charts. Therefore, many performance targets and performance plans will be untraceable if the charts change. Moreover, to decompose and deploy top objectives relying on the existing structure may hinder further adjustment and optimisation of organisational charts for SMEs.

Therefore, the new PMS should focus on the procedures of the performance generation, instead of on the current organisational charts of HB. If so, the PM operations can be carried even when adjustments to the organisational charts happen since the basic performance generation logic of an organisation is usually much steadier than its organisational chart.

3) There are insufficient opportunities for training and development under the current performance control system.

The staff of HB, especially those from the R&D and sales departments, complain that they cannot gain enough resources and opportunities to be trained and developed largely because the training module is missing from the current performance system. Accordingly, to form a mechanism to develop the human resources is another task in building up the new system.

Based on the issues above, the consulting team suggests HB should rebuild a comprehensive PMS that is in line with the modern PM ideas and theories. The new system could help HB deploy its strategies and top objectives and further motivate them to be accomplished based on the logic of the performance generation. Second, considering the SME characteristics of HB, the PMS should support the innovation of business processes and managerial process, which means the unique operations of HB should be reflected in the PMS. Finally, the new PMS should be implemented in a low-cost and convenient way.

6.3 Implementation procedure of HB project

For the enterprises with simple operating core and incomplex strategies like HB, the BSC framework can be applied to guide them to build up the PMS. However, there are two main requests of HB that cannot be met properly by the BSC framework: First, HB has many 'soft targets' in its strategies, such as the contents of organisational culture, and these soft factors cannot be easily integrated into a PMS properly by BSC (Liu et al. 2012). The second reason is that there are many new strategic factors in the current term of strategies of HB, so the innovative methods of operation and management are needed in the PMS to promote the accomplishment of the new strategy. However, in the implementation of BSC, the current organisational structure and managerial procedures are usually adopted to carry out the division, and it largely hinders the innovation of the enterprise. Therefore, the team will develop a tailored PM framework for HB to build up the PMS according to its specified demands.

Tong, Wei et al. (2014) and Tong, Zheng et al. (2016) proposed PM frameworks for classic manufacturers and universities in which the SSM is adopted to divide the strategies and objectives of an organisation with integrating soft managerial factors into the PMS. The essence of SSM is to guide an organisation to explore operational and managerial innovations based on comprehending and critical thinking about its current situation. By continuously asking the questions: 'What to do?' 'Why do it?' 'How should it be done?', the key processes attributing to the top strategies and objectives are systematically identified. In comparison with the BSC, the key processes (KPs) generated by SSM are more balanced (hard and soft factors) and management-centred. Due to the facts above, the SSM will be adopted to help HB to create its new PMS.

Moreover, considering the top-level strategy of HB is relatively clear and does not need to be further adjusted, the strategy map method will be applied to carry out the first-level division to reduce the complexity of the whole project.

The implementation procedures of the project can be summarised in the following five steps:

i) Top decomposition: Identify the KPs for each critical operation. Then, depict logic relationships to form the main branches of the PT and ascertain the primary focus and overall strategies for these operations. This process can be depicted in a strategy map from Step 1, but it is useful to continue to discuss and debate with stakeholders to ensure consensus.

ii) Conceptual decomposition: Each of the key activities (from i) is decomposed to a series of sub-actions that support their upper level objective jointly. Meanwhile, all of the decomposed sub-actions should ensure the accomplishment of the overall goals and objectives of the company (*the how*). At this stage, these sub-activities or actions may be different from the current practices in the company, and consensus needs to be achieved between management and employees. This step tends to involve facilitators having discussions with internal and external stakeholders. These discussions attempt to tackle some of the barriers to successful PMS implementation, such as organisational structure and culture.

iii) Procedural decomposition: The above sub-activities are further broken down, which should ensure that the overall purposes of these activities are achieved. At this level, where the core operations occur, the key driving processes are identified. However, if some operations need more in-depth examination, it is possible to reapply the conceptual breakdown procedure. Additionally, it should be kept in mind that the interrelationship exists amongst the key driving processes, which means if one of them has been adjusted, usually, the others will be affected correspondingly.

iv) At this point, the performance indictors and standards should be addressed to the performance criterion to form a complete performance metric. If the practitioners find that some criteria are still ambiguous, may the activities underlying the indictors need to be further specified through repeating Step 3 until all of them are explicit as needed. Moreover, based on the finalised KPs, the team should discuss the necessity of organisational structure modification (virtual performance units) with the key stakeholders of HB. This step will finish when all the KPs and their key performance indicators (KPIs) are clearly seen or until felt necessary.

v) According to the managerial needs of the organisation, complete KPs and corresponding KPIs can be developed with desirable levels of detail. Often the managers will distribute the KPs to their key staff as job assignments.

Then KPIs of the KPs will be used to measure performance of the assigned staff.

The first three steps above are to build the PT, in which, the team needs to know objectives, key strategies, culture, and activities (production, marketing, design, R&D, and service) of the HB Company to integrate them into the new PMS. Here, attention needs to be paid regarding the key soft factors like company culture, leader's overview, ideas on management and operations, etc.

In BSC, only key business driving processes are found for achieving objectives, but here, we identify both key performance generation processes and key managerial processes supporting PM operations. The rest of the steps are to create a management system for the PT, which can control, assess, communicate, monitor, and coordinate it.

Step iv reflects a highlight of the framework since the virtual performance unit is introduced into PM operations, by which the organisation can reassess and modify its current performance structure to fit with the new performance generation procedures.

Meanwhile, based on the confirmed KPs, we can develop KPIs and further develop the performance plan system as well. The co-existence of the KPI measurement and performance plan system ensures the organisation can monitor its desired performance outcomes constantly and guides and helps employees improve their performance when they face difficulties.

In the next sections, we will further introduce the details of the HB project according to the five steps above.

6.4 Building a PT for HB

The PT creation consists of the first three steps above. We will first divide and visualise the top strategy of HB via a strategy map tool and then carry out conceptual and procedural breakdowns next.

6.4.1 Orientation of PT: Top breakdown

In this step, we try to clarify the top strategies and objectives of HB, and the corresponding ‘soft factors’, such as organisational culture, to lead the operations below. Interview data was complemented with salient internal documents, such as HB Company’s planning and performance related documents, group discussion and online sources, such as the website, and customer reviews. Moreover, HB’s senior management team were interviewed to discuss their detailed visions, missions, and strategies. From the discussions, it became apparent that HB’s core value was to create an ambitious, learning, and innovative environment for their employees to flourish. The underlying philosophy being an all-win organisational culture to successfully compete in the challenging Chinese marketplace that also had to be embedded in the new PMS.

Furthermore, HB’s strategic priority was to manage its supply chains end to end and proactively respond to consumer demands and needs. This step necessitates developing strong partnerships and providing not only products but also painting and decorating services for customers. Intermediaries such as local dealers and construction companies were sought and included in collaborative discussions. It was noted that the coating industry is mature with both quality and costs being very similar across the sector. Thus, quality is not the sole differentiating factor among HB’s peers. Customer choices often depend on local dealers and construction company recommendations. Hence, liaising with these intermediaries was an imperative for HB.

Furthermore, through its organisational culture, HB is trying to create an all-win situation for its staff, which means that the company provides a platform for its staff to release their potential and realise their dreams. These core values are developed explicitly in the next breakdown stage. From the data-gathering exercise, it became apparent that HB had six key operations, which will lead to the development and implementation of a new strategy: marketing, supply chain, R&D, after-sale, painting engineering, and human resource management (HRM). To successfully achieve the ‘end-market strategy’, HB needs to identify and satisfy their customers. Therefore, marketing should identify customer needs. The production, painting, and after-sales services are the core operations that satisfy those needs. Ultimately, the R&D activity aims to continually produce better products and services to exceed customer needs. Additionally, HB also needs to ensure that all staff are competent and enthusiastic to deliver excellent service. Finally, the main strategies of the six key operations were discussed with HB's CEO and top management team. These are summarised in the next step after the interviews with HB's senior and middle-level executives. Additionally, the formation of a project management team, which was conjointly led by one of the researchers and one of HB's senior managers included representation of all key stakeholders.

Considering the core operations of HB are relatively simple and its top objectives are also not complex, the team decided to employ the strategy map method to carry out the top breakdown. The strategy map method can help further link the top strategies and visualise them to ensure that the following steps can be better oriented.

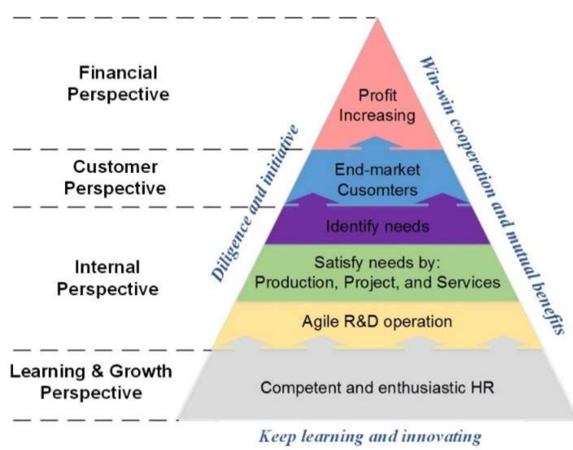


Figure 6-2 Strategy map of HB.

Figure 6-2 illustrates that the top strategy of HB is 'profiting through further expanding the end markets (details see Section 6.2)'. To achieve the top strategy, HB has very specific expectations regarding its six core operations, and, in detail, they are as follows:

- **Marketing operation**: to identify the needs of the customers in a timely and accurate manner.
- **R&D operation**: to satisfy the needs of the customers through improving the quality of existing products, researching new products agilely, and further strengthening the advantage of HB in the water-based paints market.
- **Production, painting, and after-sales service operations**: satisfy the needs of end markets directly through accomplishing their own jobs with high quality.
- **HRM operation**: all staff are competent and enthusiastic to deliver excellent services.

Furthermore, all the above strategies and objectives should be supported by the organisational culture of HB, which includes:

- Win-win cooperation and mutual benefits;
- Diligence and initiative, and;
- Continued learning and innovating.

When all these top strategies, objectives, and organisational cultures are clear, the team will use the SSM to further divide and link them with the daily operations of HB.

6.4.2 PT Building up: Conceptual and procedural breakdown

Based on the top objectives, the team breaks down and deploys the salient objectives and strategies by applying SSM to reformulate the KPs that are not in alignment with strategic objectives. During this phase, the focus is on introducing the collaborative changes to the innovative existing processes.

The key of step 3 and 4 is to clarify the details of issues, procedures, and potential improvements about the operations of HB through keeping asking questions of "*What to do? How to do (actually or virtually)? Why do it?*". The multiple key stakeholders are the main sources of these useful information. (detail steps of SSM see Chapter 4).

After the breakdown, the agreed competitive strategies were as follows:

- End-market oriented marketing based on cooperation and partnership;

- After-sales service with quick-reaction and close-to-customers service;
- End-market oriented R&D;
- Professional, economic, and safe painting engineering departments;
- Safe, economic, and just-in-time supply chain to satisfy customers;
- Professional HRM.

Then, each of the competitive strategy needs to be further decomposed via SSM to identify specified actions supporting the departmental strategies. It needs to be pointed out here that the strategies and managerial characteristics of each department should be focused, since the details about the core values, the key processes and key experiences of HB Company will be collected and integrated based on them.

A logic model below describes how an operation, such as marketing, should be operated and managed to achieve its departmental strategy. For example, to achieve the department target of marketing, the new sales teams should be organised to extend to new markets; meanwhile, the capabilities of the current sales teams should be further developed. Furthermore, the market information needs to be updated to grasp the new trends of the market. Apart from these, painting engineering is the new emphasis to increase profits. Finally, some managerial operations, such as customer relationship management, sales information platform management, and sales planning are also crucial steps to accomplish the departmental strategy.

In the above SSM-based breakdown processes, the involvement of the key stakeholders is highly crucial since a consensus is only reached among them after rounds of dialogue, after which the breakdown plan can be finalised.

The key activities and the decomposition of the strategy for marketing department are illustrated in Table 6-1, further, all these decomposed key processes will be adopted to develop the performance planning system to manage the marketing sub-performance network, which is also known as the marketing performance unit.

Following the method to decompose the departmental strategy in the marketing department, the same works are carried out in the other core departments (Table 6-2).

Table 6-1 Departmental strategy of the marketing department

Marketing Sub-actions: End-market Strategies
1.1 Establishing the sales teams (for industry and domestic).
1.2 Enhancing the skills, integrity, and qualities of the sales team (through training, guidance, and supervision).
1.3 Perform market and product research to understand customer needs.
1.4 Expanding painting engineering service (labour, material, engineering, and service, all inclusive) for all key markets and developing new domestic interior decoration partnerships.
1.5 Maintaining customer relationships.
1.6 Building an information sharing platform for the sales team.
1.7 Producing annual sales plans.

Rounds of dialogues and discussions between the PM team and the managers of HB were carried out to develop the results of conceptual decompositions. Next, the draft of the conceptual decomposition plan should be discussed by key stakeholders until a consensus were reached among them. Moreover, the discussions and feedbacks about the conceptual decomposition plan should be carried out in a wider range of participators (e.g., staffs, key suppliers, VIP customers) to enrich its details. During discussions and feedback, it may be necessary to introduce both changes in operations and managements. For instance, based on the conceptual decomposition plan, several departments feedbacked that it would be very challenging for them to handle increasing amount of HRM issues and suggested to form a new HRM department to undertake HR relevant works. And these suggestions were highly valued by the headquarters and a new HRM department finally established in this project, and the details about this organisational structure adjustment will be discussed in Section 6.5.1.

Table 6-2 Results of conceptual breakdown for the six key operations

Development strategies					
Marketing	**After-sale Services**	**Research and Development**	**Painting Engineering Departments**	**Supply Chain Management**	**Human Resource Management**
Building sales teams	Handling customers' feedback promptly	Understanding and anticipate needs for key markets, in terms of production innovation and development	Improving safety, quality and speed of engineering processes	Collecting information about quality and price of the materials and building information database	Achieving the routine HRM jobs
Cultivating talents and raising the skills	Improving customer services processes	Organizing R&D efficiently and timely.	Improving process cost assessment	Formulating production plan based on sales plan	Establishing monitoring and management regulations
Carrying out the market research and understanding customers' needs	Building the 'work-score' job system.	Cultivating talents and raising the skills for R&D staff	Constructing a regional engineering department management system	Economic, reliable and timely purchase of materials	Cultivating organisational culture
Expanding painting engineering service for the key industry markets, and developing domestic interior decoration partnerships	Enhancing the communication with customers and collecting their feedback	Enhancing quality of products and controlling costs through innovation and cost management	Improving quality management based on benchmarking, from reactive management style to a more proactive management style	Safe timely and economic production processes	Understanding concepts of performance management and deploy the performance assessment
Maintaining the customer relationship	Developing training programs for customers and relevant internal units	Effective motivation for R&D staff	Cultivating talents and raising the skills for managers of engineering departments by setting benchmarks	Total quality management	Establishing the communication channel for managers and employees
Building the Information Sharing System for sales	Cultivating talents and raising the skills through training	Enhancing the process management of R&D, and shortening the R&D period.	Reporting the customers' feedback and requirements in time	Safe and lean stock management and logistics	Understanding organisational and personnel requirements and making career plans
Making the sales plan				Cultivating talents and raising the skills through learning and training	

When the conceptual decompositions accomplished, the operational procedures should be addressed to make them executable. Considering the operation flows of HB are relative explicit, a BSC style of approach was adopted in this case. The key processes listed in the conceptual decomposition plan were broken down straightforwardly through the existing operational or managerial processes of HB according to the job descriptions of each department. When the key processes have been determined, the sub-level supportive processes, should be developed and confirmed layerwise accordingly. Next, the KPs and indicators were also developed for these supportive processes, and then, assigned to corresponding functional units and departments.

An example of the results of the decompositions is presented in Table 6-3 and all factors and actions in it are for managing the supply chain PT properly. Due to the reason that the headquarters of HB did not plan to change the flows of supply chain management, the second level processes were deployed directly through HB's current operations as the contents in the fourth column. Meanwhile, the operational and managerial processes of HB were considered holistically under this decomposition approach, where gives more room for carrying out further optimisations and improvements. Out of the doubt, it is another advantage of this approach.

Regarding the flexibility of the approach, the detail level of the decompositions can be decided by the relevant stakeholders (e.g., the headquarters, line managers, technical managers) as long as the extracted KPs and KPIs can assist them to carry out daily management effectively. For instance, the decomposition can stop at the departmental level if the departments are the focus of the PMS, otherwise, the decompositions can be further detailed to the individual level.

Table 6-3 Procedural breakdown for supply chain management

Key perspective	**Internal operation perspective**	**Tasks in conceptual model (2nd level processes)**	**Existing support process (3rd level processes)**
Internal Process	5 Supply Chain Management	5.1 Collecting information about quality and price of materials and building database.	5.1.1 Collecting suppliers and materials information by internet, phone call, etc. 5.1.2 Record and update the information
		5.2 Formulating production plan based on sales plan	5.2.1 Verifying the sales order 5.2.2 Timely price evaluation 5.2.3 Check level of storage 5.2.4 Timely production plan
		5.3 Economic, reliable and timely purchase of materials	5.3.1 Economic, reliable and timely purchase of materials
		5.4 Safe, timely and economic production processes	5.4.1 Safe, timely and economic production processes
		5.5 Total quality management	5.5.1 TQM for materials in-stock, production process, product in-stock, out stock. 5.5.2 Quality checks by two inspectors 5.5.3 Product segmentation 5.5.4 Learning and training 5.5.5 Motivation
		5.6 Safe and lean-stock management and logistics	5.6.1 Delivery by HB for local customers, 5.6.2 Delivery by external co-operators for non-local customers
		5.7 Cultivating talents and raising the skills through learning and training	5.7.1 Cultivating talents and raising the skills through learning and training

The conceptual model of the PT of HB is shown as Figure 6-3.

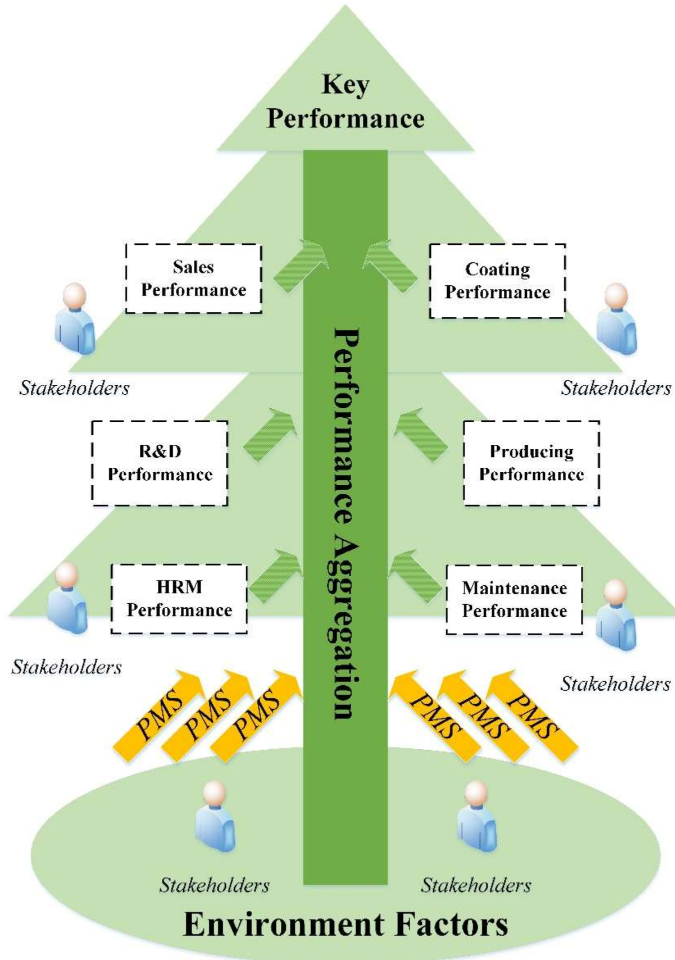


Figure 6-3 Conceptual model of HB PT

6.5 Building the management system for PT of HB

The PMS will be built in this stage to support and manage the previously formed performance tree (PT). First, based on the logic of performance generation and the current organisational structure, the virtual performance units will be considered to promote the potential organisational innovation. Then, the contents of the PT, which comprise performance goals and metrics, will be extracted in line with the key activities to generate the performance stated above. Finally, the management procedures and regulations will be addressed to formalise and implement the system.

6.5.1 Discussion of performance unit

In this step, the team discusses with the key stakeholders of HB about building (new) or optimising (current) performance units for improved performance. This step begins from regrouping the top performance of the company to supply a clear picture of how the performance units should be configured to better support the generation of the top performance. Here, different possibilities exist about the configuration of the performance units (both virtual and actual), and the team should discuss feasible selections with the headquarters of HB.

To save time and resources in discussing the configurations of performance units, some principles should be considered.

1) Less cross-points among the operations of performance units, unless operation overlaps are absolute necessary or purposely designed. In this way, the operations of different units would not affect or be affected by the others.

2) To intergrade the similar operations (similar in function, input resources, or staff skills) distributed in many units to form a new performance unit. To do this, the efficiency of overall operations can be improved, and the employees can obtain more specialized training.

In discussing the organisational adjustment with key stakeholders, the following questions should be paid more attentions since they may contain key information about the organisational structure or chart adjustments:

- The key issues exist in the current management approaches and procedures;
- The degree of organisational changing they can tolerate (*job positions? division? department? several departments? whole company?*);
- Resources availability
- Current and planned management approaches and procedures;
- Undertakers of key performance;
- Current and planned approaches to allocate resource.

Moreover, these questions may lead the key stakeholders to conduct deeper reviews about the current situation and future improvements of the operation and management systems of the company, which facilitates the improvement of the performance.

In the initial stage of this step, the planned performance units (both plan to build up and to adjust) are named as virtual performance units since they have not been finalized and adopted by the organisation. The organisations can benefit from taking the virtual performance unit into account, since it supplies a holistic view for the organisations to consider their performance generation and management, also the current practices and potential improvements, systematically. For instance, based on the latest top strategy of HB, the overall profits of the company are gained from three markets: the industrial market, end market, and coating project market. Accordingly, the team should discuss with the HB headquarters whether HB would consider forming three comprehensive departments (profit centres): the industrial market department, the end-market department, and the coating project department. Top management of HB rejected this proposal since too much reformation of organisational structure was involved here, which will turn the company from a functional structure into a divisional structure.

Apart from the significant organisational changes on the divisional or departmental level, if necessary, the changes about the performance nodes should also be taken into account. In the PT framework, the performance node corresponds to one or a series of job positions sharing similar key activities or yielding similar performance in an organisation. The adjustment of performance nodes usually leads to limited changes for the operation or cooperation ways of several job positions, but sometimes, it could also cause a significant change on the departmental level.

For instance, there are several after-sales communication positions in the customer service department, which require the employees to be communicative to access the true ideas of the customers. On the other hand, the quality accident investigation positions in the same department requires the employees to obey the rules and regulations strictly and to have a cautious character. Accordingly, the above two types of employees can be regrouped into two new divisions in the customer service department: one for customer communication and the other for sales accident investigation. Theoretically, this regrouping ensures each type of employee can have better professional development, and the operational procedures of the department can be more concentrated. The headquarters feedback indicated that this idea will be considered when the customer service department grows bigger.

Based on the principles above, the team suggests several potential organisational structure adjustments to HB and one of them is accepted. The proposal is to concentrate the HRM processes of HB into one new performance unit by establishing a new HRM department.

In the current performance generation processes, the performance of HRM is distributed in several different performance units, such as operational departments, administration office, and even the CEO office. We can take the HRM operations of the R&D department as an example. In Figure 6-4, all HRM-related performance on the R&D PT is collected to form a new brief performance map.

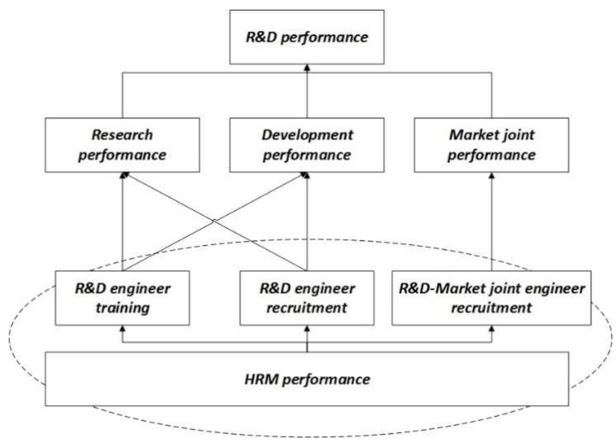


Figure 6-4 Performance map of the HRM operations in the R&D department.

From the performance map, the top performance of the R&D department comprises three main parts: research, development, and market joint performance. These three performance aspects need to be supported by HRM operations to train and recruit the R&D engineers. In the current practice, the R&D department carries out the above HRM operations by itself, for instance, to contact training agent to give lectures to the engineers and to recruit through internal referral or seeking help from recruiting agents.

However, currently, all the HRM-related issues are handled by one overloaded R&D secretary, who lacks professional knowledge background about HRM. In addition, because some HRM procedures need to be handled and approved by the administration department (e.g., salary, welfare, and HR documenting), the failures of cross-department communication are not seldom. The similar situation also exists in the sales and marketing departments, which handle the HRM issues in the departmental level.

This distributed HRM operation largely lowers the overall efficiency since the information and resources cannot be shared. Moreover, the HRM position in each department only has very limited budget and resources, so the professionalisation and development of the employees are very problematic.

Furthermore, based on the results of the conceptual breakdowns in Section 4.2, the HRM processes are involved in many department operations (Figure 6-5). However, these processes lack a concrete and unitive department to handle, which increases the hazard of strategy failure.

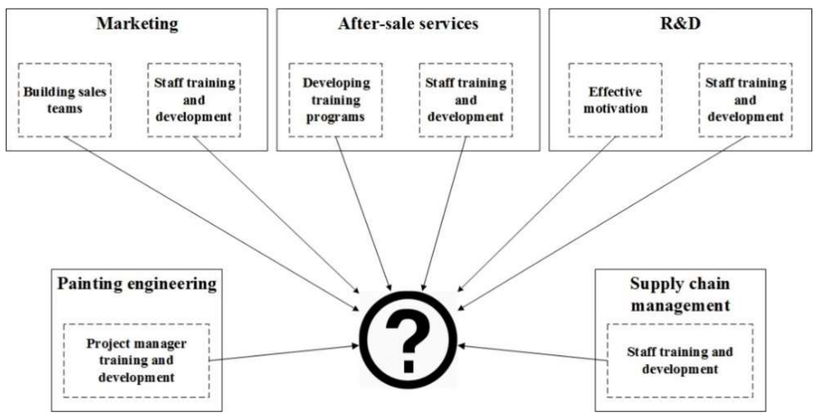


Figure 6-5 HR related processes in the results of conceptual breakdown.

Therefore, the team suggests a virtual performance unit for HB (see Figure 6-6), which combines the HRM operations of the sales, R&D, and administration departments into a new HRM department.

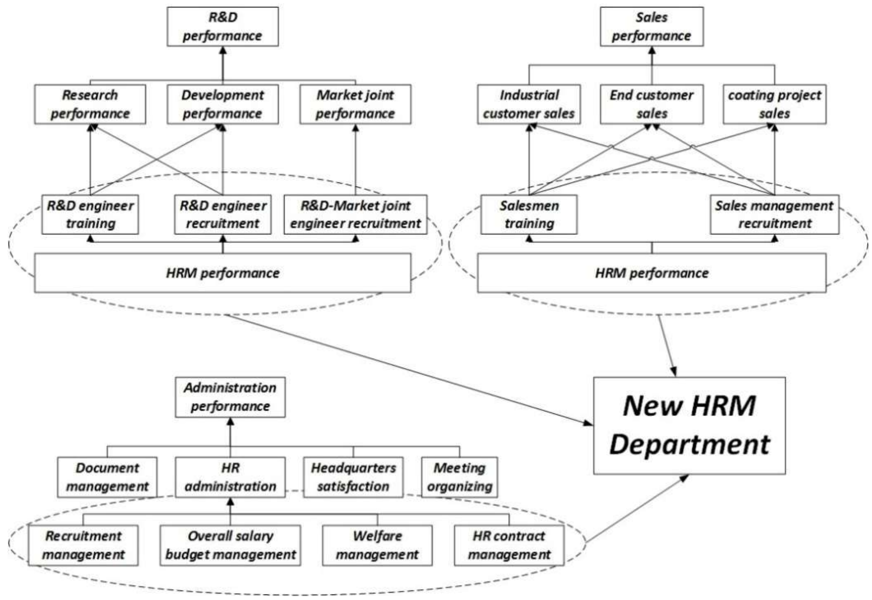


Figure 6-6 Virtual HRM performance unit proposed to HB.

It should be pointed out here that interrelations exist in an organisation hierarchically and horizontally, which means the adjustments occur in one department may affect the operations of the other departments, even the whole firm. Therefore, the thorough discussions and consensus among key stakeholders holding various department backgrounds are crucial in the implementation of the PT framework.

Meanwhile, the organisations may adopt different ways to digest the proposed virtual units depending on their wills, capacities, and resource availabilities. A company may adopt a majority of the proposed virtual units to best optimize its performance generation and management procedures if it has all aforementioned three factors in strong measure. Besides, a company may also only accept limited virtual units addressing to its specific urgent issues in performance generation and management. Moreover, an organisation may not adopt any of the proposed virtual units entirely due to particular concerns, instead, it can assign the key performance in the virtual units to its existing departments firstly to benefit from organisation innovation in a compromised way.

6.5.2 Develop performance sets and plans for departments

Next, the team utilises the KPs to formulate performance indicators for each of the KPs. The 3E indicators methodology is beneficial for each KP, for measuring efficacy, efficiency, and effectiveness to extract three groups of indicators (see Liu et al., 2010). Generally speaking, the approach is to develop a top-level root definition and action plan of the key activities for HB through dialogues and discussions with particular key stakeholders. Often, too many indicators are identified, and it is necessary to reduce these to between five and nine. These indicators must be discussed and agreed with the line managers and their key staff.

Moreover, HBs indicators consist of E1–efficacy; E2–efficiency, and E3–effectiveness, being the extent to which the outputs contribute to the objectives of the wider system. It is also possible to use quality, cost, speed, safety, and quantity to derive and classify the KPIs. Then, after the project management team gains approval of the CEO and the senior management team with input from the appropriate line managers, the KPIs are determined.

Tables 6-4 and 6-5 present the relevant KPIs for the supply chain manager and KPs for the director respectively. The indicators developed using the 3E methodology for each level of KP breakdown are varied. They will not be solely used as an operational metric, but for qualitative monitoring purposes during the HR staff appraisal process. The performance targets, KPIs, KPs and the performance plans compose the core contents of the performance set. In accordance with the underlying philosophy of an all-win organisational culture, promotions are dependent upon performance as stated in the set. Innovative managers can create and individually distribute their KPIs to their subordinate staff.

Table 6-4 KPIs in the performance set of HB supply chain unit (For supply chain manager)

HB Supply Chain KPI												
KPI weight 60%												
Indicators		**Index definition**	**Weight**	**Period**	**Assessment Grade（%）**						**Examiner**	**Remark**
					0	**20**	**40**	**60**	**80**	**100**		
General KPI	Staff turnover rate	No of staff turnover/Total staff	5%		> 4%	4%	/	3%	/	2%	**CEO**	
	Job instruction coverage rate	Completing each work and following the job instruction	5%		< 10%	10%	15%	20%	25%	30%		
	Completeness, and normative of the records	Records/records required	5%		< 96%	96%	/	98%	/	100%		
	The time for making meeting decisions	Based on minutes of meeting	5%		< 95%	95%	/	98%	/	100%		
	Staff learning and growth	Training times and effectiveness	5%		< 85%	85%	88%	90%	93%	95%		
	Internal satisfaction	Satisfaction survey	5%		< 85%	85%	88%	90%	93%	95%		
	Implementation of regulation	Implement regulations effectively	5%		< 80%	80%	85%	90%	95%	100%	**CEO**	
Production Management	Production cost control	Input/output	15%		<							
	Production quality control	POP of product and package	10%		< 85%	85%	87%	90%	92%	95%		
	Production management	Complete rate of the production plan	10%		< 90%	92%	94%	96%	98%	100%		
Purchasing Management	Purchase cost control	Average % increasing on purchase cost	10%		≥1	< 1	97%	95%	93%	90%		
	Purchase quality control	QC passed batches/Total batches	10%		< 90%	92%	94%	96%	98%	100%		
Stock Control	Storage regulation implementation	Passing rate of the storage spot check	5%		< 90%	92%	94%	96%	98%	100%		
	Inventory management	Delivery accuracy Storage deviation	5%		< 90%	92%	94%	96%	98%	100%		
Events leading to reduction of score	Safety accidents	Each__grade, reduce__ points										
	Out of stock rate	Out of stock rate___reduce_ point										
	Fire-equipment perfectness	100%-perfectness										

Table 6-5 KP system for supply chain director

KP for HB Supply Chain Director							
Key Processes	**Description of KP**	**Expected outcomes**	**Key tactic**	**Monitoring Indicators**	**Weighs (%)**	**Deliverable & Assessment period**	**KP (40%)**
Purchase Process Management	1. Building supplier evaluation system 2. Understanding material market trend, establishing price comparison system. 3. Standardizing purchasing processes, based on supplier evaluation system 4. Ensuring the quality of purchasing material 5. Reducing evaluation purchasing prices			1. Effectiveness of price comparison system of material 2. Effectiveness of supplier evaluation system 3. Number of purchasing accidents 4. Volatility of material price year-on-year			
Enhancing Quality Stock Management	1. Improving storage undamaged rate for material and product 2. Monitoring the level of storage 3. Improving the accuracy and promptness of receiving, issuing of goods			1. Damaged materials and products 2. Rate of storage level that is reaching the standard 3. Accuracy and promptness of receiving, issuing of goods			
Production Quality Management	1. Improving quality of products 2. Co-operating with Quality Control department			1. Finishing rate of quality control of production process 2. Number of quality problems that caused by production process			
Production Process Management	1. Planning and Scheduling the production 2. Maintaining equipment 3. Enhancing units' management 4. Enhancing production regulation management 5. Enhancing safety management, reducing work injury, end safety accident			1. Number of times that break the production regulations 2. Number of production accidents 3. Input/output ratio for production units			
Production Cost Control	1. Reducing production costs			1. Input/output ratio for single product			

To carry out PM effectively and also for avoiding legal risk, the PMS must have documented performance plans that enable supervisors and their key staffs to conduct effective two-way communication. Regarding the case of HB, the performance planning system was developed around the KPs and KPIs extracted in the aforementioned steps to ensure that the explicit and specific topics can be addressed to the performance talk. The HB's performance planning system functions in two main aspects: to develop performance coordination plans for departments; to develop individual performance plan to guide the employees to accomplish their performance goals. Moreover, the performance plan articulates the contents of KPIs and KPs to help department managers and employees to better understand their supervisors' expectations.

The performance plan elaborates the approach, key steps, and resources in accomplishing each departmental or individual KP and KPI according to the contents agreed in performance talks. Listed in Song (2016), the specified topics in a comprehensive performance plan include "*when, in what order, for what purpose and what task must be fulfilled? What specific method will be used in order to finish the task? What support from the supervisor and what resources are needed? When will the supervisor and their staff have the next face-to-face meeting for the fulfilment of each task?"* By discussing and clarifying these topics, both the supervisors and the employees of HB can well aware the potential obstacles may encounter in the performance generation processes.

This stage involves the design of performance plans based on the formulated KPs and KPIs. The performance plans enable effective performance communications can be carried out between superiors and subordinates of HB. The communication process can be iterative with top-down and bottom-up processes, which can occur several times prior to the final agreement of the performance plans.

Furthermore, we suggested HB to carry out performance talk every quarter to check the progress of the performance plans regularly, also, the plans may need to be adjusted halfway if environmental issues (e.g., market environment, department objectives, human resources reallocation, resources situation) changed significantly.

In the practice of HB, the approach of performance planning has been proven to be very useful, and it at least solved three long-standing issues in HB to a large extent:

1) The employees better understood the expectations from their line mangers and overall company about their performance due to rich details in their performance plan. The marketing department benefited the most from this advantage since the ways to accomplish a marketing KPI were usually ambiguous due to the complexity of their working contents. By introducing the performance planning into the marketing works, a mechanism had been formed in the department that the line managers helped their subordinates to analysis and identify the ways to conduct KPs and accomplish KPIs. Meanwhile, if marketing staffs met obstacles in their works, the helpful information or resources would be superadded in time.
2) The line managers and department managers could be aware of and monitor the performance progress of their subordinates, and thence the departmental performance in time. The coating project department emphasized the importance of this point in improving its performance since the progress and dynamic costs of a coating project are the key to profit.
3) Due to the deep involvement of the staffs in setting up their performance targets, their work commitments were improved significantly. Generally speaking, the work commitment of the employees in the manufacturing and logistic departments increased the most dramatically, and the reason can be stated in their own words “our words were listened and we could plan our works somehow”.

6.5.3 Assessment and Feedback

All of the information and data generated from the steps, such as face-to-face meetings, difficulties, and progress should be recorded and kept by the new HR department. Suitable assessment and feedback is needed with suitable built-in mechanisms for rewards or corrective interventions.

In addition, HB provides training for its staff to help managers work effectively with the PT and help explain the new system to their subordinates. This process includes providing a booklet on the ‘ABCs’ of PM (which includes main tasks, tools, and objectives), which is given to senior management and every line manager, to learn and maintain basic knowledge on the PT. Simulation-based training sessions (which include performance plans and assessments) are provided for each department, so that the nuances of each department can be incorporated. The HB staff have individual PMS in their performance plans. Heads of departments have PMS for their departments within their performance plans, and then their staff have their own more detailed ones, which are derived from the department PMS. The performance evaluation and reward process consists of two parts. The assessment for routine tasks given by line managers is 60% whereas their supporting KP is 40%.

Assessment will vary for different levels of staff. For example, assemble line workers' assessment is performed by interviews conducted by supervisors. However, the assessment for middle-level managers incorporates a 360-degree method[2]. The reasons for these differences are work complexity and span of control. The middle managers' job is much more complex and flexible, with increased uncertainty. Finally, HB assesses operational staff monthly and assesses managers and R&D staff annually.

[2] 360-degree assessment includes feedback information gained from an evaluatee's subordinates, colleagues, managers and him or herself (Edwards and Even 1996).

Chapter 7 Sub-frameworks for PT Building and Competency Assessment of R&D Staff in Some Chinese R&D units

The set-up and management of a PT-based performance management system (PMS) in an R&D unit includes two key elements: building a suitable PT and managing the competence of the R&D staff. It is well known that these two elements play a crucial role in R&D performance management (PM). However, they are also known to be very complex to implement successfully. The first regards building key operations and processes to ensure the optimal performance of an R&D unit, and the latter regards the objective assessment of R&D staff competence. This chapter will discuss these issues in detail.

Building a suitable PT for an R&D unit is clearly highly case dependent, as it depends on key performance indicators designed for the unit. However, since all R&D units have a common key performance measure – carrying out research effectively and efficiently – we can draw some conclusions about a suitable R&D structure from research management and provide useful guidance for PT building. In the following, we will present a sub-framework of PT building based on a functional R&D structure for Chinese manufacturing enterprises in order to create a tailored PT for those companies that will be illustrated through our case study. PT building under other R&D structures may be similarly conducted. We will then further discuss a sub-framework for competence assessment of R&D staff by utilizing some techniques related to big data.

7.1 R&D environment for classical Chinese manufacturing industry

In Chapter 3, we introduced several typical R&D practice approaches and representative R&D structures. In this section, we will focus on the R&D environment and practices in a more specific context – the classical Chinese manufacturing industry – to prepare for the case study later.

According to Shaff (2009), a number of studies have shed light on the general R&D features and characteristics of the classical Chinese manufacturing industry. The existence of numerous SMEs is one of the characteristics mentioned in many studies. Due to their limited organisational scale, SMEs rarely organize their R&D in a bureaucratic way. Instead, functional and virtual matrix structures are the most common to be utilized since they lead to reduced staffing costs and decision time cycles (Shaff 2009).

Another characteristic of classical Chinese manufacturing firms is the short R&D time cycle brought about by a highly competitive end market. A massive number of SMEs in the Chinese market supply homogeneous products, hence time and price are the most important factors for acquiring customers. It has been reported that the average R&D time cycle in the Chinese automotive industry is 23% shorter than the in the U.S and 36% shorter than in Europe (Dong 2012).

The final factor, culture, is also mentioned in many studies. The output-oriented culture of China makes Chinese businesses value the explicitness of their yields, and obviously the ambiguous and monolithic mode of R&D that exists under the bureaucratic structure is not in line with Chinese private corporations' preferences. A project-oriented or task-oriented R&D approach can better meet their requirements, since the authority, resources, and yields are clear and highly consistent under these approaches.

The general characteristics described above require most Chinese manufacturing companies (except perhaps for some large-sized enterprises) to establish tight connections with their key industrial customers and meet those customers' manufacturing needs quickly and within a reasonable budget. Compared with the five generations of R&D mentioned earlier, the general business environment faced by most classic Chinese manufacturers is quite similar to stages 2-3, when enterprises were pursuing improved R&D time control and flexible partnerships with internal & external customers.

This similarity has been pointed out by Zaixin (1998) and Hou, Fan and Cai (2009), who state that the R&D patterns adopted by Western companies in the mid-1980s to mid-1990s can serve as a good examples for today's Chinese businesses. Some scholars further argue that nowadays Chinese enterprises should look to lessons from the Western R&D field, so that they can combine the existing R&D approach with the latest management theories and technologies (Li and Yue 2005; Von Zedtwitz 2006).

As the typical structure in R&D stages 2-3 (see Chapter 3), the functional structure has its advantages in dealing with the overall environment faced by Chinese manufacturing enterprises due to following reasons.

First, the control layers in a functional unit are curtailed significantly compared with a bureaucratic structure, since the vertical control line is not the focus of operations. Accordingly, the functional R&D structure would not lead to an overstaffed R&D department as the bureaucratic structure does. Thus, it is favourable for classic Chinese manufacturers, who place high importance on budgetary control and operational efficiency (Guoqing 2011).

Secondly, because of the feature of high specialisation in the functional structure, R&D staffs can develop specialized skills over time and improve their proficiencies. These skills and proficiencies can enhance the efficiency of R&D operations, further contributing to the productivity and profits of the organisation (Akhilesh 2014).

Thirdly, it is well known that cross-departmental communications are highly important for organisations faced with a fast-changing market environment. With smooth communications among departments, market information streams to the segments of the organisation, driving them to adjust their focus to match dynamic market needs. All of these structural characteristics are exactly what classic Chinese manufacturers need (Milliman, Gonzalez - Padron and Ferguson 2012).

The disadvantages of the traditional functional structure have been largely overcome using new and emerging R&D management technologies. For instance, cross-departmental coordination was widely viewed as the main management challenge under the functional structure, since the synchronisation of time, outcomes and budget among sub-functional divisions towards meeting R&D targets was always difficult. However, the emergence of online team & project management systems have helped R&D managers handle such coordination, and R&D activities can be carried out in a new and flexible way under the traditional structure (Davenport 2013; Stock and Reiferscheid 2014).

Furthermore, the project-oriented coordination mechanism in this structure ensures that R&D departments can react swiftly to customer needs by collaborating with the other functional modules in the organisation (Eunni et al. 2007; Xie, Zeng and Tam 2010).

Finally, a mix of role culture and task culture in the functional R&D structure fits with the East-Asian culture, which emphasizes both order and efficiency (Lee 2004; Nengquan 2009).

Due to the above reasons, we believe the functional structure matches the general situation for most classic Chinese manufacturers (with the exception of very small or large sized enterprises). Therefore, we will provide a detailed analysis of the functional R&D structure in the following section.

7.2 Implementation of a functional R&D structure

Since the functional R&D structure matches the characteristics of classical Chinese manufacturing enterprises, we will further discuss its implementation in this section.

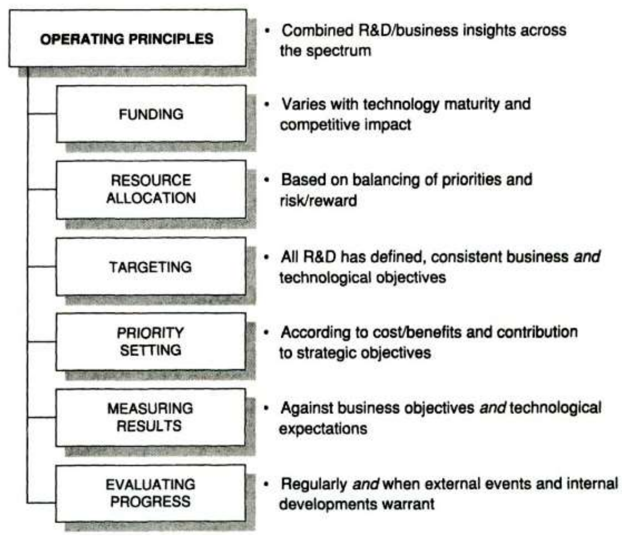
The fundamental idea behind the functional structure is the division of all R&D activities into segments based on specialisation in order to promote R&D efficiencies. Under the functional structure, R&D staffs' skills can be better improved through long-term practice and training in a particular functional field.

Many scholars have created frameworks to describe the operation procedures in a functional R&D department. The first such framework was built by Roussel, Saad and Erickson (1991) (see Figure 7-1), and included five main steps for structuring an R&D in a functional way:

1) Decompose the overall R&D targets into segments;

2) Allocate these segments to existing divisions (a new division or task group needs to be formed if there is no existing functional unit fitting with a segment);
3) Set priorities among above segments towards the accomplishment of the top R&D target, and allocate R&D resources correspondingly;
4) Measure each unit's R&D yields and adjust the above priorities and resource allocation dynamically;
5) Performance appraisal, feedback, and incentives

As a pioneer effort in this domain, the above framework covers most crucial elements in a functional structure, including job decomposition, segment-based R&D work and continual measurement and evaluation.

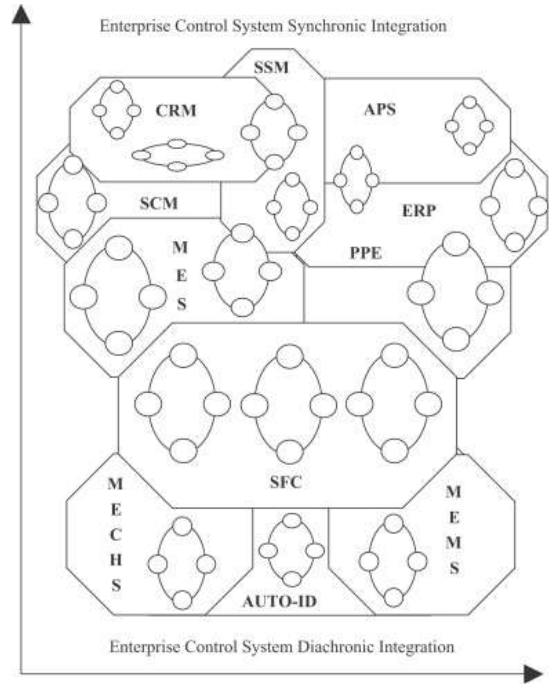


Source: *Roussel, Saad and Erickson (1991)*

Figure 7-1 An initial management model for functional structured R&D units

However, with the increasing complexity and uncertainty of the present market environment, the above framework's linear nature has been criticized widely (Bush and Frohman 1991; Kancs and Siliverstovs 2012; Ringuest and Graves 1990). Although the linear R&D structure reduces the hazard of internal coordination failures, it also weakens the organisation's capability for environmental adaptability.

For this reason, Morel et al. (2007) proposed a non-linear framework to explain R&D activities in the functional structure as shown in Figure 7-2.



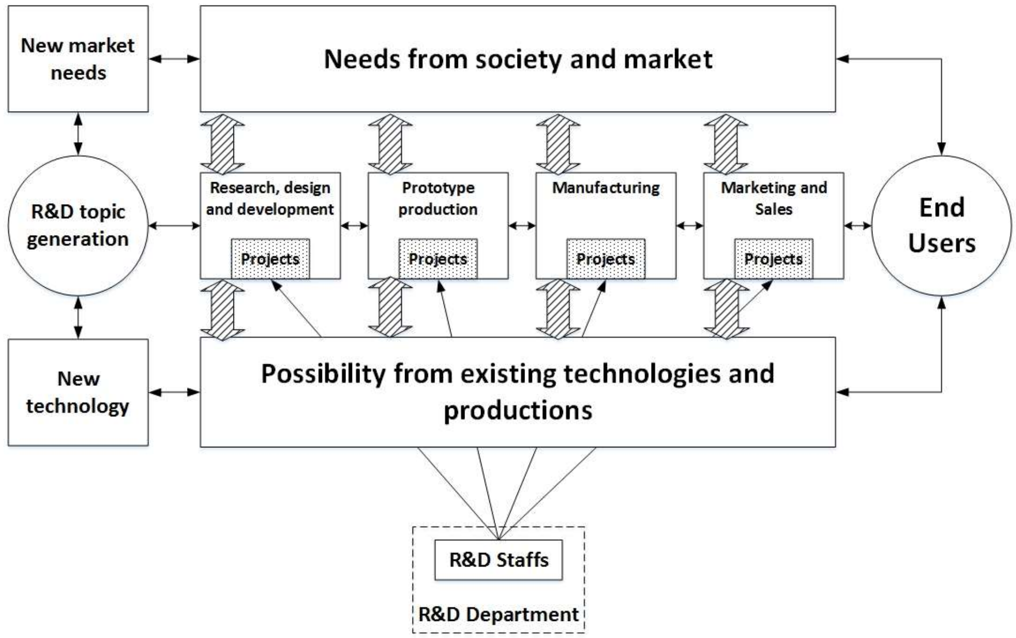
Source: *Morel et al. (2007)*

Figure 7-2 Non-linear framework for functional R&D units

In this framework, the R&D process has been distributed into operational blocks, and all basic modules are presented in an interlaced way. For example, the functional modules of customer relationship management (CRM) and sales services management (SSM) are crossed with one another and R&D staffs need to join both modules to provide their technical views.

Valckenaers et al.'s (Morel et al. 2007) theoretical framework only covers the nonlinear R&D process in the functional organisational structure (Figure 7-3); more implementation factors can be found in Rothwell (1994).

A nonlinear R&D process can be observed in the figure above. R&D staffs participate in the overall operations of an organisation through projects, and their functional roles are in line with projects' needs. The functions of technology or development management for the R&D department are largely weakened, and their new mission under this framework is project management and staff training.



Source: *Rothwell (1994)*

Figure 7-3 Non-linear implementation framework for functional R&D units

Based on the above frameworks and the description of the Chinese business environment, we propose the following steps for implementing a nonlinear functional structure for classical Chinese manufacturers:

1) R&D topic generation: R&D topics will be generated by considering both market needs and available technology. Depending on the managerial context, R&D topic generation step can be led by the R&D department or the market-related departments. Regardless, both sides need to be involved in this step to supply their respective technical and market information.

2) Research, design and development: When an R&D topic is confirmed, the respective project and resources should be allocated. Under normal circumstances, the initial stage of the project is headed by R&D department, with the goal of tackling key scientific & technical problems. However, the marketing and sales units should also evaluate the progress of the project from their perspective.

3) Manufacturing and sales: When the core scientific and technical problems have been solved, the project should be handed to manufacturing and marketing employees for further development based on more specific market needs. The role of the R&D staff remains crucial in this step, as they are needed to solve

issues regarding technology and production engineering.

4) The final point in the process is the role of R&D department per se. Although, R&D staffs participate in the operations through individual projects, they still need a platform through which to be trained and developed – this is the department. Therefore, as an environmental step, the R&D department needs to cooperate with HR and the other internal and external partners to further improve staff competencies.

7.3 Sub-framework for building a functional PT R&D structure

As mentioned before, although building a suitable PT for an R&D unit is highly case dependent, as it depends on key performance indicators designed for the unit, we can draw some conclusions about suitable R&D structures from research management and provide useful guidance for PT building. In this section, based on the implantation model for a functional R&D unit, we will provide a framework and some suggestions for how to establish a PT with the functional R&D structure for the R&D units of Chinese enterprises.

Multiple departments are involved in the process of building up an R&D structure, but here we will focus on the role of the R&D department. Based on the four steps outlined above, the core functions and activities of the R&D department are illustrated in Figure 7-4.

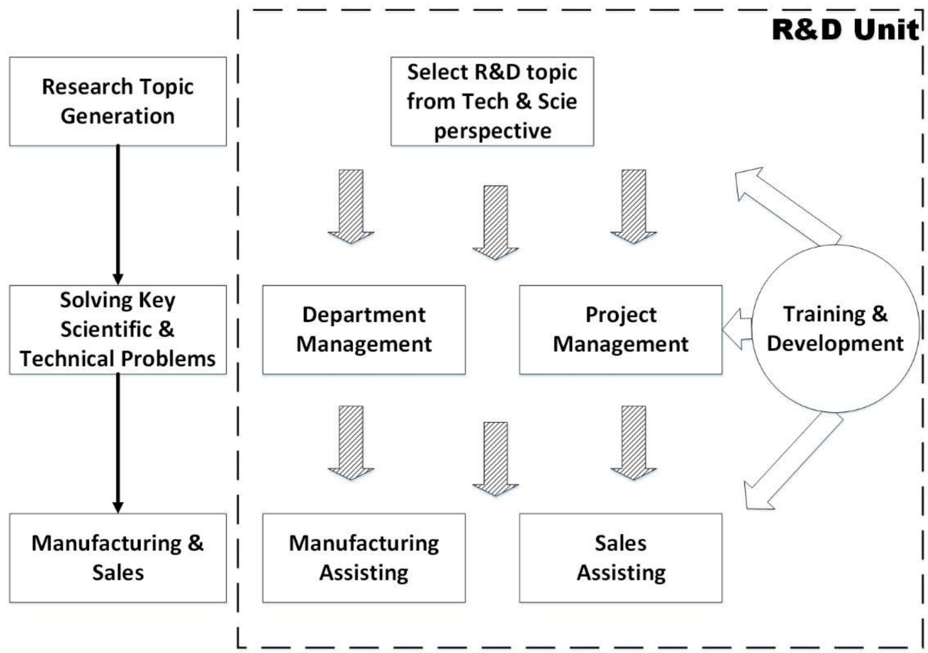


Figure 7-4 Logic model to build a functional PT R&D structure

In the R&D topic generation step, the R&D unit should lead or cooperate with other departments by offering information and suggestions from the technical perspective. Once the topics are confirmed, the R&D department needs to solve key scientific and technical problems via research projects. Since the progress of such research projects is highly reliant on the resources and facilities available on a departmental level, departmental project management is crucial here. When the R&D unit accomplishes its research, the results are handed to the manufacturing and sales departments. The role of the R&D department is assistance-oriented in this step; the R&D staff mainly help the other departments solve problems that occur in massive manufacturing and sales units. Moreover, the R&D department trains and develops its staff to ensure they have sufficient knowledge and skills to carry out the above jobs.

Corresponding with the main jobs of the R&D unit in a functional R&D structure, four key blocks of R&D operations can be abstracted. These are:

1) Cross-departmental communication and R&D topic generation guided by R&D strategy
2) Conduct project and department management to solve key technical and scientific problems in an R&D topic
3) Assist related departments in better applying R&D results
4) Train and develop R&D staff

Procedures and guidance on how to set up of these blocks (the key parts form PT with a functional R&D structure) are described below.

Block 1

The operations and procedures in the first block (their key parts form PT) can be built in an either bottom-up or top-down manner, guided by the R&D strategy (see Figure 7-5). In the former case, implementation of the structure starts from staff in line departments or divisions, since they have the closest connection with customers and the market. Therefore, they will identify the R&D needs from the bottom end, guided by the R&D strategy. Then, the R&D needs must travel from the bottom to the top of the organisation to form a potential R&D topic.

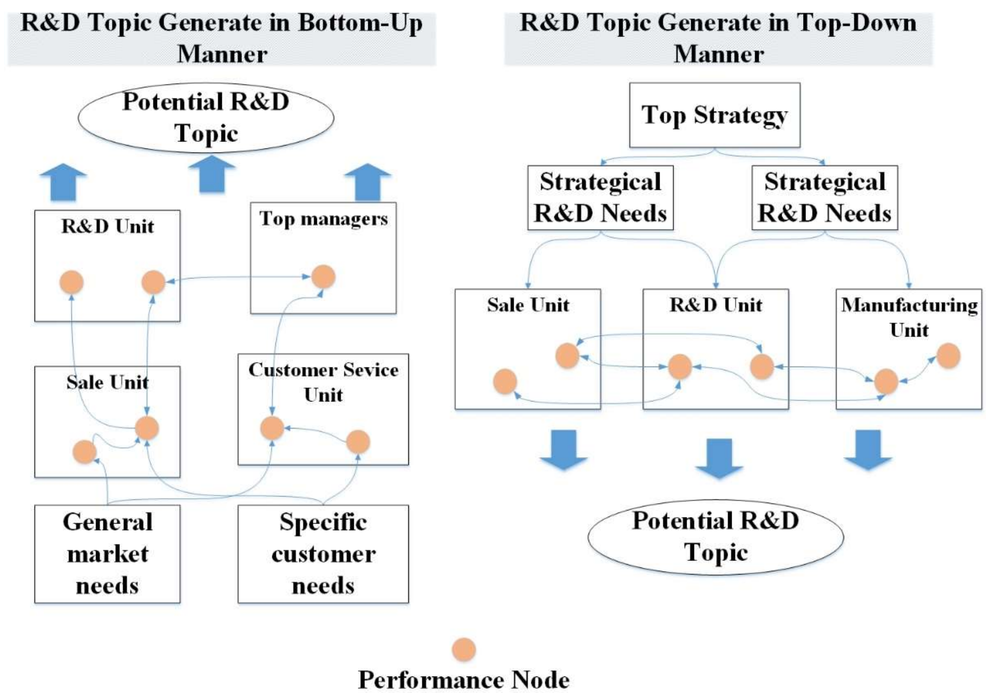


Figure 7-5 Two ways to generate R&D topic

On the other hand, the top managers of the organisation can also direct the process due to the fact that they have the widest strategic view and may also be experts in current R&D, particular in small R&D units. Under this circumstance, the top can deliver the strategic R&D needs to related performance units, who will further specify the needs into R&D topics.

In both ways, rounds of vertical and horizontal communication are highly important, since R&D topics should reflect a balance among market demands, R&D

capacity and strategic needs.

Under normal circumstances, such communication and topic generation are carried out through the existing formal structure of an organisation. Thus, adjustments to unit administration are often not necessary.

Block 2

Once the R&D topics have been formed, the R&D unit needs to implement them through R&D projects. Depending on the technical clarity and complexity of the projects, the operation procedures can also be developed from different orientations in this step.

If the projects are uncomplicated and are being conducted with an explicit target and well-known approach, work on building this block can be mainly conducted by the higher-ups of the R&D unit, since those people can take the R&D topics, identify explicit R&D targets and assign tasks for subordinates to accomplish.

However, for highly complex R&D projects with an ambiguous technical approach, it would be difficult for the department managers to plan the projects by themselves. In such cases, technical information held by first-line R&D staff is highly crucial. Accordingly, the operations and PT should be developed in a bottom-up manner in this situation. The first-line staff can first propose suggestions, and then the technical managers will discuss possible selections with them. The above process may be carried out in several rounds until the technical roadmap of a project is sufficiently clear.

When the target and technical roadmap of an R&D project is clear, the project will be split into task segments and allocated to units or R&D staff. It should be noted that the ways to split and assign projects should be clarified using the targets and roadmaps since they are linked closely with each other.

At this stage, the necessity of adjusting the current R&D formal charters should be reviewed, as the existing ones may not fully support the accomplishment of the R&D projects (e.g., if segments of the projects may not be assigned to a suitable unit). If changes are necessary, some operations or components of relevant R&D units will need to be modified. Again, these changes can be directed by the managers or suggested by the first-line staff, depending on the characteristics of the project. These changes may lead to new research units or the rescaling of existing research units.

Details regarding how to adjust formal charters will be demonstrated in the case study.

Block 3

After the R&D department accomplishes its research tasks, the results of the projects need to be handed to departments such as manufacturing or sales. Since the R&D department plays an assisting role, the PT in this block mainly concentrates on developing and measuring the performance set content, as well as carrying out the feedback mechanism. Internal customers' satisfaction should be the focus of the performance sets in order to reflect how well they assist in developing, manufacturing and selling at the back-end of the projects.

Block 4

Suitable procedures for R&D staff training and development are highly case dependent, and will be illustrated in the case study.

7.4 Sub-framework for competency assessment of R&D staff

We have analysed the function of the competency model as an enabler of R&D PM in Chapter Three. According to our review, numerous competency models currently exist, and some of them are aligned with the nature of R&D, such as the PAKS model. However, one of the key challenges in implementing such models is how to assess competency objectively and in a timely manner, and how to apply the results of the assessment to R&D PM.

Therefore, in this section, we will discuss a sub-framework that utilizes the competency models by making objective and timing-based assessments of competence factors and then competency to assist PM in R&D units. The main idea is to first select a competency model to determine the competency factors to be measured. Then possible data sources for the measurement of the factors (these can be identified via discussion with key stakeholders) will be determined. Finally, suitable models from the artificial intelligence field will be determined to produce proxy assessment of the factors, and then competency and performance will be measured from the data sources. Since the PAKS model includes most essential competency factors for R&D staff, we will use this model in the sub-framework below for illustration. However, the framework is also compatible with most of the existing competency models, and users could replace PAKS with other preferred models.

The overall structure of the sub-framework is illustrated in Figure 7-6:

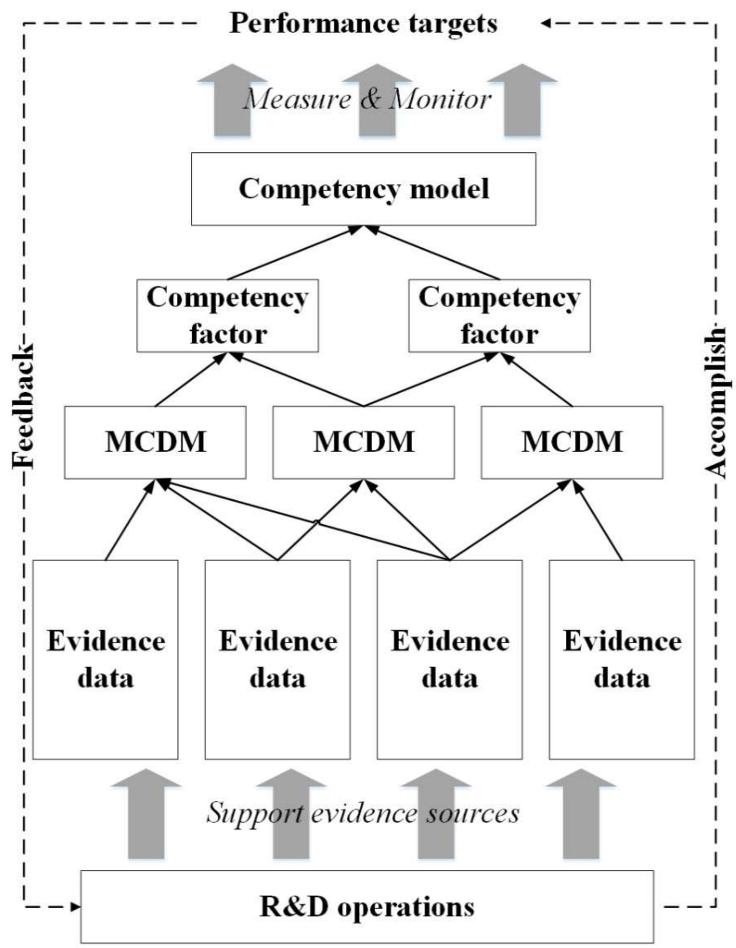


Figure 7-6 The conceptual model of the sub-framework

Generally, the sub-framework consists of four main steps:

Step one: Establish a competency model based on the strategies & objectives of the organisation (or simply apply an existing model).

The competency factors reflect the characteristics of R&D staff that affect job performance. In practice, CM selection is one of the most important issues in carrying out CM-based management. Practitioners should review a range of available CMs and compare them in terms of feasibility within specific managerial contexts.

Under some circumstances, users can directly employ the selected model.

However, if the company wants to develop a tailored competency model from a general one, it will need to further refine the competency factors under the competency dimensions based on their specific managerial needs. The following methods can be adopted to customize and refine specific competency factors:

- **Technologies for competency model development:** earlier we introduced some common technologies and tools for use in developing a competency model; these can also be employed to refine the competency factors of an existing model. For instance, users can carry out BEI-style job interviews to identify key competencies for positions, or they can define factors with the help of questionnaires such as the JCA questionnaire or FJCM scale.
- **Literature review:** for users with limited resources or time, a literature review is a good way to develop a customized model. The company should collect competency factors from a wide selection of existing research and business cases, and then ask key stakeholders to select desired factors from them.
- **Expert opinion:** the expert here mainly refers to technical experts who can make suggestions about what kinds of competencies make an R&D staff member successful. Experts can also participate in the literature review process by filtering factors for the company using their knowledge and experience.

Step two: Search for supporting evidence for the competency factors

The supporting evidence is crucial in carrying out proxy assessment for the competency factors, since their qualities affect the results, and hence affect the management directly.

Generally speaking, there are several common sources of evidence:

- ***Past assessments***: the information on past assessments reflects the performance and capability of an R&D staff member; such information is often supplied by the HRM department.
- ***Biographical information***: this is the background information on an R&D staff member, including gender, age, educational background, past academic performance, etc.
- ***Online (Intranet and Internet) behaviour information***: since most of the daily activities of R&D staff are carried out on computers, their online behaviour is one of the most important forms of evidence reflecting their characteristics and

competencies.

- ***Subjective assessment information:*** this is competency-related evidence generated from the staff member and his/her line managers and peers through subjective means such as 360-degree evaluation, self-evaluation, questionnaires and scales.

- ***Information generated from the other available sensors***: all environmental sensors in an organisation can potentially be evidence sources, such as the entrance guard system, a movement or sound detection system, eye tracker, radio frequency identification devices, etc.

The key stakeholders should have in depth discussions about how to select and link these data sources with the competency factors. Meanwhile, according to the availability of the evidence sources, the competency factors should be altered again – those factors lacking evidentiary support should be eliminated.

Following the above guidance, we have carried out extensive discussions with all sorts of experts, R&D staff, and managers about possible evidence sources for the factors included in the PAKS model.

It should be pointed out that here we only consider the availability of the evidence in a general managerial context and adopt some of the most common evidence sources (the first four sources mentioned above). The company can further enrich the factors if they have better hardware.

In Table 7-1, we listed some competency factors, and their corresponding evidence points developed for a company by considering its managerial needs and data availability (detailed case about this company will be presented in Chapter 8).

Table 7-1 Competency list and corresponding evidence designed for a company

Competency dimensions	Competency factors		Evidence 1	Evidence 2	Evidence 3	Evidence 4	Evidence 5
Personality	***Serial or parallel thinking pattern***		The average number of software processes on the computer	Using sole-window or multi-window browser	Open several browser windows in short time	Maximum number of windows of IM software	Gender
	Conscientiousness		The average number of punctuations in per 50 words	The richness of the punctuations used in email per week	The average time consuming for drafting an email	The average number of thread under one email topic	Age
	Thoughtfulness		The number of the favorited websites in the same category	Frequency of web visiting with consequence	Total number of website favorited	Consequences among phrases of the email	Age
	Carefulness		The richness of the punctuations used in email per week	The average number of phrases in the sent email	Number of wrongly written or mispronounced characters	Gender	Age
	Dilatoriness		Average time lag of replying the received emails	The waving of the length of visiting professional contents	Time length for visiting nonprofessional contents in working time	Long-time inactive pages	The waving of the working time length
	Pessimism or optimism		The emotion trend of the visiting contents	Thoughtfulness	“like” in the social networks websites	Number of friends in the social network websites	Buy lottery or not
	Sense of honor		Score of emotional tendency in the visiting contents	Longer working time	Searching the information about the other colleagues online	Show off in the social network websites	
	Responsibility	***Understand the work requirements***	Memory	Associative strength	Searching work regulations in the OA system		
		Passion of the work	The ratio of the number of received and sent emails	The time length of visiting professional contents in the off-work time	The ratio of the time length visiting professional and nonprofessional contents	Post the contents about the company and products on the own social network website	
		Precision of the work	The average time length of visiting a webpage	Trend to visit official or high-reputation websites	Searching work regulations in the OA system	Wrongly written or mispronounce d characters in the emails	
		Self-improvement	The time length of visiting professional contents in the off-work time	Searching professional contents in the other domains	Purchasing online training contents (book, video, or course)		
Ability	***Memory***		Frequency of searching the same keyword	Frequency of checking company regulations related with own works	Frequency of searching the similar keywords	Patterns exist in search keywords	
	Perseverance	***Concentration***	Serial or parallel thinking pattern	Average time length on visiting webpages	Would professional and nonprofessional visiting would appear together	The time length of focusing on one topic	The time length of visiting professional contents in the off-work time
		Accomplish long-term and complex work	Total working time	Frequency of questioning online	Time length staying in the laboratory	Memory	
		Keep thinking	Frequency of questioning online	The time length visiting professional contents in the off-work time	Memory		
	Logic thinking	***Comprehensiveness of thinking***	The visiting depth under the same topic or keyword	Associative strength	Applying various keywords to search one topic	Comprehensiveness	Age
		Consistency of thinking	The pattern of keywords switching	The depth of the file tree on the computer	Strictness of the working time cycle		
		Accuracy of thinking	Frequency of delete	Frequency of withdraw	The number of wrongly written or mispronounced characters in emails	Average keywords in completing one search	

		Reasonability of thinking	The average number of phrase in the sent emails	The pattern of keywords switching			
	Innovation	***Try different ways***	The number of the favorited websites in the same category	Patterns in the online contents visiting	Quantity of software installed	Fan of developmental game	
		Try to solve tough problems	Fan of DIY	Search cutting edge topics in the domain	The total number of favorited websites		
		Perceive unnoticed questions	Feedback of line manager	Frequency of searching	Logic sequence among keywords of searching		
		Know the boundary of existing knowledge	Reading quantity	The total number of types of favorited websites	Pattern of online contents visiting		
	Associative strength	***Approaching association***	The sequence of keywords applied in searching	The frequency of switching between types of webpages			
		Analogy association	The range of websites visited	Visit types of the webpages at the same time	Read novels		
		Consequence association	The depth of webpage visiting	The sequence of keywords applied in searching	Using productivity software	Purchasing related items online at the same time	
		Reverse association	Searching background information when read a news	Writing the address of receiver(s) before or after the main contents	Comprehensiveness of thinking	Consistency of thinking	
Knowledge	***Professional knowledge***		The number of the favorited websites in the same category	The number of professional websites and forums visited frequently	The length of time visit non-professional contents in the off-work time.	Total number of websites visited	The length of time visit professional contents in the off-work time.
	Amateur knowledge		The width of the nonprofessional searching keywords	The number of the favorited websites in the same category	The frequencies of reading various news (e.g., international, economic, entertainment etc.)	The length of time visit non-professional contents in the off-work time.	Total number of websites visited
	Knowledge about customers	***Understand the needs of customers***	The number of emails received from customers	The frequency of visiting the websites of customers	Searching general information of market and products	The frequency of the email with sales and marketing depts.	
		Know the information of customers	The frequency of visiting the websites of customers	The frequency of the email with sales and marketing depts.	Frequency of searching market database		
		Communicate with customers initiatively	The number of emails send to customers	The average time lag between receiving and replying customers' emails	The number of emails sent to customers in the noon-breaking		
Skills	***Team cooperation***	***Cooperative attitude***	Share contents on the social network websites	Frequency of forwarding emails to the colleagues	Longer working time	The number of emails enclosing attachments	
		Team leadership	Frequency of sending emails to the division mates	Frequency of initiating email conversations	Average length of the email threads	Searching the information about the other colleagues online	
	Past academic performance		Diploma level	Performance on transcripts	Awards in the school	Publications	
	Information collection	***Various information sources***	Number of search engine adopted	Number of databases adopted	Searching on foreign websites	Searching with foreign languages	
		Searching skill	Use advanced orders in searching	Use both Chinese and foreign language keywords	Associative strength		

Step Three: MCDM method selection and measurement

In our sub-framework, some MCDM methods are employed to produce the proxy assessment of competency and then performance, as discussed in Chapter 3. After discussion with experts in this area, the evidential reasoning (ER) method was adopted for the following reasons:

- The output of the ER method is a likelihood matrix composed of multiple managerial events and corresponding probabilities. Therefore, this result can provide more information for elaboration management and managerial diagnosis compared to deterministic-output methods;
- The ER method is also highly compatible with different data forms; both the sequencing data and continuous data can be inputted for analysis;
- The probability-based logic of the ER method matches with the nature of managerial practices more so than numerical fitting methods since alternative options always exist in business operations.

It is also possible to utilize other types of MCDM methods in the sub-framework depending on user preferences.

Step four: Apply the results of the assessment to the PM of the R&D unit

The results of the assessment can be applied to the R&D PM in two layers:

1) The predictions of individual performance can help R&D managers carry out PM at the individual and departmental levels. They may intervene in both levels of R&D operations before a poor-performance situation occurs.
2) The results from the competency factor assessments can assist R&D managers in training their subordinates and assigning jobs. For instance, R&D managers can design a specific training program for an R&D staff member based on his/her competency scores; or they can create more detailed performance plans for the employee according to his/her competencies.

Chapter 8 Case Study of TS Company

Based on the new PT framework introduced in Chapter 5, a tailored implementation approach addressing the pressing PM issues in the Chinese R&D units will be developed in this chapter.

8.1 Background

TS Inc. is a high-tech enterprise specialized in industrial adhesive R&D, manufacturing and sales. Since its establishment in 1993, the company has helped customers solve problems by supplying high-quality adhesive products and services (Tonsan Adhesive 2016).

The product lines of TS cover eight main categories (silicone sealant, polyurethane adhesive, epoxy adhesive and acrylic ester adhesive, anaerobic adhesive, cyanoacrylate adhesive, neoprene adhesive, and modified silane sealant), and their applications can be found in 29 key industries (e.g., automobile, engineering machinery, rail transportation, new energy, electronic and electrical appliances, medical treatment, aeronautics and astronautics, shipbuilding, metallurgy, petroleum, coal, electric power, etc.) (Tonsan Adhesive 2016).

Based on the market data, TS is the leading Chinese adhesive company in terms of overall competitiveness. TS now owns three manufacturing bases and has more than seven hundred full-time employees. In the fiscal year 2015, TS had a total revenue of $130 million and the corresponding net profits thirty million dollars.

With a mission of "making customers' machines being more safe and reliable," TS has the vision of being "No. 1 in the Chinese adhesive market by 2023 (the 30th anniversary of the company)" and "a world-famous brand by 2033 (the 40th anniversary of the company)."

To achieve this vision, TS plans to improve its financial performance and customer satisfactions by further strengthening its R&D capability. Although the company's current PMS has functioned well for most departments, R&D managers have complained that the current PMS has done little help in their project management operations, individual performance evaluation, or development of junior staff. Furthermore, the characteristics of R&D practice are not fully taken into account in the current PMS.

For these reasons, TS invited the Kent PM consultant team to help build a new PMS for the R&D unit. The new system should give full consideration to the characteristics of TS R&D practice and should be able to fully support R&D managers in their operations. Moreover, the new R&D PMS needs to be compatible with the company's overall PMS.

8.2 Information gathering and diagnoses

The process for assessing and building the new R&D PMS is as follows. A joint performance group will be established in the beginning stage. This group will include key stakeholders (i.e. external performance experts, the heads of the company, managers of key departments and executive secretaries).

The external experts will review various accessible information, managerial documents and operation files to build background knowledge about TS to better support the further work. The joint performance group will carry out in-depth, semi-structured interviews with key stakeholders (i.e. top managers, departmental managers, line managers and key staff) to collect primary information about the practices and issues involved in R&D work.

The interviews will be carried out with people ranging from the leaders of the company to the line staff, and their feedback will be cross-checked and reconfirmed to generate consensus. In the interviews, different dialogue styles and detail levels will be adopted based on the qualities, personalities and job duties of the interviewees. For instance, more general but strategic questions will be asked if the participator is a top manager, and the interviewee will be encouraged to answer a question by describing a true work scene.

After the primary and secondary data have been collected, the group will carry out rounds of dialogue with headquarters to form a common view of the current situation and issues in the R&D practice. Some key points about rebuilding the PMS should be clarified with headquarters in the dialogue, since these points will largely shape the PMS and help the team determine the project contingencies. Through rounds of discussion, the headquarters of TS will confirm the following:

The main purpose of the project is to build a tailored PMS for the R&D department of TS in order to solve some long-standing problems in its R&D management. Although the R&D department is the focus of the project, the related departments, such as sales and manufacturing – will be involved if necessary.

Moreover, some additional requirements of the company are given as follows:

1. The company does not want to change the formal structure of the R&D department significantly, due to the importance of continuity and stability in its R&D activities. However, it may accept necessary modifications to the managerial relationships in its R&D practices.
2. The team expects full involvement of the R&D staff in the R&D PM rebuilding process so that their technical and managerial views and interests can be reflected in the system.
3. The company emphasizes efficiency in its operations due to the fact that the lack of R&D efficiency is one of the main reasons driving the company to carry out this project.

Details about TS and its R&D system and practices are presented in the following section.

8.2.1 Overall structure of TS Inc.

In general, TS is organized in a functional format – several functional segments are organized in a chain that covers the processes from materials purchasing to after-sale service. All these functional departments are led by headquarters through a very short order-chain that reflects the main pursuits of Chinese private corporations: efficiency and budget control.

More specifically, the partners and CEO form the strategic apex of the company;

they develop the company's top strategies/objectives. At TS, all partners have a strong technical background and one of them leads the R&D activities on the strategic level. The departmental managers play the role of the middle line in the firm – they implement the company strategies/objectives in their departments, while contributing primary information about internal (e.g., information about operations or finance) and external (e.g., information about market trends or key customers) environments to the company heads to support decision making. The operating core of TS consists of various employees, from assembly line workers to R&D staff in the laboratory, and these employees require different managerial styles based on the characteristics of their jobs. At TS, key staff (e.g., senior R&D engineers and senior manufacturing engineers) and managers design technical routes with the help of external technical experts, so they make up the main body of the techno-structure. Some service units, such as the security and maintenance offices, play the role of the support structure in the company. The basic organisational chart of TS is shown in Figure 8-1:

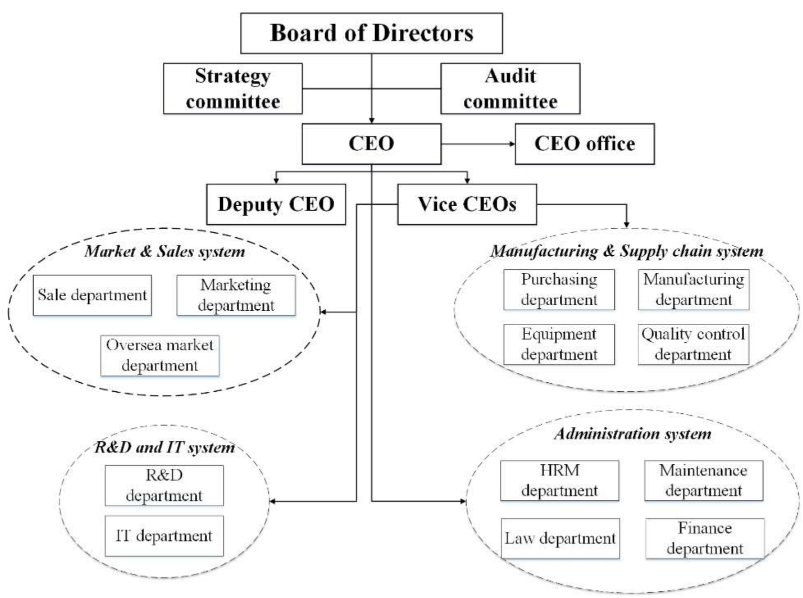


Figure 8-1 Organisational structure chart of TS Inc.

8.2.2 Structure of the R&D department

The R&D department at TS has about 50 staff members, with seven advanced chemical and physical laboratories to support technology and product innovation. The department manager is responsible for all technical and operational issues in the R&D unit; he is also one of the top managers in the entire company and makes strategic decisions along with the other leaders at headquarters. All R&D staff belong to one of the six divisions, five of which are R&D divisions and the other an experiment support division. The five R&D divisions are set up following the product strategies of the company; these are the silicone, cyanoacrylate, polyurethane, epoxy and synthesis divisions. Each R&D division has a line manager and several project managers. The line manager is in charge of both technical and administrative issues in the division. They also assist department managers in making departmental decisions and implementing these decisions in their divisions.

Apart from this bureaucratic rank system, a professional title system also exists in parallel in the R&D department. There are five layers in this system: the chief engineer has the top rank, and this role is usually held by the department manager. The principal engineers are at the second level. Usually, there are no more than two principal engineers in each R&D division – one of them is the division manager, and the position of deputy principal engineer is taken by senior the R&D staff member in the division. The R&D engineers make up the main body of employees in the department; they are experienced R&D staff who can carry out activities independently. The assistant engineers are at the bottom of the ranking; they are junior staff who need to be mentored to carry out their work.

The organisational chart (including both bureaucratic and technical ranks) of the R&D department is illustrated in Figure 8-2:

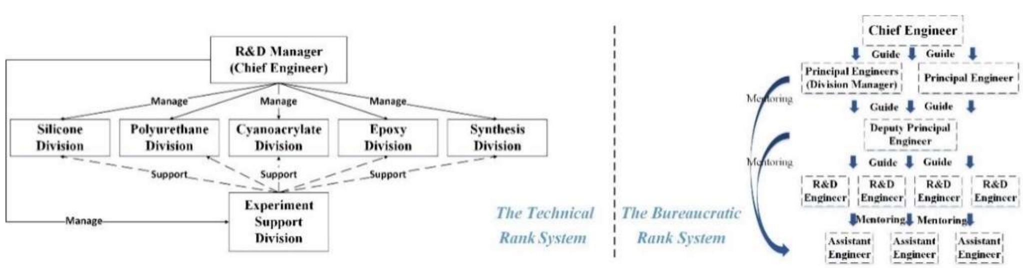


Figure 8-2 Technical ranking and bureaucratic ranking systems in the R&D department

8.2.3 Current R&D procedures of TS

The current R&D practices at TS reflect the company's linear functional R&D structure, meaning that the R&D segments are configured based on the functions of the divisions but cooperate in a linear way.

In the R&D topic formation block, the R&D manager and division managers organize the annual R&D plan at the beginning of each year based on the company strategy and information gathered from other departments (e.g., marketing, sales, manufacturing, etc.). The plan is then broken down into specific R&D topics and further assigned to each R&D division according to the main product line they support. Limited interaction between the top and bottom of the department can be observed during the topic formation process, and any interactions are usually triggered by a negative event. For example, if the subordinates reject the assigned R&D topics due to insufficient facilities, resources or abilities, the managers will interact with them to revise the initial topics or persuade them to agree.

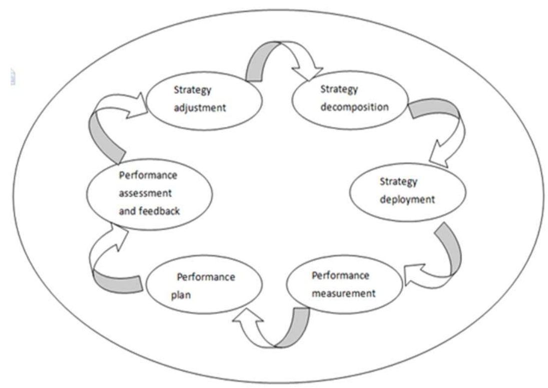
Furthermore, in the R&D project management block, the staff in each division submit proposals for confirmed R&D topics according to their specialties and technical backgrounds. The division and department managers review these proposals using the criteria of feasibility, technical risk, resource availability and applicant's experience, and then decide who will undertake each topic.

In this process, the R&D projects are managed loosely – the budget, milestones, and yields in each project are not strictly managed. Although the company has requested several times for R&D managers to supervise the projects in a more detailed way, the managers consider this demand very difficult, if not impossible, to meet, considering most of their time and energy is occupied by daily management. As one division manager stated, "After relatively strict reviewing of project proposals in the initial stage, we can only hope the project undertakers will accomplish what they have promised."

Regarding the cross-departmental cooperation block, a top manager of the company remarked that the cross-department communications in the R&D unit rely highly on several senior staff members. This means that the manger's personal network, rather than a reliable mechanism, plays the most crucial role in departmental cooperation. A similar issue exists in the training and development block. Since mentoring activities are not included in the old performance measurement and incentive system, the mentors lack the motivation to put more time and energy into this role.

8.2.4 Current R&D performance management system and practice

TS currently employs a six-step performance management (PM) system for all departments (see Figure 8-3).



Source: *Li (2010)*

Figure 8-3 The six-step cycle of PMS

The R&D department also carries out its PM through this six-step cycle.

In the strategy adjustment and decomposition steps of the cycle, the R&D strategies and objectives are generated to align with those of the company through the decomposition method introduced earlier (SSM, Chapter 4). Once the top R&D strategies and layers of specific R&D objectives are developed, the R&D manager and division managers will deploy them through assigning key processes (KPs) and key performance indicators (KPIs) to the staff. The KPs include key activities for accomplishing job tasks and the KPIs reflect the expected performance yields, from the company to the individual employees. In the R&D department, each staff member's KPs and KPIs are designed specifically by the line managers based on the employee's past performance, abilities, and potential. The line managers' performance tasks are assigned by the department manager in a similar way, but include more items to reflect their management contributions. Performance measurement is a regular managerial activity in the R&D department, and the staff face two types of performance measurement in a year:

- **Monthly measurement**: the division manager gives a performance grade to each staff member based on his/her performance on routine activities and contributions to the R&D project(s).

- **Annual measurement**: the overall performance measurement is carried out through 360-degree appraisal (in which line manager, work partners, and internal & external customers participate the process). The employees' performance bonuses are highly linked with the result of this appraisal.

In the R&D department, the steps of performance planning and feedback are conducted along with the performance appraisal. When the line manager delivers a staff member's performance grade, he provides corresponding remarks and suggestions about how to further improve performance.

In the final step, the employees' performance is reflected in their rewards. The performance incentive system has been changed several times in the past years, and the current R&D manager believes that the gap in performance bonuses between staff members of the same rank should not be large since R&D work is team based. Accordingly, the on-going performance incentive mechanism in the R&D department of TS is largely division-based, rather than individual-based. At the end of each year, the department manager calculates the performance bonus of each division in three parts, as follows:

- **Overall performance bonus**: if the department has accomplished its annual departmental targets, a bonus will be allocated to each division based on its staff number.

- **Key project bonus**: if the division has completed the keys projects set at the beginning of the year, the bonus will be allocated to the division in the amount initially agreed upon.

- **Product bonus**: if the division has invented new products or cut the costs of existing products, it can obtain a sales-based bonus according to the ratio as presented in Table 8-1. Tables 8-2 and 8-3 display the individual performance appraisal and the existing product improvement bonus for the R&D department respectively.

When all of the three parts have been calculated for each division, 70% of the total amount is put into a division bonus pool and paid to all staff members at different levels based on their technical rank (for instance, two principal engineers will receive 10% of the pool, one deputy engineer will receive 3.5%, R&D engineers receive 60%, and assistants share the remainder). The other 30% of the total amount is paid to R&D groups based on the significance of their R&D projects, and then the group leaders further allocate the bonus to subordinates based on their individual contributions.

Table 8-1 New product bonus for the R&D department

The number of years	Bonus Ratio
1st year	5% of the net profits
2nd year	3% of the net profits
3rd year	1% of the net profits
4th year	2% of the growth in net profits compared to the 3rd year
5th year	2% of the growth in net profits compared to the 3rd year

Apart from routine bonus described above, the R&D manager and division managers receive an extra bonus paid by the company, the amount of which depends on the company leadership's satisfaction with their annual work.

In our study, the R&D department managers had very negative feedback regarding the current PMS. The main reason for this is that the characteristics of R&D are not fully considered in the system. For instance, the customized KP and KPI system requires a great deal of time and energy from division managers, but its effects are poor because it ignores the nature of uncertainty in R&D. One division manager remarked, "The linear PMS may be suitable for the manufacturing or admin departments, because their work flows are highly fixed and yields are predictable. However, in the R&D department, the procedures and work results are sometimes unclear until the project has been carried out."

Table 8-2 Individual performance appraisal table of the R&D department

Name	**Job position**	**Department**	**Line manager**	**Appraisal cycle**

Part 1: KPI based appraisal (70% credits)

Name of KPI	Definition of KPI	Appraisal Stander				Weight	Data supplier	Cycle	Score	The Score of the last year	The Score of the year before last	Notes
		50	80	100	120							
Total						70%						

Part 2: KP based appraisal (30% credits)

Name of key work	Key processes descriptions	Milestones	Indicators of accomplishment	Expected yields	Weight	Self-appraisal		Superiors-appraisal	
						Remark	Score	Remark	Score
Total					30%				

Part 3: Additional information

Awarded points (If the evaluee had remarkable works in the appraisal cycle, line manager can add extra 0~5 points to his/her final performance grade) Key facts: Point(s): Signature of line manager:_________	**Deductions (If the evaluee had significant work faults in the appraisal cycle, line manager can deduct 0~5 points from his/her final performance grade)** Key facts: Point(s): Signature of line manager:_________

Part 4: Final score

KPI grades	**KPI grades**	**Adjust scores(±)**	**Overall scores**	**Keynotes:**	**Signature of line manager**

Table 8-3 Existing product improvement bonus for the R&D department

A= growth in net profits in one year	Bonus Ratio
A≤¥ 250,000	2% of growth
¥ 250,000＜A≤¥ 500,000	2.5% of growth
¥500,000＜A≤¥ 750,000	3% of growth
¥750,000＜A≤¥ 1000,000	3.5% of growth
¥1000,000＜A≤¥ 1250,000	4% of growth
¥1250,000＜A≤¥ 1500,000	4.5% of growth
¥ 1500,000＜A	5% of growth

8.2.5 Main issues in the current R&D system and practice

Several key issues with the current R&D system and practices were confirmed after discussions with the leaders at TS headquarters.

Firstly, the company's R&D strategies are not sufficiently enough. The current R&D strategies and objectives were formed four years before, so the company wishes to reform its R&D strategies.

Second, current R&D operations are weak in terms of internal operational efficiency and external departmental collaboration. The company hopes to these issues, to some extent, by rebuilding the PMS.

Third, the unique nature of R&D activities needs to be considered in the PMS and the new PMS should match the characteristics of R&D work, such as bottom-up work flows, indispensability of staff training, and uncertainty in R&D projects.

To be more specific, the above issues are reflected in the following aspects:

1) The current procedures in the R&D topic generation block cannot fully reflect the needs of multiple stakeholders. A sound procedure that integrates the voices of all stakeholders is needed in the R&D orientation forming processes. Moreover, the R&D strategies have not been discussed for years, which has made the focuses of R&D unclear.

2) The inefficiency of the project management approach was another issue reported by many interviewees. The following problems exist in the current project management approach of TS: lack of real competition in project

initialisation; inability of reviewers to accurately judge the market position of the proposed technologies; absence of progress monitoring for R&D projects, etc. Therefore, a restructuring of the current R&D project management procedures is highly necessary. Moreover, the current way of managing projects is fairly loose: the milestones and technical indicators for the expected yields are blurred; the progress of the project, however forward or backward, is not reflected in the income. Therefore, the R&D staff generally lack the motivation to carry out the project research in an effective way.

3) Too many administrative and technical management burdens are placed on the division managers, so they can neither focus on research nor manage their units properly. For instance, all performance measurement, planning, and feedback activities rely highly on the division managers, leading to substantially similar KPs and KPIs and average performance grades for all staff members.

4) The staff, especially outstanding members, lack motivation under the current incentive system, since most of the performance bonuses are allocated evenly.

5) The inadequacy of the junior staff development system is another issue. A comprehensive system for training and cultivating new staff does not yet exist. New staff can only seek help from the department's informal mentoring system. Furthermore, the mentors have insufficient motivation to put more time and energy into guiding their apprentices, since these activities are not reflected in the existing performance measurement and reward system. Hence, a junior staff cultivation system is urgently needed to increase human capital in the company.

8.3 Building a new R&D PM system

Based on the information presented above, the joint team will develop a new R&D PMS for TS. Due to the existence of numerous "bottom-up" work flows in the R&D department, the PM frameworks that depend on the simple decomposition of top strategies/objectives (e.g., BSC, PBS, etc.) are not suitable here. The benchmark methods, such as the EFQM, lack guidance on setting up a PMS (see Chapter 2). Therefore, the performance tree (PT) framework is employed in this case.

The activities are carried out in two interrelated stages. The first stage includes rebuilding the PT by adjusting and modifying the current R&D performance generation procedures in line with the characteristics of the functional R&D structure (see Sections 8.2.2 to 8.2.4). Then, in the next stage, a new R&D PMS will be developed corresponding to the new performance generation procedures.

8.3.1 Rebuilding the R&D PT

By rebuilding the PT, the team aims to establish tailored R&D performance generation procedures for TS that match with and fully support the company's R&D strategies and objectives.

Principally, the rebuilding process follows the four blocks introduced in the previous chapter, although their sequences will be adjusted and some blocks will be integrated into others.

Since the entire PT of the R&D department contains too many details, it is very difficult to visualize them in one performance map. Therefore, we will focus on describing the details of the key parts of the PT and try to visualize some of them by the performance map tool to help people to understand.

In general, the rebuilding process will follow the sub-framework introduced in the former chapter. Below, we will introduce the key parts of the R&D PT by giving more detail

8.3.1.1 R&D strategy repositioning

Initially, the external experts help TS formulate procedures to reposition its R&D strategies. By considering the shortcomings of the existing strategy formation processes at TS, the external experts aim to bring multiple stakeholders viewpoints to the new procedures, considering their opinions through interactive procedures. The orientation of the TS R&D PT will be determined by the headquarters in this stage and to guide the following PT building works.

After reviewing the current R&D processes of TS and discussing them with headquarters, the external experts identify the key stakeholders involved in the R&D activities of TS, as follows:

The managers and research staff of the R&D department are indispensable in the repositioning processes. The company headquarters also plays a crucial role in the R&D activities, since along with joint with top managers, company leadership sets the technical orientations for the R&D department. The internal customers then supply market information and technologies to be developed the R&D unit for their final products, so they are also key stakeholders. The external customers, which mainly include key suppliers and customers, also took part in the R&D strategy repositioning. Moreover, some external technical experts were also invited to review the new strategies.

After the participants have been confirmed, the repositioning work is carried out according to the following steps:

1) The company headquarters reviews the company's overall R&D orientation over the past five years. Meanwhile, the managers of the R&D department are asked to review their experiences in successful R&D cases and lessons from failed cases over the past five years. The cases should cover aspects of new product and technology research, new technology development, and existing product improvement. Based on the comprehensive reviews, the joint team helps TS establish an R&D case base to support its R&D strategy repositioning. The base consists of cases in the fields of R&D strategy positioning, project application, resource allocation, R&D process management, information management and technology development.

2) The internal experts (key staff in each division) are requested to conduct investigations into the product and technology trends in the market and competitors' information, to be written up in a technology trend report. Meanwhile, the external experts are invited to give speeches about the latest technical trends in the industrial adhesive field.

3) Due to the importance of the strategic research topics, a further review is carried out to validate those topics. The proposers of the strategic research topics are required to submit a justification report and conduct a presentation to headquarters, R&D managers, reviewers from related departments (e.g., manufacturing, sales and marketing) and external experts. After the final examination by the above reviewers, the strategic R&D topics are determined.

4) The key departments partnering with the R&D department are requested to

summarize current issues and provide suggestions for improving their cooperation with the R&D unit.

5) The sales and marketing departments are required to carry out a comprehensive survey of the key external customers of TS. The survey aims to help the company further understand the concerns and expectations of its key customers regarding TS products.

6) Based on the information collected in the previous steps, the company leaders are asked to organize a joint meeting with managers from related departments to discuss the R&D orientation in the next five years.

The main R&D strategy of TS needs to be clarified in the meeting, for instance, by determining whether the company will emphasize technology tracking or original innovations. The market-related departments need to predict the hot spots in the adhesive market in the next five years. Moreover, based on the new R&D orientation and potential hot spots in the future market, the R&D department needs to explain how to respond to these issues in the R&D operations. After the joint meeting, a strategic report is formed by the participants, consisting of:

- New R&D orientation of TS for the next five years;
- Promising new markets and corresponding product lines for the next five years;
- Cutting edge technologies and currently leading companies in the new markets;
- Current position of TS in the new markets or the feasibility of entering the new markets;
- R&D challenges that come with the new markets;
- The extra resources it will take to strengthen TS's position in the new markets.

7) The R&D strategy report is submitted to multiple key stakeholders to review and discuss until a consensus is reached. Then the new R&D strategies will be confirmed and will guide all following work.

8.3.1.2 Research topic generation

After the new R&D strategies and objectives have been confirmed, the R&D

department will need to further specify them into research topics. In general, the research topic generation process is carried out in a bottom-up manner. The top structure of the PT will be established largely in this stage, since the core works of the TS R&D department are carried out in the form of R&D projects.

Firstly, the updated R&D orientation is handed out to all R&D divisions to allow R&D staff members to discuss how to support the new strategies and objectives using their specific expertise. The results of these discussions are summarized by the project managers and submitted to the division header.

The division manager and key engineers then hold rounds of meetings to further clarify the division’s role in the new strategies and objectives. The main topics for the meeting will include new technology and products that the division intends to research, and the extra resources it needs to support further research. After the meeting, each division should formulate and submit their initial research plan to the R&D manager.

The R&D manager first reviews all potential research topics submitted by the divisions and screens them roughly based on the research topics’ feasibility (e.g., proposals that exceed the resource capacity of the company will be eliminated). Then, the R&D manager discusses the proposed topics with the manager and key staff of each division to further screen them. Finally, each division ranks the remaining topics by their strategic priority and catalogues them into strategic R&D topics, promising R&D topics, generic R&D topics, and exploratory R&D topics.

Due to the importance of the strategic research topics, a further review is carried out to validate them. The applicants for the strategic research topics are required to submit a justification report and conduct a presentation for headquarters, R&D managers, reviewers from related departments (e.g., manufacturing, sales and marketing) and external. After the final examination by these reviewers, the strategic R&D topics will be determined.

Similarly, examination of the remaining types of R&D topics (promising, generic and exploratory) is also required, but this only needs to be carried out inside each division. The principal and senior engineers of each division will review and give their decisions about these topics.

When levels of R&D topics have been confirmed, the joint team carries on rebuilding the next R&D block, the project management, for TS.

8.3.1.3 Rebuilding project management procedures

Generally speaking, project management consists of the steps of start-up management, process management, and outcome management. In this section, attention will be placed on the rebuilding of procedure, while the changes to the corresponding managerial approaches will be introduced in Section 8.4. Since most performance of the TS R&D department is generated from the projects, the main body of the R&D PT will be built in this stage.

In order to address the problems of TS project management diagnosed previously, the joint performance improvement team decided to introduce the lean project management framework into the R&D practices of TS (Ballard and Howell 2003). Under the lean project management framework, all potential projects should be considered and managed using a 4×3 matrix.

Here, the "4×3" represents four dimensions and three stages in an R&D project. The four dimensions are customer needs, product functions, R&D procedures and manufacturing feasibility; the three stages are conceptual design, implementation plan design, and finalisation design.

More specifically, the new project management procedures consist of five detailed stages.

Stage 1: Project formation

Although the main body of R&D topics is determined by the R&D department, the related departments (e.g., sales, marketing, and manufacturing) can also initiate R&D projects based on their R&D needs. For example, the sales department can request an R&D project based on the technical needs of the customers, and the manufacturing department can plan from the aspect of manufacturing cost control.

The project plans need to be initially approved by the manager of the corresponding department, and then they can enter into the next stage.

Apart from R&D projects formed through this routine approach, the company heads may assign strategic research topics directly to the R&D department.

Stage 2: Proposal submission

In this stage, the potential R&D projects should be enriched with more detail, so the applicants will need to fill out a proposal form to formally apply for the project.

To better support this stage, a 4X3 matrix-based proposal form was designed in collaboration with performance experts and R&D managers. The new form requires the applicants to reflect on their plans in terms of the above-stated aspects and provide more comprehensive information about the project to the reviewers to support their decision.

Each project team needs to provide the following information about the project:

- **Market information**: overall market background, potential market scale and competitors in the market
- **Sales information**: target customers, overall costs, and sales challenges
- **Technical information**: technical feasibility, technology gap, R&D risks and R&D costs
- **Manufacturing information**: manufacturing feasibility, manufacturing risks and manufacturing costs

The multiple categories of information required in the proposal form will drive applicants to organize a cross-department team to complete the proposal; this is highly encouraged by the company. The details of the proposal form are shown in Table 8-4.

Stage 3: Proposal review

At the beginning of this stage, a project review committee is formed to examine the proposals. Depending on the type of project, the size of the committee can vary. For instance, a committee to review strategic projects should include top managers of the company, the R&D manager, managers of related departments and external experts, while a committee for a generic project can be formed by key engineers of a division.

The reviewers in the committee need to review the proposal reports and form a final conclusion about the project. Possible results will be “approval”, “disapproval” and “resubmit proposal”.

Table 8-4 The matrix of lean R&D management

		Customer	Product	R&D	Manufacturing
Conceptual design	Questions	**Potential customers?**	**Product functions?**	**How to research and integrate the functions?**	**How to manufacture the product?**
	Supporting materials	* Market positioning report (Sales / Marketing depts.) * Customer needs report (Marketing / R&D depts.) * Competitor report (Sales / Marketing depts.)	* Expected functions of the new product (Marketing / R&D depts.)	* Research plan (R&D dept.) * Technology & product review (R&D dept.)	* Manufacturing technique review (R&D / Manufacturing depts.)
Implementation plan design	*Questions*	**Whether the potential customers need the product?**	**Can the functions be fully accomplished?**	**Potential technical risks in the R&D processes?**	**Can existing manufacturing capabilities meet the needs of the new product?**
	Supporting materials	* Marketing plan (Sales / Marketing dept.)	* Key technical indicators of the new product (R&D dept.)	* Technical risk assessment report (R&D dept.)	* manufacturing feasibility assessment report (R&D / Manufacturing depts.)
Finalisation design	*Questions*	**Will the potential customers accept the price ?**	**How to promote the new product?**	**Any risks in technology development?**	**Can large-scale manufacturing be conducted continually?**
	Supporting materials	* Costs / pricing report (Sales / Marketing / R&D depts.)	* Detailed sales / marketing report (Sales / Marketing / R&D depts.)	* Final function assessment report (R&D dept.) * Technology development risk assessment report (R&D / Manufacturing depts.)	* Manufacturing implementation report (R&D / Manufacturing depts.)

Stage 4: Project meetings

For the projects approved in the previous stage, an initial project meeting is held in this stage. The purpose of the meeting is to clarify important managerial details of the project, such as resource allocation, key outputs, key members and awards.

For a strategic project, the company heads and departmental managers should participate. However, if it is a generic or exploratory project, the meeting only needs to be held in the division.

The project team leader should convene a team meeting in the two weeks following the initial project meeting to begin the project. In this meeting, additional details about the project should be confirmed, such as division of work the staff and key time points for progress.

The conclusions of the meeting need to be recorded in a written report and submitted to the R&D manager.

Stage 5: Progress report

At each key time node of the project, the team needs to submit a progress report to the R&D manager or division manager, depending on the project type.

For a strategic project, a joint meeting is needed at three key time points: the end of laboratory research, the end of prototype research and the end of manufacturing development.

This is the entire project management process for the R&D department; the overall flow chart is presented in Figure 8-4.

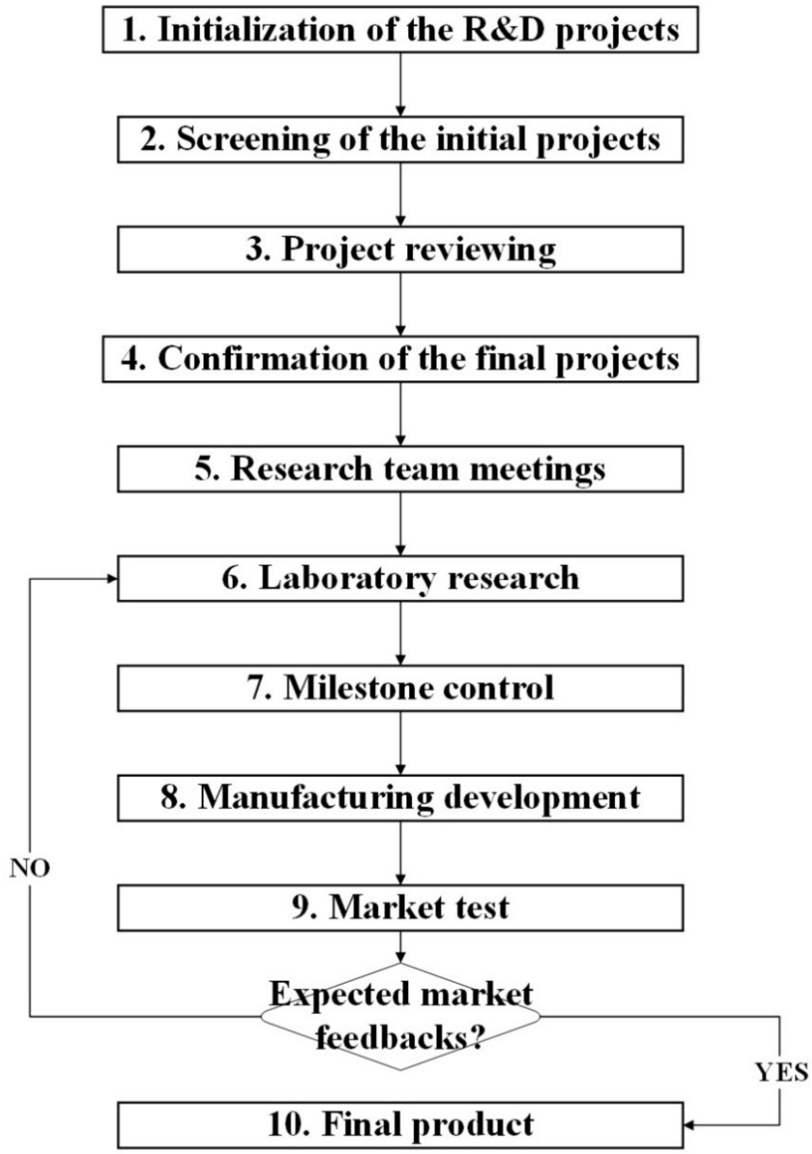


Figure 8-4 Flow chart for TS R&D project management

8.3.1.4 Building a PT for staff training and development

The last block in a functional R&D structure is to train and develop R&D staff and this system plays an environmental role in the R&D PT. Based on the diagnosis of the issues at TS, the general training and development system in the R&D department is not problematic. The main issues revolve around the cultivation system for junior staff. To solve this issue, the team redesigned the junior staff cultivation system in the R&D department. The basic structure of the system follows the structure reported by (Béret et al. 2003), which has been proven effective in multiple cases.

The first major change is the induction training system for junior staff members. Currently, the induction training for new R&D staff is implemented by the human resources department, which mainly focuses on teaching them the general regulations of the company.

To help new R&D staff become familiar with the research being conducted, an extra orientation training will be organized by the R&D department. The new training emphasizes the R&D procedures, R&D projects, laboratory management and facility instructions, which the new staff will encounter in their future work. All of these contents are delivered by senior engineers in each division.

Moreover, the practices of the mentoring system have also been improved. In the new system, each junior staff member will be assigned to a deputy engineer (or someone of higher rank), who will mentor them for up to 36 months. The mentor will guide the new employee in the aspects of general research, project research, and R&D-market relationship maintenance. Initially, the mentor will lead the new staff member to complete a career development report that describes his/her professional development direction, research interests and product interests. Then, according to the contents of the report, the new staff member will be asked to deliver presentations to the senior staff of the division to report his/her progress quarterly. Meanwhile, the mentor will also need to submit a personnel development report to the division manager on the same timeline. At the end of the mentoring cycle, the progress of the new staff member will be reviewed by the division manager to decide whether to finish or extend the mentorship.

Additionally, a reward system is attached to the new mentoring system. This means that an extra performance bonus for the mentors will be connected with the progress of his/her apprentice. More details regarding this incentive system will be introduced below.

8.4 Developing the PT management system

So far, we have described the processes of building the PT in the R&D

department. In line with the characteristics of the functional R&D structure, the new R&D strategies have been repositioned. Moreover, a new system to generate R&D topics, manage R&D projects and cultivate junior staff has been built.

In this section, we further explain the process of building the PMS. It needs to be pointed out that the processes of creating the PT and its corresponding management system are interconnected. Here, in consideration of presenting these processes clearly, the processes are split into two sections.

A complete PT based management system includes performance sets, units, and corresponding managerial routes to monitor and control the tree. According to the requests of the company headquarters, the performance units in the R&D department will not be modified significantly. Most of the modifications are focused on performance sets and managerial routes.

In this section, the focus of our work shifts to the R&D PMS of the R&D department. By improving and rebuilding the R&D PM procedures, a PMS corresponding to the rebuilt PT will be developed for the R&D department.

8.4.1 R&D performance measurement system

Performance measurement is one of the basic tools for managing the PT. Based on the local managerial needs and repositioned R&D strategies, the individual performance of the R&D staff mainly consists of three parts: routine activities in the job description, key tasks assigned by the managers and R&D project research.

All contents of these three parts are reflected in an |R&D member's performance sets, which include the descriptions of key performance for each part and the corresponding metrics. If potential issues are identified in a staff member's work, the managers can steer the person onto the right track by adjusting the indicators and metrics.

According to the contents of the individual performance items, the performance measurement system for the individual R&D staff members consists of three main sub-systems:

1) The routine performance measurement system ensures that the R&D staff are following job rules and regulations (e.g., absent rate and laboratory operation

procedures). The routine performance appraisal is carried out monthly, and full performance scores will be obtained if an employee has no record of violating rules or regulations in the appraisal cycle. Table 8-5 displays a sample routine performance appraisal items.

Table 8-5 Sample routine performance appraisal items

Name	Criteria	Regulation	Data supplier
Engineer A	Attendance rate	*Labour rule of TS*	HR department
	Using protective device in the laboratory as required	*Laboratory safety regulation of TS*	R&D department

2) The key performance measurement system focuses on the tasks assigned by the line managers to form more specific and short-term KPIs, which reflect management requests. Multiple measurement dimensions can be adopted for the same KPI based on the needs of the line managers. For example, a line manager can measure one staff member's KPI of "complete the recipe improving work for product A" from the aspect of time control, if that is what is most important to the manager. The manager can also measure the KPI from dimensions of the budget control or satisfaction of internal customers (see Table 8-6).

3) Project performance measurement is carried out using the performance plan system. One part of project performance is included in the KPIs and measured in that system. The remaining project performance scores are given after a face-to-face talk between the evaluee and the manager; the talk is focused on the agreed-upon milestones and yields of the project.

The contents of an employee's performance set are aggregated into the contents of a divisional (performance unit) performance set; the remaining contents come from the R&D manager directly, according to local and global managerial needs. The departmental (performance unit) performance set is also formed in this way.

Under the new key PMS (see Figure 8-5), the contents of the performance sets are flexible and can be adjusted. Moreover, the metrics used to measure the KPIs are also adjustable. The new system gives the managers a higher degree of freedom to express their preferences and priorities about work performance by adjusting KPIs and/or metrics.

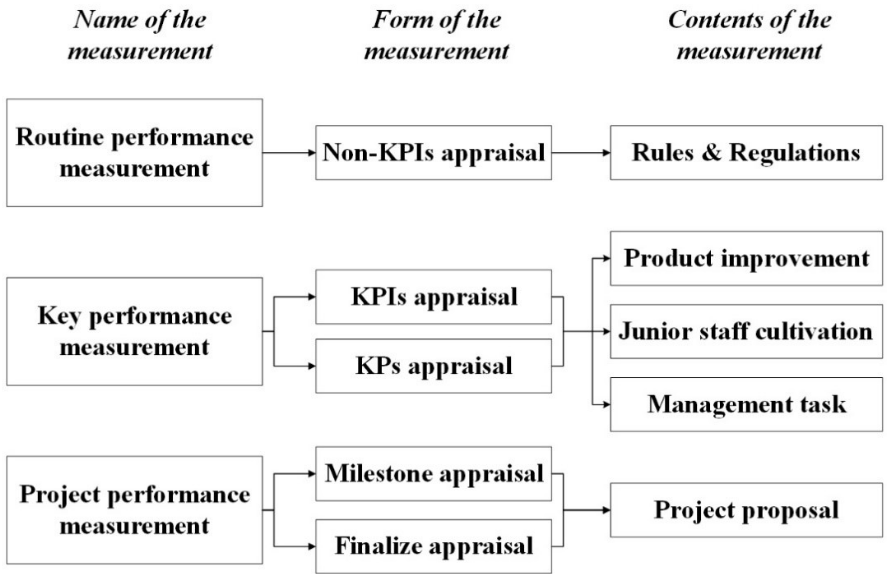


Figure 8-5 Overall individual performance measurement system of the TS R&D department

Table 8-6 Samples of KPIs and KPs for an R&D staff member

NAME	Staff H	Line Manager	Manager D	Date	
KPIs	Description	Time cycle	Metrics	Data suppliers	Weight
Meet milestones of project A	Meet five milestones of research project A in terms of quality and time.	Eight months	*Number of milestones met on time *Number of milestones met in terms of quality	Manager of silicone sealant division	20%
……					
KPs	Contents of KPs				Data suppliers
	Methods to complete KPs	Difficulties	Expected results		
Optimize products in charge	*More negotiations with product manager A *Customer investigations (customers Y, T, and P) *Historical data review	*Detailed information about customer Y *Extra budget needed	*Market report about the products in charge *Customer needs report about the products in charge		*Staff H *Manager D *Marketing department
……					

8.4.2 Performance plan system

The performance plan system is another pillar in the PT-based PMS and its importance is even higher in the R&D department. To form a performance plan, a performance meeting between each R&D staff member and his/her line manager is needed. In the meeting, the line manager should clarify the details regarding key performance for the employee, and let them know that their performance will be measured and appraised accordingly. Furthermore, each staff should list potential challenges in accomplishing the performance targets and the extra resources needed to overcome the challenges. After rounds of dialogue, when the employee and his/her line manager reach an agreement about the details of key performance, the performance plan is formed.

In the new PMS designed for the R&D department, the contents of the performance plan have undergone several changes.

First of all, according to the new performance generation procedures, more milestones in the R&D project are included in the performance plans. The new system requires division managers to trace specific milestones when they dialogue with subordinates about their performance plans.

Secondly, the new system suggests that line managers set or adjust contents of the performance sets according to the performance plans. This will ensure that key tasks in the plans will be monitored and driven by the KPIs.

Thirdly, the junior staff development activities must be included in the performance plan. The senior staff members who will act as mentors should explain their plans, and the line managers should supply resources to support these activities.

8.4.3 Changes to the performance unit and management

To better manage the rebuilt PT, the joint team modified the performance units and the PM structure of the R&D department.

One issue cited by many line managers was the overload of administrative work. Considering that all of the line managers are also experienced R&D engineers, it is a waste of time and effort to burden them with a large amount of repetitive daily tasks.

To solve this issue, the team modified the R&D department's existing organisational chart by including several virtual performance units and holding discussions with key stakeholders to select the best one. Two plans were suggested by the team (see Figure 8-6):

In the first plan, the majority of the administrative activities of the line managers will be reallocated to an adjunct secretary; this position will be held by the deputy principal engineer of the division.

In the second plan, a new full-time "research secretary" position will be created to assist all line managers and the R&D manager.

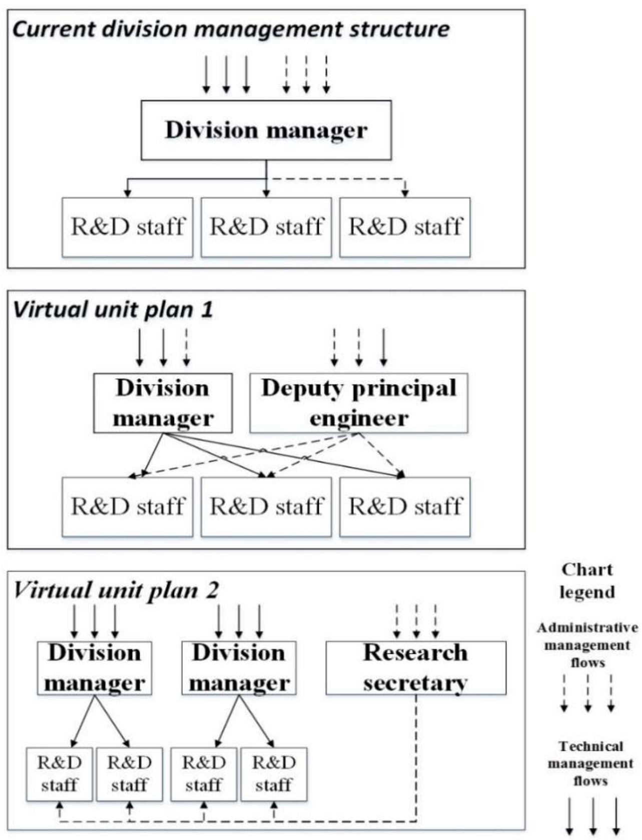


Figure 8-6 Virtual performance unit in two plans

After comparing the pros and cons of the two plans and discussing them with the managers, TS decided to adopt the second plan eventually, since it will have the minimum impact on the current structure and will save R&D human resources to the maximum extent.

In the new administrative structure, most of the repeated administrative tasks have been removed from the job description of the line managers and R&D manager, allowing them to put more time into technical management.

8.4.4 Incentive system

The current incentive system in the R&D department cannot fully reflect the performance differences between R&D staff, and hence is unable to motivate those employees. To address this situation, the team redesigned the incentives system by linking the incentives more tightly with the scores on the performance measurement.

In the new incentives system, the income of an R&D engineer consists of four parts:

1) Post wage: fixed income related to professional title, bureaucratic rank, and seniority.
2) Performance bonus: variable income depending on the scores from the three performance appraisals (see Section 3.2.2).
3) Project bonus: depends on the importance of the project and the contribution of the individual to the project research. The total bonus is agreed upon during the start-up stage of a project and each participant's portion is decided by the project manager.
4) Manager award: The R&D manager can directly award staff who have made outstanding contributions in research or management through the department bonus pool.

In the old TS R&D incentive system, the R&D staffs' 80% income came from their fixed post wage, but this figure decreased to 65% in the new system. By increasing the weight of performance pay, the performance team aims to improve the R&D staffs' commitment and motivations to the R&D tasks and projects. For instance, under the new system, a junior staff may earn more than the senior ones if he accomplished the assigned tasks soundly and contributed significantly to the research project.

8.4.5 R&D staff competency management

In Chapter 3, we reviewed multiple studies and concluded that the state of R&D staff competency plays a crucial role in determining staff performance. Traditionally, information on staff competency is collected through the managers' judgments or performance appraisals, which are often objective and time-consuming. However, the large amount of behavioural information generated during R&D operations is a potential source of information that can help the organisation measure and monitor the competencies of its staff.

In this project, we designed and built a behavioural-data-based system to help the R&D managers easily and continually measure their subordinates' competency status.

More specifically, the competency factors function in the R&D PM process in the following two ways:

1) **Performance monitoring:** the traditional performance monitoring system operates based on the historical performance data of the R&D staff, so it is unable to supply real-time information to help the managers. In the new system, we attribute the R&D staffs' competency to their performance, and furthermore, monitor the staff's R&D performance by continually measuring their competency scores.

   With the new performance monitoring system, the managers can take managerial action before low-performance events actually happen. Meanwhile, the managers can also adjust their emphasis and approaches to management according to the overall performance status of their subordinates.

2) **Performance improvement:** training and development are very important activities in the R&D department, since the R&D staff represent core human capital for TS. By adopting the competency management system, the R&D

staff members can be trained and their competency shortcomings improved upon more effectively. Moreover, the managers of the R&D department can summarize a “best competency pattern” for their subordinates, and then cultivate those patterns to strength employee job performance.

More details about the system are introduced in Section 8.5 below.

8.5 Online behaviour data-based performance monitoring and prediction system (BPMPS)

8.5.1 General steps for building the system

In the aforementioned new PMS of TS, an online BPMPS was built for the R&D department.

Generally speaking, the system analyses the R&D staff’s online behavioural data through the multiple criteria decision-making (MCDM) method and outputs results regarding the staff’s working status and potential performance. PM can then be carried out based on the results.

The system was built using the following main steps:

1) Establish a competency model based on the strategies and objectives of the organisation (or apply an existing one). The competency factors in the model should be attributable to the staff performance generation process.
2) Measure the competency factors initially for the staff members and gather historical performance information. The competency measurements can be carried out in multiple ways, such as scales, questionnaires, 360-degree evaluation or equipment.
3) According to the confirmed competency factors and availability of data sources, confirm that there are behavioural evidence points supporting each of the factors. Expert opinions, brainstorming, and literature reviews are useful methods for determining supporting relationships.

4) Depending on the company and data volume, multiple MCDM methods can be employed to establish reasoning relationships between behaviour and performance.

5) Based on the managerial needs and characteristics of the data sources, select proper MCDM method(s) to establish reasoning relationships between layers of behavioural evidence points vs. competency factors and competency factors vs. job performance.

6) Estimate the staff members' competency grades through their behavioural data in a real-time or periodic manner, and predict their performance accordingly. Then, apply the results to PM practices such as performance plan formulation, incentives or performance feedback.

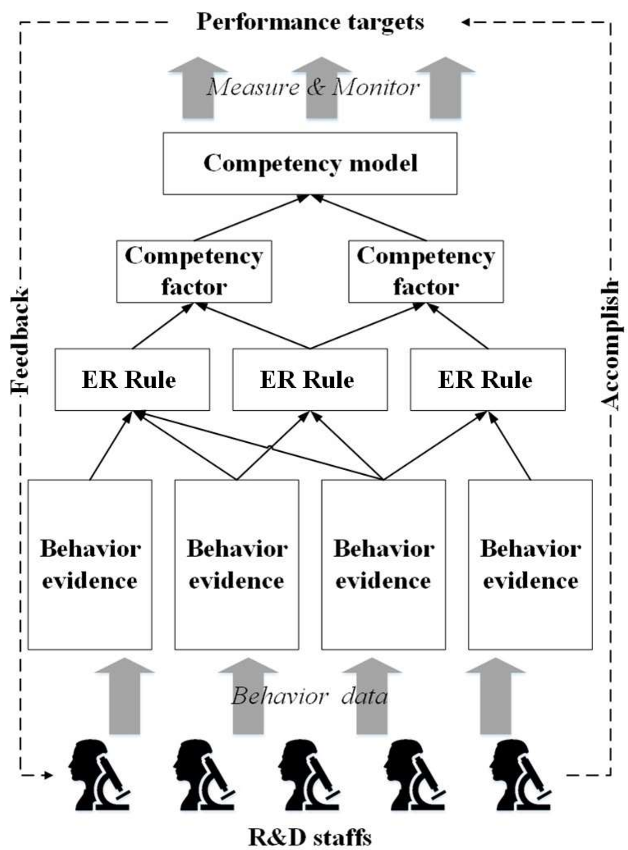


Figure 8-7 Conceptual model of the BPMPS for TS

The overall structure of the system is illustrated in Figure 8-7.

8.5.2 Competency model creation

The competency factors of an individual reflect some deep characteristics of the employee and their potential for use in PM has been increasingly recognized (See Chapter 3).

The most important thing for carrying out CM-based management is selecting an appropriate CM model. In the initial stage of the project, the team helped TS establish a tailored competency model for its R&D department. Various CMs were reviewed and compared in Chapter 3, and it was found that the competencies in the PAKS model match well with the qualities of an R&D employee, although they are by no means easy to measure with traditional management methods. In the case of TS, the company leadership accepts the structure of the PAKS model since they think it is in line with the managerial philosophy of the company.

The team then searched for specific competency factors under each dimension of PAKS. To do that, multiple methods were adopted:

- **Literature review:** the team reviewed most of the accessible materials about competency factors in the PAKS model and further constructed a competency database for the company.
- **Expert opinion:** based on the competency database, the team interviewed twenty-six experts in the managerial and industrial adhesive fields. The background of the experts included a national research institution (Chinese Academy of Sciences), and domestic and overseas universities and industries. The experts filtered and altered the competency factors in the database according to their expertise and experience.
- **Brainstorm**: referencing the competency database developed, the senior engineers and managers of the R&D department further discussed the factors according to the practical situation of the department.

After rounds of discussion, the initial competency factors for the R&D department were confirmed. Furthermore, the team filtered the initial database by considering the following criteria:

- **The availability of behavioural evidence for the factors**: the team contacted the IT and HRM departments of TS to verify the availability of the online behaviour data. The factors lacking data support are listed as backups.
- **The quantity of behavioural evidence attributable to each competency factor**: in order to ensure the accuracy of the ER analysis, each competency factor should be supported by at least three evidence points. The details of possible behavioural evidence points can be found in ***Chapter** 7*.

After another round of discussions with the key stakeholders, the team arrived at the final competency factor list and corresponding behavioural data sources (see Table 9).

Table 8-7 Competency model for the R&D department of TS

Competency dimensions		Competency factors	
1	Personality	*1.1*	Careful or not?
		1.2	Dilatory or not?
		1.3	Pessimism or optimism?
		1.4	Perseverance
		1.5	Conscientiousness
		1.6	Sense of honour
		1.7	Leadership
2	Ability	*2.1*	Logical thinking
		2.2	Communication
		2.3	Memory
		2.4	Associative strength
		2.5	Concentration
		2.6	Research
		2.7	Innovation
3	Knowledge	*3.1*	Professional knowledge
		3.2	Amateur knowledge
		3.3	Educational background
		3.4	Past academic performance
4	Skills	*4.1*	Teamwork
		4.2	Experimentation
		4.3	Product development
		4.4	Information collection

Now, the key issue is how to measure these objectively and over time. According to our conceptual model, we will apply a suitable MCDM to the behavioural evidence points in order to obtain objective and timely assessment of competency factors, and consequently, we will arrive at the employees' performance states.

8.5.3 MCDM method selection

In the present case, TS hopes to apply the analysis results to diagnose and improve its R&D process management. Moreover, the company's existing IT facilities can fully support heavy-duty computing. Therefore, based-on the discussions in Chapter 7, the performance experts suggested TS to adopt the ER rule method in the project through the following steps:

1) Measure the competency factors listed in the competency model through questionnaires and 360-degree assessment. Then, based on the specificity required by the company, set the bins for the measurement results.

2) Pre-process the outliers, inverse data and missing values in the raw data. Then, establish correspondences between competency factors and their supporting data points (behavioural evidence) in the same term as:

$$\mathrm{E}_i = \{\mathrm{e}_1, \mathrm{e}_2, \dots, \mathrm{e}_L\}$$

(E_i: the competency factor I; e_L: the supporting date point L)

3) Calculate of the joint reliability matrix, the details of which can be found in Appendix 1.

4) Following the ER calculation steps introduced in Chapter 4, establish a joint reliability matrix between the performance grade and the behavioural evidence. The table below is an example of this:

Table 8-8 Example of a joint reliability matrix

		Behavioural Evidence Patterns					
		{1,1}	{1,2}	{2,1}	{2,2}	{3,1}	{3,2}
Performance Grades	1	0.15	0.27	0.01	0.08	0.00	0.00
	2	0.15	**0.61**	0.03	0.39	0.00	0.01
	3	0.66	0.08	0.92	0.39	0.08	0.01
	4	0.00	0.03	0.00	0.09	0.05	0.42
	5	0.04	0.01	0.04	0.05	**0.87**	0.55

It can be seen from the above table that there are two pieces of behavioural evidence attributable to the performance grade. Moreover, the behavioural data and performance grade data are divided into three and five bins, respectively, based on managerial needs.

The shadowed cell in the second column shows that the staff member has a 61% probability of obtaining a ***Grade 2*** on performance when he/she scores ***1*** in the ***first behavioural evidence*** and ***2*** in the ***second behavioural evidence*** ({1,2}→2). In terms of the high-performance scenario[3], when a staff member scores ***3*** and ***1*** in the ***first and second behavioural evidence, respectively***, the manager can predict with 87% confidence that the employee will show ***Grade 5*** performance ({3,1}→5, see shadowed cell in the fifth column).

5) Based on the result matrix above, the manager can carry out management actions to maintain high performance and avoid low performance.

8.5.4 Data collection and reprocessing

Considering that some forms of behavioural evidence lack a direct data source for support, further data conversion is needed. In the table below, we show how to convert data to support the "memory" factor as an example:

Table 8-9 Conversion of indirect data to support the "memory (2.3)" factor

	Evidence	Description	Data Source	Way to convert the indirect data
Competency factor of "Memory"	Evidence 1: Time gaps between two searches with the same keywords	Poor memory can be evidenced if an R&D staff member searches the same keywords in a short time span.	Internet browsing records	1. Filter the search records from the total online browsing records 2. Extract keyword strings from the search records 3. Label the synonyms in the keywords string based on the "Xinhua Dictionary" and "Chinese synonyms Dictionary" 4. Calculate the time gap between each browsing record
	Evidence 2: frequency of searches with the same keywords	Poor memory can be evidenced if an R&D staff member searches the same keywords frequently	Internet browsing records	1. Filter the search records from the total online browsing records 2. Extract keyword strings from the search records 3. Count the frequency of records with the same keyword
	Evidence 3: The frequency of searches with keywords having logical connections	Good memory can be evidenced if an R&D staff member search different keywords with logical connections.	Internet browsing records	1. Filter the search records from the total online browsing records 2. Extract keyword strings from the search records 3. Label the keywords with progressive relationships in content and meaning 4. Count the frequency (layers) of the progressive searches

To analyse Chinese strings in the web browsing record, we used a Chinese text segment tool (Che, Li and Liu 2010) to split an entire sentence into several analysable morphemes. Furthermore, to identify the catalogue of a browsing record, a web

[3] For the performance grade, 1=worst and 5=best.

crawler tool was employed to collect keywords on catalogues of highly-visited websites (e.g., news website, adhesive professional website, hobby-related website, shopping website, etc.) to construct a keyword-tag database.

To reduce calculations, principal component analysis (PCA) was firstly applied to reduce the dimensionalities in the initial variables. Then, the principal components generated from the PCA were further analysed to establish relationships with performance.

8.5.5 Implementation and results analysis

In this approach, the tool for reducing dimensionality was applied first to reduce the calculation complexity, and then relationships were established between selected behavioural data and performance grades.

After reviewing data from the HR and IT departments of TS, 71 initial behavioural data sources were identified; these include biographical information, historical performance information and online behaviour information for the R&D staffs. Then, pre-processing was conducted on the initial data set to check for incompleteness and multi-collinearity. Twenty-six variables were removed due to significant missing data and multi-collinearity, and the remaining 45 variables were included in the further dimension reduction analysis.

Table 8-10 KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.824
Bartlett's Test of Sphericity	Approx. Chi-Square	13232.402
	df	990
	Sig.	0.000

The value from the KMO-Bartlett test was 0.824, indicating that the data is suitable for PCA according to the empirical value (Jolliffe 2002) (Figure 8-10). Thirteen principal components have been extracted from the initial variables, which explained the 94.8% changes of the total variance. Based on the introductions in Chapter 4, the first eight principal components were kept since they explained 85% variation already. According to the competency dimension each behavioural data belongs to and the universal feature of the behavioural data in each principal component, we rename the principal components, and form the new complex behavioural data as they are shown in Figure 8-11.

Table 8-11 Newly named principal components

	Name of principal component	Behavioural data included	Variation explained (%)
1	Innovation	● The standard deviation of the time length of the professional contents visiting ● The total number of favorited websites ● Frequency of searching ● The total number of types of favorited websites ● Feedback of line manager ● The range of websites visited ● The frequency of switching between types of webpages	32.6%
2	Responsibility	● The time that non-professional content was visited during work time ● Searching work regulations in the OA system ● The time length of visiting professional contents in the off-work time	14.2%
3	Conscientiousness	● Ratio of received and sent emails each month ● The average number of thread under one email topic ● Longer working time ● Long-time inactive pages	10.3%
4	Leadership	● Percentage of email threads as the initial sender ● Frequency of sending emails to the division mates ● Searching the information about the other colleagues online	8.2%
5	Concentration	● Frequency of switching between professional and non-professional content ● Average time length on visiting webpages ● The time length of focusing on one topic	6.3%
6	Professional knowledge	● Time length of visiting professional contents ● The number of professional websites and forums visited frequently	5.6%
7	Customer communication	● Frequency of visiting customer & competitor websites ● The number of emails send to customers	5.2%
8	Perseverance	● Total frequency of searching ● Total working time	4.1%
		Total	86.5%

Here, we only keep the principal components retained more than one factor for the further analysis (Conway and Huffcutt 2003; Loo 2002), which means 26 (out of 45) behavioural data points are selected. Apart from the behavioural evidences listed in Table 8-11, other types of evidences, such as the biographical data and historical performance related data, are also categorized into each competency dimensions to make sure more than three evidence points are included.

The evidence data was then scattered with the performance grades to observe the numerical trends for determining the number of bins, also the specific managerial needs in TS were taken into account. Finally, in this case, the performance grades and behaviour data were divided into four bins to cover the two-peak trends in the scatter diagrams, in which the 1 represents the lowest performance grade and behaviour frequency and 4 represents the highest.

The ER calculation then was conducted by the steps described in Appendix 1, in which we adopted an equal weight for each of the eight pieces of evidence since the key stakeholders had no experiences to rely to judge the importance of those behavioural evidences and weighted them properly. Moreover, due to all behavioural data was collected automatically through the company's servers, we assumed its reliability is 100%.

Since the final joint reliability matrix contained 262,144 cells, only the typical values are summarized in Table 8-12. The typical values include the low-performance scenarios with the top three probabilities and likewise for the high-performance scenarios.

Table 8-12 The typical values in the final joint reliability matrix

	Behaviour evidence pattern	Probability
Low performance situation (performance score = 1)	11111214	0.829332
	31111214	0.826437
	11131214	0.823566
High performance situation (performance score = 4)	31434433	0.953461
	31424434	0.950780
	31424433	0.949373

Table 8-12 actually reflects the results of a behavioural competency model, which embodies the relationships between the potential performance of an R&D staff and his/her competency factors attributed to the behaviour evidence. For instance, the pattern of behaviour evidence "{1,1,1,1,1,2,1,4}→1(0.829332)" means the R&D staff member:

- Scored 1 in the first piece of behaviour evidence
- Scored 1 in the second piece of behaviour evidence
- Scored 1 in the third piece of behaviour evidence
- Scored 1 in the fourth piece of behaviour evidence
- Scored 1 in the fifth piece of behaviour evidence
- Scored 2 in the sixth piece of behaviour evidence
- Scored 1 in the seventh piece of behaviour evidence
- Scored 4 in the eighth piece of behaviour evidence

Then

- The manager can say with 82.9332% confidence that the staff member will achieve Grade 1 performance (poor performance) at the end of this appraisal cycle.

It can be pointed out from Table 8-12 that the significant differences exist in the third, the fifth, the sixth, and the seventh evidence points between the poor performance R&D staff members and those with high performance. Therefore, the team conducted in-depth interviews to the key stakeholder to explore the impact of each key attribute on the final performance outcome.

Evidence 3: Conscientiousness.

The result shows that the high-performance R&D staff members have significantly higher scores on this item than the low-performance employees. Based on the in-depth interviews, the reasons for this are as follows:

1) High-performance staff members usually have both technical and market information, so they tend to receive more emails than their peers.
2) For the high-performance staff, the average number of threads in each email are significantly lower than for the low-performance employees, which means they can communicate in a short time with prominent themes, clear logic and extraordinary communication skills.

3) The longer working hours reflect the commitment of the staff to the company so it influences a staff member's performance significantly.
4) The most common scene leads to a long-time active webpage is that the staff member leaves his/her office, and go to laboratory. Thus, the score of this evidence can be viewed as a proxy measurement for the time a staff member stays in laboratory to a large extent. Based on the management experience of the R&D managers, the staff members who spend more time on experiments have higher possibility to achieve higher performance.

Evidence 5: Concentration and **Evidence 6: Professional knowledge**

Based on the in-depth interview, these two pieces of evidence are interrelated. Thus, we will analysis them as a combination. The combination of these two pieces of evidence shows that high-performance employees have higher motivation to update their professional knowledge, and they are more concentrated in the working time. Based on the in-depth interviews, the reasons for this are as follows:

1) The continuous renewal of professional knowledge is a crucial factor leading to high performance for R&D staff. Hence, employees who spend more time on renewing their professional knowledge tend to have higher performance. Moreover, the top three forms of online professional content visited by the high-performance employees are peer communication in online professional forums, online inquiry about professional issues, and collection of market/product information.
2) High-performance staff also visit non-professional content during the work time, but the total length of time is shorter. In addition, they always switch back to professional content after visiting the non-professional content.
3) Therefore, the combination of this evidence reflects that high-performance R&D employees have more initiative in terms of collecting professional knowledge through multiple avenues. Furthermore, they do not spend a long time visiting job non-professional online content.

Evidence 7: Customer communication

The result from this evidence indicates that high-performance R&D staff tend to visit customers' and competitors' websites more frequently than the rest of the staff. Based on the in-depth interviews, the reasons for this are as follows:

1) Communication with customers is a key factor determining whether an R&D project will be successful. Therefore, it is very important for R&D staff to collect in-depth information on market trends, customer needs, and competitors' products.
2) It improves success rates significantly if the R&D project members have sufficient knowledge of their market and customers. Accordingly, their performance scores will increase as well.

Next, to verify the accuracy of the analysis, the predicted results were compared with two reserved actual samples (one high-performance and one low-performance samples). The results show that the approach of predicting future performance through past behaviour is practicable, and it also has sufficient accuracy to assist R&D managers to carry out daily management (for details, see Table 8-13 below).

Table 8-13 Comparison of predicted and actual performance grades

Low-performance sample		**High-performance sample**	
Actual performance score	1	Actual performance score	3
Behaviour pattern	11111214	Behaviour pattern	43223342
Predicted performance score		Predicted performance score	
Score	Probability	Score	Probability
1	82.93%	1	0.76%
2	10.45%	2	3.60%
3	1.60%	3	90.90%
4	5.02%	4	4.74%

It can be seen from Table 8-14 that a staff member who actually scored 1 in terms of performance had a behaviour pattern of {1,1,1,1,1,2,1,4}. Looking at the joint probability matrix, the corresponding results for this pattern are:

Table 8-14 Joint probability table of the behaviour pattern {1,1,1,1,1,2,1,4}

Performance score	Probability
1	82.93%
2	10.45%
3	1.60%
4	5.02%

The results indicate that the manager can predict with 82.93% confidence the staff will score a grade 1 on this performance appraisal, which matches with what he actually scored. Similarly, for the high-performance sample, his behaviour pattern ({4,3,2,2,3,3,4,2}) gives the manager 90.90% confidence to believe that the employee would have grade 3 performance on the appraisal, which is what he actually scored.

In terms of the usability, more than half (59.8%) of the behaviour patterns in the matrix had a significant gap (>15%) between the highest probability and the second highest, which means they can lead the managers to a clear decision.

Based on the results from the ER analysis, the managers can carry out managerial actions on the departmental and individual levels. For instance, on the departmental level, managers can monitor the time their subordinates are spending on acquiring market and customer information. Accordingly, the managers can adjust the contents of performance sets to add or delete corresponding KPIs. On the individual level, if the behavioural pattern leading to low performance is identified for a staff member, the line manager can intervene through a performance meeting or mentorship before a negative situation actually occurs.

8.6 Implementation of the PT system

The implementation of the PT-based PMS will be conducted by TS. To improve the efficacy of the PT system in practice, the external performance experts have pointed out several potential difficulties in implementation:

1) The new PT system may result in management culture shock for the R&D department. In the past, the R&D department adopted an egalitarian culture; the gaps in income amongst staff with the same rank are not significant and outstanding work was not rewarded. Under the new R&D PMS, 35% of R&D staff income will be related to their performance, which means that their salaries will vary to a large extent. Therefore, it will be a challenge for the managers to persuade their subordinates to accept the new system. Our suggestion to the managers is to offer more training and guidance to the staff and to ensure they have the resources to improve their performance in a short period of time.

2) Compared to the old R&D PMS, which operated in a fixed way, the new system requires more managerial skills from the managers. For instance, the new BPMPS delivers extra managerial information and it will take time for the R&D managers to utilize and benefit from the information. To solve this problem, the performance experts will conduct several PM trainings for the R&D managers to help them understand the new system. This will include letting them discuss how to use the information gained from the BPMPS. Meanwhile, the experts also suggest that the managers identify the "best performance pattern" in each division and apply the patterns to management.

3) Inadequate hardware, software, and IT support are additional challenges in implementation. In the new system, large-scale PM activities are carried out online (confirmed KPIs and KPs should be unloaded and measured online; the performance plan is also filled out and submitted online), and the performance monitoring and prediction system also requires massive computing capability. Therefore, the performance experts suggest that TS further expand and update its IT facilities. In the future, with updated facilities, the BPMPS can be fed by both online and offline behavioural data, which will further improve the accuracy of the results.

The effects of the new system will take a long time to present. In the initial stage of implementation, much positive feedback was received from the R&D staff and managers. Under the new system, outstanding staff members are fully motivated and the managers have more methods to deliver their managerial ideas. However, the project was delayed unexpectedly, as TS merged with the HB-Fuller Co., the most competitive company in the international adhesive market. The new company has accepted the new R&D strategies provided by the Kent team and will gradually implement most of the PT-based PMS after revising it based on the new regulations.

Chapter 9 Conclusions and Future Research

9.1 Conclusion

This thesis began with a review about overall situation and pressing issues in the current performance management (PM) domain. The two of the main problems identified for the overall PM field is that most existing PM frameworks rely significantly on an organisation's current organisational chart and business process instead of its performance generation procedures. Furthermore, some pressing issues in the PM domain are caused by the general problem to a large extent, which include the applicability of the current PM frameworks in small sized enterprises and complex operating cores.

To deal with aforementioned problem and issues, four basic research questions were set for this research, and in the end of the thesis, it is very necessary to address these basic research questions to ensure they have been echoed throughout and explicitly.

Q1: *what is the typological overview of the current state of PM frameworks?*

Q2: *What PM framework can be developed around performance generation processes and also contains mechanisms to accommodate different approaches for a wide range of organisations seeking to handle the pressing issues discussed above?*

Q3: *What further approaches can be developed within the new framework to effectively handle implementation of PM for at least some Chinese small- and medium-size manufacturers with frequent changing organisational charts, as tested by case studies?*

Q4: *What effective approaches and methods can be developed to enhance performance by introducing innovations in a PM setting within the new PM framework, at least for Chinese small- and medium-size manufacturers and R&D units, as tested by case studies?*

In order to answer these four interrelated question, a comprehensive typological literature review was carried out to analysis the characteristics and features of the existing PM frameworks. Two categories of PM frameworks were identified in this literature research as generic and versatile PM frameworks and special PM frameworks. The generic frameworks guide PM implementation either by their inherent fixed logic steps (e.g., Otley's two procedural frameworks, performance prism model) or best practice model (e.g., EFQM model, MBNQA) in a straightforward way. The special PM frameworks address special organisational or managerial contexts, such as those for public sectors, manufacturing corporations, and high-tech companies, etc.

It is clear that these generic and versatile frameworks only work well for PM in organisations with level of simple or simplified operating cores and clear work flows and managerial relationships, since those frameworks are designed for the common PM scenarios. On the other hand, those special frameworks take utilized some of the particular organisational features, so they may work more efficiently in organisations with complex operating cores. Although, their application scopes are limited to particular types of organisations. Thus, there is a need to develop a PM framework, which can be applied to a wide scope of organisations with various complexities of operating cores.

Furthermore, five basic elements of PM were identified from the existing framework as the foundation of PM generation and management. Based on the elements, a new PM framework as the performance tree (PT) framework was introduced in Chapter 5 to echo to the second research question. In contrast to the existing PM frameworks that highly rely on organisational chart and managerial and operational procedures to implement, the PT framework focuses more on the performance and performance generation per se. In the PT framework, a series of new concepts in accordance with the nature of PM process are adopted to describe the PM process. For instance, the basic PM unit under the PT framework is not a job position but a performance node, which can be a set of job positions generate similar performance. Moreover, the way an organisation generates its performance is an important parameter in developing a PMS for the organisation, in which performance optimization, organisational reengineering, and PMS building up are considered and implemented holistically. Another advantage of the PT framework is that tailored PM approaches are derivable for organisations with specified PM issues and needs.

In addition, to answer research question three and four, two approaches of PT frameworks were developed in the thesis for the sake of solving two of the most pressing PM issues: PM in SMEs and R&D unit.

In the first approach for SMEs, the PMS is built up on the performance generation procedures for improving its adaptability to fast-changing internal and external environment. Meanwhile, the SSM is adopted as a convenient way to bring organisational innovation perspective into SMEs. In the second approach for R&D unit, the PMS is developed under the guiding of both R&D management and PM theories since the operational and managerial flows are always twisted in complex operating cores. Moreover, a competency-based performance measurement way is attached to the approach to measure and monitor R&D staff's performance status effectively, which was also a dilemma in the R&D PM domain on the instrumental level. Additionally, both approaches were applied in the case studies to show their implemental details and effectiveness in the real Chinese enterprises.

9.2 Research Limitations

Complementary to the characteristics and challenges discussed before, this research comes with some shortcomings and limitations.

Firstly, we only developed the implementation approaches of PT against two pressing PM issues in this research. However, a number of the other general challenges and problems are still waiting to be solved in the current PM domain. (e.g., How to establish HPWS in SMEs? How to evaluate the impact of performance results? etc.). Therefore, extra efforts are needed to further enrich the usability of PT framework in operating cores with levels of complexity and confronting types of PM issues.

Secondly, by considering the availability and accessibility of data, two Chinese enterprises were selected to carry out the case studies of this research. Nevertheless, the framework and its approaches' feasibility can be further examined in western companies, which is a key work in our future research agenda.

Thirdly, the online behaviour data-based performance monitoring and prediction system (BPMPS) can be further developed by getting more types of behaviour data involved (e.g., geographical data, physical data). Meanwhile, it is worthy to study how the evaluatee's behaviour patterns are influenced and transformed by the evaluation system in the future research, which can help managers (especially the line managers of operating core with high complexity) better improve and develop their staff through the BPMPS.

9.3 Future research

Some potential directions and topics for the future research were implied in the previous part of this research, yet some promising areas worth further emphasizing here to draw more attention.

Firstly, the "performance generation procedure" is an innovative PM perspective raised in the PT framework, which is promising in solving some pressing PM issues caused by traditional performance angles. Therefore, more conceptual and practical elements can be added into the PT framework to further clarify how to understand and implement PM under the perspective.

Secondly, more specific implemental approaches can be derived from original PT framework to help organisations to carry out PM according to their various characteristics and needs. In this thesis, two approaches were developed for SMEs and R&D units, which are two of the most pressing PM issues in the domain. Nevertheless, some the other issues also call for more attention, such as PM for public sectors (Radnor and McGuire 2004; Fleisher and Mahaffy 1997; Christensen, Lægreid and Stigen 2006), virtual organisations (Sparrow and Daniels 1999; Cascio 2000), complex supply chain (Hervani, Helms and Sarkis 2005; Lambert, Cooper and Pagh 1998), and so on.

Thirdly, a behavioural evidence-based R&D performance measurement and monitoring system was reported in this research as a PM tool. However, the potential of this performance measurement approach is not limited in the R&D units, most organisations holding ambiguous or highly complex operating flow can benefit from this approach. Therefore, in the future research, this general performance measurement tool can be customized for various organisations that have obstacles in measuring performance via traditional ways.

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Appendix 1: The Calculation Steps to Combine Multiple Pieces of Evidence

Step 1: Gathering the base value and the scores of L behavioural evidence points through multiple ways, which can be equipment measuring or questionnaire. In the case of this thesis, the base value is the monthly performance grade of each R&D staff member, and we have eight behavioural evidence points (L=8).

Step 2: Setting N Bins for the base value and $\mathrm{K}_j (j = 1, \dots, L)$ Bins for the scores of L behavioural evidence points depending on their numeric features and the users' managerial needs. In our case, N=$\mathrm{K}_1 = \mathrm{K}_2 = \cdots = \mathrm{K}_8 = 4$.

Step 3: Confirming the weights for L pieces of behavioural evidence.

$$\mathrm{W} = \{\mathrm{w}_1, \mathrm{w}_2, \dots, \mathrm{w}_L\},\ \sum_{j=1}^{L} \mathrm{w}_j = 1 \qquad \textbf{\textit{(1)}}$$

Step 4: Confirming the reliability for L pieces of behavioural evidence.

$$R = \{\mathrm{R}_1, \mathrm{R}_2, \dots, \mathrm{R}_L\}, 0 \leq \mathrm{R}_j \leq 1 \qquad \textbf{\textit{(2)}}$$

Step 5: Calculating the basic probability mass by combining the weights and the reliabilities using the following equation:

$$\theta_j = (1 - R_j)/(1 + w_j - R_j) \qquad \textbf{\textit{(3)}}$$

($\theta_j =$ basic probability mass for evidence e_j)

Step 6: Constructing the L frequency matrixes between the base value and each of the L behavioural evidence points. The $N_{ik_j}^{j}$ $(i = 1, \dots, N; j = 1, \dots, L; k_j = 1, \dots, K_j)$ is the element in row i, column k_j of matrix j.

Step 7: Building the likelihood matrix for each piece of evidence by using the following equation 4.

$$C_{ik_j}^j = N_{ik_j}^j / \sum_{k_j=1}^{K_j} N_{ik_j}^j \; (i = 1, \dots, N; j = 1, \dots, L; k_j = 1, \dots, K_j) \qquad \textbf{\textit{(4)}}$$

Step 8: Constructing the belief degree matrix for each piece of evidence by using the following equation 5.

$$P_{ik_j}^j = C_{ik_j}^j / \sum_{i=1}^{N} C_{ik_j}^j \; (i = 1, \dots, N; j = 1, \dots, L; k_j = 1, \dots, K_j) \qquad \textbf{\textit{(5)}}$$

Then, to calculate the degrees of individual support matrix by using equation 6.

$$M_{ik_j}^j = w_j * P_{ik_j}^j (i = 1, \dots, N; j = 1, \dots, L; k_j = 1, \dots, K_j) \qquad \textbf{\textit{(6)}}$$

Step 9: Combining *j* pieces of evidence to form compounded support matrix by using equation 7.

$$M_{i,(k_1-1)K_2+k_2}^{1\oplus 2} = (\theta_2 M_{ik_1}^1 + \theta_1 M_{ik_2}^2) + M_{ik_1}^1 M_{ik_2}^2, \;\; \theta_{1\oplus 2} = \theta_1 * \theta_2 \qquad \textbf{\textit{(7)}}$$

Let $M_{i,(k_1-1)K_2+k_2}^2 = M_{i,(k_1-1)K_2+k_2}^{1\oplus 2}, \;\; \theta_2 = \theta_{1\oplus 2}$

$$(k_1 = 1, \dots, K_1; k_2 = 1, \dots, K_2; i = 1, \dots, N)$$

$$M_{i,(k_2-1)K_3+k_3}^{2\oplus 3} = (\theta_3 M_{ik_2}^2 + \theta_2 M_{ik_3}^3) + M_{ik_2}^2 M_{ik_3}^3, \;\; \theta_{2\oplus 3} = \theta_2 * \theta_3 \qquad \textbf{\textit{(8)}}$$

Let $M_{i,(k_2-1)K_3+k_3}^3 = M_{i,(k_2-1)K_3+k_3}^{2\oplus 3}, \;\; \theta_3 = \theta_{2\oplus 3}$

$$(k_2 = 1, \dots, K_1 K_2; k_3 = 1, \dots, K_3; i = 1, \dots, N)$$

Iterate above steps until the last piece of evidence

$$P_{i,(k_{L-1}-1)K_L+k_L}^{(L-1)\oplus L} = M_{i,(k_{L-1}-1)K_L+k_L}^{(L-1)\oplus L} / \sum_{i=1}^{N} M_{i,(k_{L-1}-1)K_L+k_L}^{(L-1)\oplus L} \qquad \textbf{\textit{(9)}}$$

$$(k_{L-1} = 1,2 \dots \dots (K_1 K_2 \dots K_{L-1}); \;\; k_L = 1,2 \dots \dots K_L)$$

Appendix 2: A Contributions to Knowledge

Academic Papers

1. (Final Revision) Y.Zheng, W.Wang, W.B.Liu, J.Mingers. (2016). A Performance Management Framework for the Public Sector:The Balanced Stakeholder Model. *Journal of the Operational Research Society* (Submit at 03/2016).
2. (In Revision) Y.Zheng, P.Phillips, W.B.Liu. (2015). Developing a dynamic strategic performance measurement system through a performance tree approach: evidence from China. *Journal of Business Research* (Submit at 12/2015).

Conference Paper

1. Y.Zheng, W.F.Shen, W.B.Liu. Performance Tree: A Performance Process-Oriented Management Framework. *Business Process Modeling, Development and Support Conference (BPMDS)*, Ljubljana: Slovenia, 2016

A Performance Management Framework for the Public Sector: The Balanced Stakeholder Model

Yi Zheng, Wei Wang, Wenbin Liu, John Mingers

1. *Performance Management in the Public Sector*

Performance management (PM) is a term borrowed from the management literature which has only recently been adopted in the public management field. The term 'performance management' was first used in the 1970s, but it did not become a recognized process until the latter half of the 1980s (Armstrong & Baron, 1998). Performance management has been extended to every aspect of business and management. A large number of researchers and practitioners from different fields are engaged to the exploration and study of performance management, for instance: stakeholder theory (Berman, Wicks, Kotha, & Jones, 1999; Choi & Wang, 2009; Clarkson, 1995; Freeman, 2010; McAdam, Hazlett, & Casey, 2005; Ogunlana, 2010), strategic management (Atkinson, Waterhouse, & Wells, 1997; Freeman, 2010; Grigoroudis, Orfanoudaki, & Zopounidis, 2012; Kald & Nilsson, 2000; Kaplan & Norton, 2001a), human resource management (Farndale, Hope-Hailey, & Kelliher, 2011; Guest, 2011; Huselid, Jackson, & Schuler, 1997; Singh, Darwish, Costa, & Anderson, 2012; Van De Voorde, Paauwe, & Van Veldhoven, 2012) and operational research(Boland & Fowler, 2000; Crawford, Costello, Pollack, & Bentley, 2003; W. B. Liu, Meng, Mingers, Tang, & Wang, 2012; Wang, Liu, & Mingers, 2015; White, 2000).

1.1 Early development and successes of performance management in the private enterprise

Performance management has developed from a 'results oriented' approach to a 'process oriented' approach and then to the integration of the two in support of the organization's strategy. Early studies on performance management developed out of a concern for the measurement of performance. Initially within performance management, maximizing profits was the primary target for enterprises and, before the 1970s, financial factors were almost the only criteria for performance evaluation. Later, people paid more attention to other perspectives such as: customer satisfaction, organization strategies, extent of innovation, and so on. After the 1970s, some of these factors were incorporated in systems of performance evaluation in private companies and they aimed to reflect the operational efficiency and effectiveness, and developing trends of the enterprises. The balanced scorecard (BSC) was first introduced by Kaplan and Norton as a multi-dimensional performance measurement tool (RW.ERROR - Unable to find reference:80), but its focus soon shifted to performance management (Kaplan & Norton, 2001a; Kaplan & Norton, 2001b). The original design and initial practices of BSC focused on private enterprises. It linked the organizational strategy and vision to the four performance perspectives: financial, customer, internal process and learning and growth. From more than 20 years of development, the BSC has gained widespread acceptance as one of the most successful performance management tool for enterprises (Kald & Nilsson, 2000; W. B. Liu et al., 2012; Malmi, 2001; F. Mitchell, Nørreklit, Seal, & Ye, 2014) 。

1.2 Performance management in the public sector

Much later than the private sector, performance management was gradually introduced into the public sector although it was not applied and developed as successfully as in the for-profit sector. The initial practices of PM in the public sector were centered on the assessment of value for money and other resource usage. This was normally conducted by external auditors or government authorities (Boland & Fowler, 2000). However, public sector organizations are often professional organizations providing public services. These public services are multiple and are rendered in co-production. A single output or efficiency oriented performance measurement system will inappropriately reduce the complexity of public management into a single dimension (De Bruijn, 2007) . As emphasized by Moore (1995) , in the public sector the goal might be creating the social (public) value because the majority of public sector organizations still gain most of their income from the State and they have to create value for citizens, taxpayers and other stakeholders. Later researchers (Brookes & Grint, 2010; Kelly, Mulgan, & Muers, 2002) further demonstrated that all public leaders need to engage in understanding, creating and demonstrating public value. As Brookes (2010) stated

“it requires the identification of social (public) goals, and delivering those goals in a way that secures trust and legitimacy and ensuring that the public sector organization has the capability and the capacity to deliver these stated goals” (p. 15)

More recently, it has been accepted that PM in the public sector emphasizes the consideration of wide-ranging stakeholder groups who may directly or indirectly affect or be affected by the actions of the organization (Alford, 2002; Larsen, 2008; M. H. Moore, 1995; O'Flynn, 2007; Sanger, 2008; Yang & Holzer, 2006). As Morgan et al (2013) claimed, public PM should move from NPM (new public management) to NPG (new public governance)**.** They argued that NPG is value centered. The goal of the public sector is to promote the larger common good not just improved efficiency, effectiveness, or responsiveness in the implementation of a given program (Alford, 2002; M. H. Moore, 1995; M. Moore, 1994; Stoker, 2006). And NPG emphasized the importance of creating government processes that facilitate the generation of implementable agreements among wide-ranging stakeholders who may disagree on what course of actions will produce the maximum public value (Larsen, 2008; Sanger, 2008; Yang & Holzer, 2006).

More recently, stakeholder theory has been emphasized and the stakeholders and communication have been deemed as two key factors of PM in the public sector (Choi & Wang, 2009; Clarkson, 1995; Freeman, 2010). Public organizations are complex systems that include many different groups within them, and affect many different groups and elements of their environment. As defined by Freeman (1984) a stakeholder is: ‘…any group or individual, who can affect or is affected by the achievement of organization’s objectives (p.46).’ Some of these stakeholders are important for the successful operation of the organization; some are important because of the effects that the organization has on them. In both cases the organization needs to be aware of these stakeholders and manage them successfully, the former for reasons of effectiveness, the latter for reasons of legitimacy and ethicality (Wang et al., 2015).

In spite of the wide concerns on ‘stakeholders’ or ‘balance’ in performance management, public sector organizations have turned to borrow enterprise performance management practices and successful tools for improving and demonstrating their own performance and accountability such as BSC ((Hood, 1995; Kollberg & Elg, 2011; Niven, 2011). However, there is a lack of studies to examine the issues and challenges that exist in public PM implementation (Northcott & Ma'amora Taulapapa, 2012). Most existing PM frameworks do not offer practical procedures to guide us in how to identify and balance the key interests of the stakeholders which is the ultimate driving force of performance management in the public sector (Shapira & Kuhlmann, 2003). Therefore, we argue that one of the key factors in the effective implementation of PM in the public sector is the need to balance the motivations and interests among various stakeholder groups at all levels of the system, rather than simply to concentrate on a mechanistic process of decomposing objectives, monitoring, and collecting feedback. Thus, how to develop a framework or methodology to help public management to identify and manage the various (often conflicting) stakeholder (or interests) groups is still a huge challenge in the public PM field. In light of this, we will review some of widely used multidimensional models or frameworks in public performance measurement/management including the model of the European Foundation for Quality Management (EFQM), the Balanced Scorecard (BSC) (Kaplan & Norton, 1996; Kapłan & Norton, 1992), the Public Scorecard (Moullin, 2002), and the Performance Prism (Neely, Adams, & Kennerley, 2002).

2. Existing Performance Management Frameworks

The existing methods can be classified into three types.

Type 1 methods: List all the key elements related to performance management.

Otley (1999) proposed a performance management system (PMS) to analyze the operation of management control systems structured around five central issues. These five issues relate to objectives; strategies and plans for their attainment; target-setting; incentive and reward structures; and information feedback loops. He proposed five questions related to those issues:

1) What are the key objectives that are central to the organization's overall future success, and how does it go about evaluating its achievement for each of these objectives?
2) What strategies and plans have the organization adopted and what are the processes and activities that it has decided will be required for it to successfully implement these? How does it assess and measure the performance of these activities?
3) What level of performance does the organization need to achieve in each of the areas defined in the above two questions and how does it go about setting appropriate performance targets for them?
4) What rewards will managers (and other employees) gain by achieving these performance targets (or, conversely, what penalties will they suffer by failing to achieve them)?
5) What are the information flows (feedback and feed-forward loops) that are necessary to enable the organization to learn from its experience) and to adapt its current behavior in the light of that experience?

Ehreth (1988) extended Otley's (1999) PMSs framework for both for-profit organizations and not-for-profit organizations. The extended framework is called 'performance management systems framework' and extended Otley's five 'what' questions to ten 'what' and two 'how' questions.
Smith and Goddard (2002) examined performance management from an operational research perspective and constructed a framework to examine the performance management process. They argued that performance management should contain four broad blocks:
1) Formulation of strategy;
2) Performance measurement instruments;
3) Analytic techniques;
4) Encouraging appropriate organizational responses.
Smith and Goddard (2002) claimed that the success of a performance management system will depend on how well these four indispensable elements of the performance management process are welded into a coherent whole.

Type 2 methods: Standardized models from the total quality management perspective (EFQM)

Nabitz, Klazinga, and Walburg (2000) reviewed the practices of TQM in European health care and they claimed that one way to meet the challenges in creating a high performance organization in health care is the approach of the European Foundation for Quality Management (EFQM). The European Foundation for Quality Management (EFQM) was created by 14 presidents of European companies in 1988. The EFQM Excellence model is a non-prescriptive framework with 9 main criteria and 32 sub terms for organizational self-assessment and also for benchmarking to compare with others. It is one of the most widely used total quality management (TQM) framework in the Europe and it is the most influential Quality Awards in the world. It has been revised in 1999, but the principals still remain the same.

Type 3 methods: Logic models for performance management

The balanced scorecard

During recent years, increasingly public organizations have adopted the balanced scorecard (BSC) framework for their performance measurement or management system (Grigoroudis et al., 2012; Kollberg & Elg, 2011; Niven, 2011; Northcott & Ma'amora Taulapapa, 2012; Santiago, 1999; Sharma & Gadenne, 2011). The BSC was first introduced by Kaplan and Norton(RW.ERROR - Unable to find reference:80; Kaplan & Norton, 1996). The original design and initial practices of BSC focused on private sectors. BSC linked the organizational strategy and vision to the four performance perspectives: financial, customer, internal process and learning and growth.

Kaplan (2008) emphasized that, since financial success is not the primary objective for nonprofit and public sector enterprises (NPSEs), they cannot use the standard architecture of the balanced scorecard and strategy map wherein financial objectives are the ultimate. NPSEs generally place highly an objective related to their social impact and mission. Some practitioners have elevated the organization’s strategy or mission or customer perspective to the top of the hierarchy of perspectives of BSC. As Kaplan and Norton (, 2001b) noted, the public sector should be accountable for how well they meet a need in society rather than how well they raise funds or control expenses.

The public sector scorecard

The public sector scorecard (PSSC) was originally developed in 2002 (Moullin, 2002) and it is an integrated quality management and performance measurement framework for the public and voluntary sectors developed from the balanced scorecard. It is designed to help the public organizations to find ways to deliver improved outcomes for service users. The fundamental construction logic and structure of the PSSC are very similar to the BSC. The Public Sector Scorecard focused on outcomes, the processes that deliver those outcomes, and the organization's capability to support its people and processes in achieving the relevant outcomes efficiently.

Soft Systems Methodology (SSM)

SSM is a systems-based general purpose problem solving methodology developed by Checkland (1972). As Checkland (2010) explained in his book: 'it (SMM) is an action-oriented process of inquiry into problematic situations in which users learn their way from finding out about the situation, to taking action to improve it (p.191).'

He explains the complexity of problematical situations in real life contain multiple interacting perceptions of 'reality'. This comes about because different people have different taken-as-given (and often unexamined) assumptions about the world. Thus, in order to improve the performance of the social system (e.g. public sectors), the fundamental idea of the SSM is to identify or understand the key interests of stakeholders in the situation before taking actions. It develops notional or conceptual models of purposeful human activity based upon "root definitions" that describe succinctly what a system is, and "activity models" that describe what it must do. The root definitions generally specify the Customer, the Actors, the Transformation, the Weltanschauung, the Owners (and stakeholders) and the Environment which is generally not within the system's control (CATWOE).

When applied in performance management, firstly primary task activity models are developed that specify the outputs or services to be produced (What), the manner in which they are produced (How); and the reason for their production (Why). These models start at the top level and are decomposed downwards to whatever level of detail is required. They can be used to develop key measures of performance in terms of three criteria (the 3E's model) (W. Liu, Cheng, Mingers, Qi, & Meng, 2010): efficacy (E1), efficiency (E2) and effectiveness (E3). They can also be used to identify key stakeholders at a variety of levels within the organization. The application area for SSM is very broad. It has been applied to all sizes of company from small firms to large corporations, from organizations in both private and public sectors including the National Health Service (P. Checkland & Poulter, 2010). Many researchers have applied it in the public sector and government projects and showed positive results on their performances (Crawford et al., 2003; W. Liu et al., 2010; W. B. Liu et al., 2012; White, 2000). And some researchers provided the evidence of a wide range of successful applications of SSM as a methodology used both by itself and in combination with other approaches (P. Checkland, 2000; Mingers, 2000).

2.1 Evaluation of PM frameworks

From the literature review, there are three kinds of performance management methods that can be applied to PM in the public sectors and which have their own advantages and disadvantages. The first type of methods summarizes and refines the performance management activities and index system based on practical work experience. The indicator systems developed by this kind of methods do not often have good internal logics among different dimensions. Moreover, the KPIs and organizational strategies are often disconnected, and the KPIs are often hardly applicable to other public sectors. The second method is to develop standardized models from the total quality management perspective, represented by EFQM, which advocates a standardized model applicable to all organizations. They are often used as a PM diagnostic tool, but are not suitable for our purposes to develop a new PM framework. Moreover, the EFQM's logic is that the management work and performance could be improved by comparison with benchmarks. However, every public sector has its unique strategic choice, participants, stakeholders and external environment. From the diagnostic results by using EFQM, it is often difficult to know how to improve the performance in a particular organization.

The third approach is represented by the BSC, PSSC and SSM. It has been widely used in private sector enterprises with some success. However, the inherent priority for the finance performance in the four dimensions of balanced scorecard made it unsuitable for public sector organizations, thus it needs to adjust the original four dimensions when it is applied to the public sectors. Even if a set of the most optimized key indicators and management measures are obtainable by using the adjusted balanced scorecard, it is still often difficult to work effectively in public sectors. Moreover, none of these existing PM frameworks offered the practical procedures to guide us in how to identify and balance the key interests of the stakeholders, which is the ultimate driving force of performance management for public sector (Shapira & Kuhlmann, 2003). Thus, those activities decomposed by the BSC or SSM may not be necessarily balanced with the key interests of the 'involved stakeholders' in the organization, and therefore are often hard, if not impossible, to implement (Wang et al., 2015). One of the main purposes of this study was to design a generic performance management model or methodology (referred to as the Balanced Stakeholder Model - BSM) to fuse those separated key tasks of public PM (strategy decomposition, stakeholder identification and balancing interests) into a cohesive whole.

3. A New Performance Management Framework: the Balanced Stakeholder Model (BSM)

As we discussed above, there is no existing PM framework that offers practical procedures to guide us on how to identify stakeholders and balance their key interests, which is the ultimate driving force of performance management for the public sector (Shapira & Kuhlmann, 2003). Thus, we introduce the Balanced Stakeholder Model (BSM). From the systems thinking perspective, BSM is designed as a stakeholder-oriented performance management framework especially applied in performance management in the public sector. It aims to answer two fundamental questions: 1) How to translate the complexity of public goals and contexts into a series of manageable key activity and stakeholder systems. 2) How to help public sector managers to decide which combination of factors (activities, stakeholders and balanced interests) is more likely to lead to success.

Therefore, the main tasks of the BSM are to decompose the strategic goals of the organization into the necessary activities at a variety of levels, identify internal and external stakeholders, and balance their key interests. SSM is the fundamental method for strategy decomposition and this forms a core part of our stakeholder identification and analysis method (Wang et al., 2015). In order to balance interests, the BSM will identify the key interests, more importantly, the key conflicting interests among the stakeholders, then try to balance them by making a balancing strategy or plan, and then to amend the overall objectives and strategies of the organization. Thus, BSM takes the key interests of stakeholders as a part of the organizational goals (objectives) for further decomposition in order to keep discussing 1) does this objective represent the common interests of us all? 2) Do the objective and relative activities damage the key interests of particular stakeholder group or individual? 3) If there is a conflict, how to make a suitable balancing strategy by amending the objective or action plans? Thus our objective set consists not only of strategies and financial targets but also key interests of employees, customers and other stakeholders, even outside the organization.

However, BSM by itself cannot directly uncover the key interests or conflicts of stakeholders. Those interests are normally identified through different kinds of formal or informal communication with stakeholders such as questionnaires, interviews, formal or informal meetings and so on. Although the BSM emphasizes the importance of identifying and attempting to balance the stakeholders' interests throughout the whole process of decomposition, in reality it may be difficult to achieve these. We will discuss this in more detail in later sections.

3.1 Introduction to the stakeholder identification and analysis method

We proposed a systemic methodology for identifying and analyzing the stakeholders of an organization at many different levels. The methodology is based on soft systems methodology and is applicable to all types of organization, both for profit and non-profit (Wang et al., 2015).

Based on CATWOE from SSM and the idea of the “involved” and the “affected” from critical systems heuristics (CSH) (Reynolds & Holwell, 2010), we have developed a framework of different categories of potential stakeholders (Table 1).

The Involved				**The Affected**	
Owners who can create, change or destroy the system and who supply the Weltanschauung	**Customers** who are the direct recipients of the output of the system. They may be seen as beneficiaries or victims	**Actors** who perform the activities of the system	**Partners** groups who are directly necessary for the system, e.g., suppliers of resources	External groups indirectly affected by the systems activities	External groups who indirectly affect the systems activities

Table 1: Categories of stakeholders derived from CATWOE and CSH

The stages of this method can be summarized into the following five steps:

1. Determine the overall objectives of the organization (or part of it).
2. Search for “initial stakeholders”.
3. Build root definitions (RDs) and conceptual models (CMs) – in practice, one often

repeatedly ask questions “what to do”, “why to do”, “how to do” to build RD and CM.

4. Continuously decompose the activities into lower levels, e.g., by asking what to do and how to do.
5. A complete set of stakeholders can then be produced from the key activity models bottom to top and level by level. Through the process of inducing and summarizing the stakeholders, the set could clearly represent the functions of the stakeholders at each level of key activities in the process of achieving the organizational strategic goal.

3.2 Four perspectives of BSM

One of the most distinctive features of BSM is, when combined using with our Stakeholder Identification and Analysis method (Wang et al., 2015), that it helps us to keep alignment with the actual organizational strategic goals and management hierarchy structure during the whole decomposition and analysis processes. And the findings (key activity and stakeholder systems) can be better presented to the managers so that they can more directly understand and perceive them and to help them to make decisions. Furthermore, it is able to allow managers to allocate the jobs and stakeholders into related key operational and supportive departments, as well as to set performance indicators and rewards system. Generally speaking, BSM smoothly fused our system-based stakeholder identification and analysis method into the public PM framework and made it more practical to public managers (they can easily understand and adopt it without OR expertise).

The BSM consists of four logically linked perspectives. The first perspective of the BSM is the ‘goal’, where goal normally refers to the system’s objectives. The rationale is that the BSM is a performance management framework especially designed to be applied in the public sector from a stakeholder and systems perspectives. If we view the public sector as a system, the performance or output of the system will be significantly decided by its own system goals and affected by its wider systems. Therefore, for this purpose, the BSM also starts by analyzing the primary goals.

The BSM considers the stakeholder as the second perspective, differing from other existing frameworks. We consider a much wider and deeper range of stakeholders including both internal key participants (involved groups) and the external groups (affected groups) (Wang et al., 2015) through the different levels of organizational hierarchy. We used 'stakeholder' as one of our key perspectives instead of 'customers' in BSC or 'service users' in PSSC. According to the literature of stakeholder theories, one of the key points is considering the wider stakeholders in effective management (Friedman & Miles, 2002; Goodpaster, 1991; Wood & Jones, 1995). Some researchers have emphasized the balancing of interests and the salience for management (Clarkson, 1995; R. K. Mitchell, Agle, & Wood, 1997). Moreover, Shapira (2003) summarizes three categories of PM studies and concludes that the ultimate driving force behind modern performance management for the public sector is to balance the interests of the key stakeholders according to their actual contributions. Therefore, balancing the contributions and demands of the stakeholders and hence determining the extent to which implicit claims are fulfilled is the core of this balanced stakeholder model.

The goals and interests of the key stakeholders are to be fulfilled by the next two perspectives: Operation and Capability, which are similar to the most widely used existing PM decomposition tools (such as BSC, PSSC), discussed in the above sections. According to the purposes of the BSM, it aims to decompose the strategies then select the combination of the key activities and stakeholders and match them into the current management hierarchy. It is necessary to emphasize that the entire decomposition processes should involve the people (stakeholders) in the situation. Agreement or at least accommodation should be generated to ensure that the interests of different stakeholder groups have been considered and balanced.

Furthermore, in order to ensure that organizations operate more efficiently and effectively, they need to obtain necessary resources. These resources include physical resources such as funds and facilities, and non-physical resources like staff, learning and growth, knowledge and external partnership -this is what we call '*capability perspective*'.

To sum up, the organizational strategy is the core of the BSM, and it is surrounded by the following four perspectives: goal, stakeholder, operation and capability (see Figure 1 below).

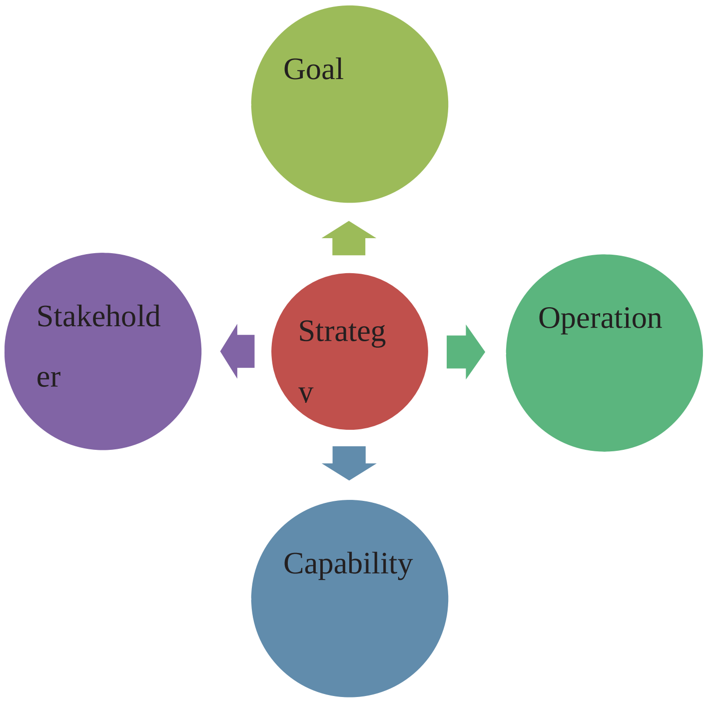

Figure 1 The Four Perspectives

Unlike the other existing models that often only apply to the top level of an organization, the BSM is applicable to any level of an organization from overall strategic level to departmental or even individual day to day operational level. Compared to the BSC for example, clearly, the BSC takes finance as its top goal. Therefore it is more suitable for for-profit companies. And the BSC only addresses two key stakeholders: the company (owner or shareholders) and its customers, which are extremely important in private companies. However, the literature review of stakeholder theory suggests that there is a much wider range of stakeholder groups that the organization should consider. Therefore, we believe that the BSM is more suitable for the public sector in this regard.

3.3 Five steps to use the balanced stakeholder model

Step 1 Understand the key system goals.

Normally, we analyze the system goals from the top level of the organization, which means we need to consider both the organizational and the wider (upper level of) system goals. However, we can also start from any level of organization. For instance, we can start from analyzing the departmental objectives (as a system goal) and then align them with the organization's overall strategies (as wider system goals). When we analyze the system goal, it is not only to think about the objectives (what to do?), upper system goals (why to do it), but also the critical paths to achieve the objectives (how to do it)). This is also known as the root definition (RD) in SSM.

Step2 Identify and analyze stakeholders

Using the CATWOE analysis in SSM can help us to identify some of the stakeholders such as owners, actors, customers. However, as we discussed before, performance management in the public sector trends to consider a much wider range of stakeholder groups. To this end, we can use the method of stakeholder identification and analysis in Wang et al., (2015). The goal and the stakeholders are mutually supportive to each other. On the one hand, the goal has to be decided and carried out by stakeholders (both involved and affected by the action of the organization in order to achieve those goals.). On the other hand, to represent the collective interests of stakeholders the organization has to put their key interests into its overall strategic objectives for further decomposition and effective implementation.

Step 3 Balancing stakeholder interests

This is a core step of our method. As we discussed in the beginning, it is very important to try to balance the key interests of different stakeholder groups in order to minimize the resistances and to implement the PM more efficiently and effectively. First of all, it is not possible and necessary to identify all the interests of stakeholders. Our priority is to identify and balance the key interests among stakeholders in support of the system goals. This normally can be done through the stakeholder meeting by discussing following key questions: 1) Does this objective represent the common interests of us all? 2) Do the objective and relative activities damage the key interests of particular stakeholder group or individual? 3) If there is a confliction, how should we make a suitable balancing strategies by amending the objective or RD?

Step 4, Decompose the objectives

After we reach an agreement about our objectives among the stakeholders, then we can start to decompose the objectives into more detailed key-activity systems, (i.e., steps 3-4 in Section 3.1, similar to conceptual models in SSM. However, ther differ from CMs in that our BSM models have four logical perspectives. Our model shows not only the key actions but also objectives, stakeholders and the causal links among those key activities. The BSM models are more like strategic maps, and are more suitable for a performance management tool. Again, at each level of the decomposition, we will try to involve as many stakeholder groups as possible to discuss and debate the course of activities the organization will choose. This process is vital to minimize the risk of occurring resistances and conflictions during the implementation stage. And it gives us a second chance to rethink the key activity systems from both the systematic feasible and local desirable point view.

In the stakeholder literature, there are several methods or theories that try to identify, analyze or balance the interests of stakeholders. For example, the risk-based model of stakeholders proposed by Clarkson (1995) distinguished ‘voluntary stakeholders’ and ‘involuntary stakeholders’. The “power-interest grid” method proposed by Eden and Ackermann (1998) which is a means of mapping potential stakeholders on a two-dimensional grid. Or, Mitchell’s (1997) model which discussed how to give different degrees of salience or priority to the different stakeholder groups from a macro level perspective. In comparison with the methods mentioned in the literature, our approach, by utilizing the SSM, is able to carry out in-depth analysis through the whole processes of strategy intervention, decomposition and deployment at different levels, related to organizational strategies and the key supporting activities (Liu et al., 2012). We explicitly link stakeholder identification, analysis and the interest balance with strategy and top management by starting to identify stakeholders from the top level of an organization according to its objectives and strategies. Also our approach can conveniently disaggregate the identified stakeholders according to the management hierarchy of the organization for management (Wang et al., 2015).

Step5 Allocate the key activities into the 'operation' and 'capability' perspectives

After initial decomposition, we can then allocate the decomposed key activities (key tasks) into operational units (departments or teams) and the capability perspective (both internal staff learning and growth and external partnership and supports). Through the locating and mapping process, it gives us a second chance to rethink the key activities systems from both the systematic feasible and local desirable point view. The operational processes (key activities) are supported by key activities in the 'capability' perspective. After decomposition and allocation, the inter-relations and logic within the key activities are clearly presented in BSM models. We may find some of the operational or supportive key activities are missing. And sometimes we also could identify some of decomposed activities are not well fitted in the model - they may not be key activities for these particular goals and stakeholders, and then they could be removed from our list.

Step 6 Repeat step 1 to 4 to build sub-system or sub-strategy level of BSM until all the key activities and indicators are clearly to be seen.

The differences between using the BSM and SSM-based method in the decomposition stage are: the BSM has four logic-related perspectives which give more guidance for the public sector management practitioners. SSM is a generic tool, but is much more difficult to apply properly. Moreover, the stakeholders and their key conflicting interests are clearly identified and presented in the BSM, but they are not in the conceptual models of SSM. Consequently, SSM often only decomposes some optimal or the most efficient CMs (key activities). However, these activities are not necessarily balanced with the key interests of the stakeholders, which are therefore often hard to be implemented in public sectors. In the following section, we will illustrate how to adopt the BSM step by step in a real case study.

4. Case Study: BSM in a Public Hospital in China

4.1 Project background and introduction

The Chinese healthcare system and public hospitals are at the reforming stage (Chen, 2009). There are challenges in the healthcare system and in the management of public hospitals. For example, they lack sufficient investment from the government (Yip et al., 2012). The government has fixed the prices of medical services and commonly used medicines which are always lower than the actual costs and so hospitals have to rely on charges to fill their financing gap (Liu & Mills, 2005; Yip et al., 2012). Consequently, many Chinese public hospitals just simply adopted the financial performance related payment systems. The rewards for medical staff do not link to personal performance, risk, responsibility, technical capacity and service quality, but often only related to the departmental incomes (Xia, Zhang, & Tian, 2011). All these lead to the inefficient use of the medical resources, the high cost of healthcare services and the increasingly prominent contradictions between doctors and patients in the Chinese public hospitals (Zhou & Li, 2012). To improve the current situation, there is a need for the government to change its policies (such as the investment budget) (Chen, 2009). However, the Chinese public hospitals should operate more efficiently and should improve their internal management (Mao, Wu, & Yu, 2008). There is an urgent need for them to adopt a multidimensional stakeholder oriented PM framework in order to face these challenges (Tian, Zhang, & Liang, 2010).

Hospital H is a traditional Chinese medicine (TCM) hospital which is committed to providing medical treatment, teaching, research, rehabilitation and health care for local citizens. Hospital H has many TCM services such as oncology, TCM preparation room, emergency department, cardiovascular, orthopedics and acupuncture. The annual revenue of hospital H is over 100 million Yuan. Hospital H has a large market share with regard to orthopedics and oncology in the local area, but its overall performance in terms of efficiency is relatively worse than its main competitors. Invited by hospital H, the performance management system working group was set up, consisting of different key stakeholder groups in the hospital (hereinafter referred to as working group). The aim of this project was to examine the performance management system of hospital H, and further to adjust and implement the improved system. The balanced stakeholder model (BSM) was applied in this case study.

4.2 Build the BSM

Step 1. Understand the key system goals

First of all, we need to understand the system goals including both the wider system (health system goals) and strategies of the hospital H. In China, the Ministry of Health has the following requirements for public hospitals: provide basic health services, emphasize fairness, and guarantee efficiency in resource use and availability (Eggleston, Ling, et al 2008). Moreover, the citizens and patients expect hospitals to provide them with high-quality and low-cost medical services to improve residents' health. If the ultimate goals at the public hospital level are regarded as the fulfilment of the interests of external stakeholders, health improvement could be the common interest for all the relevant stakeholders of Chinese public hospitals (Chen, 2009).

Secondly, the vision of hospital H is to be a national recognized and preferred TCM hospital by offering advanced TCM technology, highly skilled and knowledgeable professionals and a patient focused caring culture. The hospital 'mission' is to provide highest quality service in total patient care, education for health care personnel and research, in partnership with other health education and health care institutions or organizations and the community. The strategy of hospital H for the next five years is identified in terms of three main objectives: 1) attract the best professional medical staff; 2) provide a high quality of medical services, and 3) create a selflessly dedicated hospital culture.

How did we ascertain the top goals? According to the information above, the wider system goal is to improve health, and the strategic objectives of the hospital H we take as given (this is very common as most of organization already has their own strategies objectives). However, if necessary, we can discuss and modify the original strategies through meetings with the top management team.

Step2 Identify and analyze stakeholders

To achieve the ultimate goal of the hospital, we need to identify relevant stakeholders (at the top level) by using our stakeholder identification and analysis method.

The Involved				**The Affected**	
Owners 1.Government 2.Hospital management	Customers 1.Patients	Actors 1.Hospital staff	Partners 1.Suppliers	Indirectly affected 1.Local residents	Indirectly affect

Table 2. Stakeholders at top level

Step 3 Balancing stakeholder interests

Then we need to identify key interests of different stakeholder groups. Generally, this can be done through interviewing staff, carrying out questionnaire survey, discussing and debating with different stakeholders to balance the conflict interests. In this case, we issued questionnaires for all the staff of the hospital and also for patients, and interviewed all the top management team, some of middle management team, doctors and nurses in order to identify their particular needs. The key interests of stakeholders in the top level of Hospital H are summarized in following Table 3:

Stakeholders	**Key Interests**
1. Government	Improve health
2. Hospital Management	Increase income, Personal development, Build hospital brand and reputation
3. Patients	Curative effect, Patient experience,
4. Hospital Staff	Incomes, Improve skills,

5. Supplier	Long-term partnership,
6. Local Residents	Community services, Medical information and education

Table 3 Key interests of stakeholders

During the stakeholder meeting, we agreed that the improve health and the initial three strategic objectives are the common interests of all stakeholders. However, hospital H is a public hospital. It needs obtain necessary extract resources to attract the best medical staff and provide better services. Finding a public-private partnership opportunity might be a possible option to gain the funding for the hospital. We also realized that most of medical staffs are demanding to have more training and learning opportunities in order to improve their professional skills. Thus we amended our initial strategies and RD by adding two key activities: obtain necessary resources and provide training teaching and research opportunities for hospital staff.

Step4, Decompose the objectives

Based on the strategy of the hospital, the root definition (RD) of the top level of the BSM is:

"A system to be a nationally recognized and preferred TCM hospital by obtaining resources, attracting the best professional medical staff, creating a selflessly dedicated hospital culture, providing training opportunities, providing a high quality of medical services, and creating a selflessly dedicated hospital culture, in order to improve the health of local residents".

Then, we decomposed the RD into more detailed key activities known as a conceptual models (CM). During the decomposition stage, it is very important to identify relevant stakeholders to each of key activities. This is the key step for further decomposition. The hospital needs to identify who is involved and is affected by this key activity. And are there any special needs or conflicting interests among them. Thus it provides a chance for the hospital to rethink its development strategy and management procedure and to see whether a proper operational mechanism can be established for supporting the realization of the goal. The following Table 4 shows the decomposed key activities, and relevant stakeholders.

Upper level initial stakeholders	Key activities		Relevant initial stakeholders
1.Government (Owner and Wider), 2.Hospital Management (Owner) 3. Patients (Customer) 4.Hospital staff (Actor) 5.Local residents (Wider) 6.Local suppliers (Partner)	1	Obtain necessary resources	Hospital (Owner), Administrative departments (Actor) , External partners (Wider & Actor)
	2	Attract best medical staff	Hospital (Owner), Medical departments (Actor), External partner (Actor, Customer), Local residents (Wider), Patients (Customer)
	3	Create a selflessly dedicated hospital culture for everyone	Hospital (Owner), Staff (Actor and Customer), Patients (Customer), Local residents (Wider),
	4	Provide high quality medical services	Hospital (Owner), Medical team (Actor and Customer), External partners (Actor, Customer and Partner), Local residents (Wider), Patients (Customer)
	5	Provide training, teaching and research opportunities for staff	Hospital (Owner), Medical staff (Actor and Customer), Administrative departments (Actor) ,

Table 4 Key activities, upper level initial stakeholders and relevant initial stakeholders for ultimate goal "Improving health"

Step5, Allocate the key activities into the 'operation' and 'capability' perspectives

Then we allocate the stakeholders and key activities into the four perspectives of BSM. Some of the key interests of the stakeholders at the top level are also discussed and represented in the top level of the BSM decomposition. For instance, the patients pay most of their attention almost equally to the patient experience (service quality and attitude) and the curative effect; the hospital management is more concerned about the incomes, profits, hospital brand, reputation, etc.; the medical staff are interested in improving income level, improving professional skills with training or communication opportunities; the local government requires improving health with fairness, efficiency of public resources usage, and so on (see Figure 2 below).

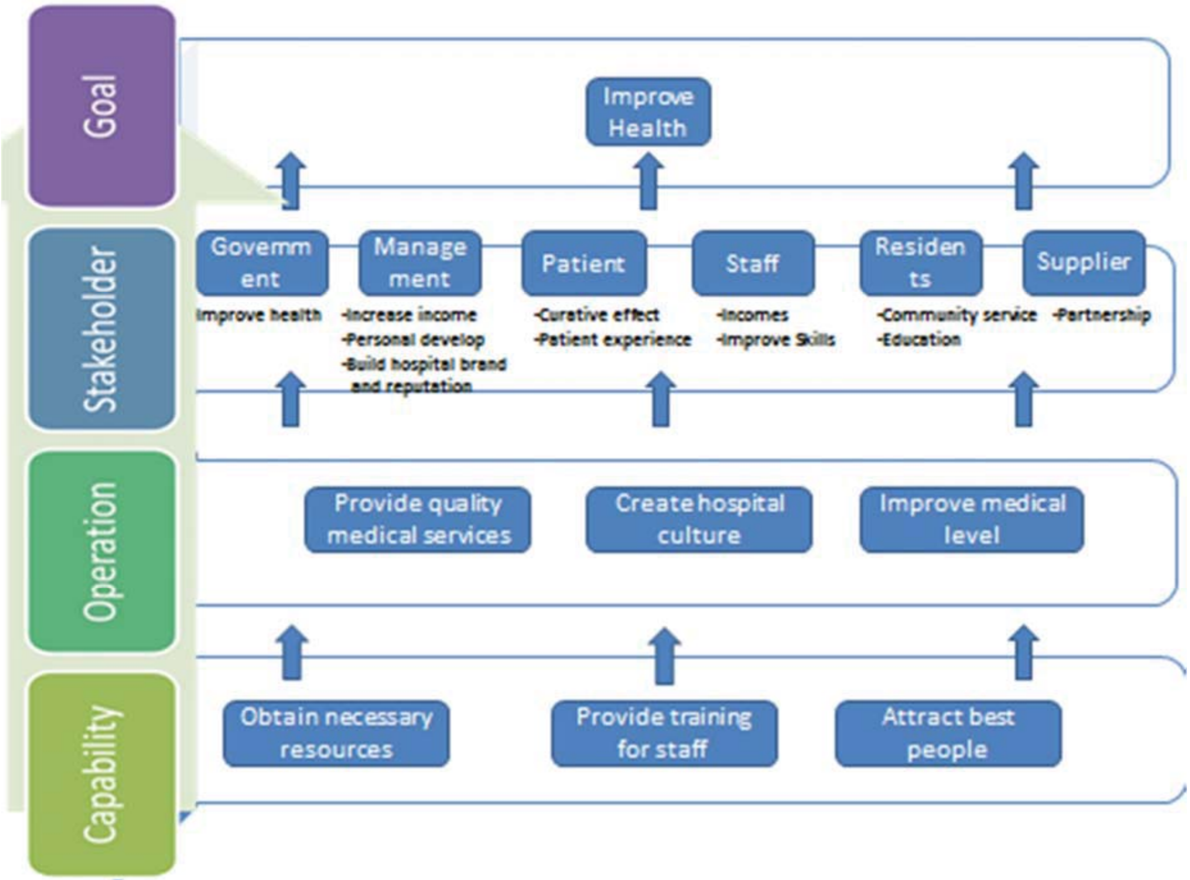

Figure 2, Top level activities allocated to the four perspectives

Step 5 decompose the key activities into next level (sub-strategy level)

Here we illustrate how to build sub-strategy level of BSM for the key activity 4 ‘provide quality medical services'. First, we need to identify and analyze the stakeholders who are involved or affected by the hospital for implementing the key activity (see Table 5).

The Involved				**The Affected**	
Owners 1.Hospital management	Customers 1.Patients	Actors 1.Medical department	Partners 1.External partners	Indirectly affected 1.Local residents	Indirectly affect

Table 5 Stakeholders for activity 4.

And some of their key interests have been identified through interview and questionnaire (see following Table 6).

Stakeholder	**Key Interests**
1 Hospital Management	Build the outstanding service brand,
2 Patients	Curative effect, patient experience,
3 Medical Department	Training opportunities, incomes
4 External partners	Incomes,
5 Local residents	Improve medical services, medical information and education

Table 6 Key Interests of stakeholders for activity 4

After discussions with stakeholders, the hospital agreed 7 key activities to achieve this key activity. Thus, the root definition is:

"A system to provide quality medical services (What) by understanding its own marketing position, carrying out internal operation analysis, improving process standardization, providing training, carrying out assessment, managing complaints and investigating patient satisfaction (How), in order to improve health of local population (Why)"

The sub activities and stakeholders are summarized in the Table 7.

Upper level initial stakeholders	**Key activities**		**Relevant initial stakeholders**
1. Hospital Management (Owner), 2. Medical departments (Actor), 3. External partner (Actor, Customer), 4.Local residents (Wider) 5. Patients (Customer)	4.1	Understand our own market position and core competitiveness	Hospital(Owner), Medical team(Actor), External partners (Customer and Partner)), Patients (Customer) , Administrative departments (Actor), Government (Wider)
	4.2	Carry out the internal operation analysis	Hospital (Owner), Medical departments (Actor), Administrative departments (Actor),
	4.3	Improve process standardization of the medical services	Hospital (Owner), Medical departments (Actor), Patients (Customer), Local residents (Wider), Government (Wider)
	4.4	Provide service training for medical staff	Hospital (Owner), Medical team (Actor and Customer), Administrative departments (Actor), External partners (Actor and Partner), Patients (Wider)
	4.5	Carry out the whole process TQM and assessment	Hospital (Owner), Medical staff (Actor and Customer), Administrative departments (Actor) ,
	4.6	Manage the patient complaints and public relations	Hospital (Owner), Administrative departments (Actor) , External partners (Wider & Actor), Patients

			(Wider), Government (Wider)
	4.7	Investigate the patient's satisfactions	Hospital (Owner), Administrative departments (Actor) , External partners (Partner& Actor), Patients (Actor and Customer)

Table 7 Key activities, upper level initial stakeholders and relevant initial stakeholders for key activity 4

Then we locate the stakeholders and key activities into the sub-strategy level of BSM (see Figure 3).

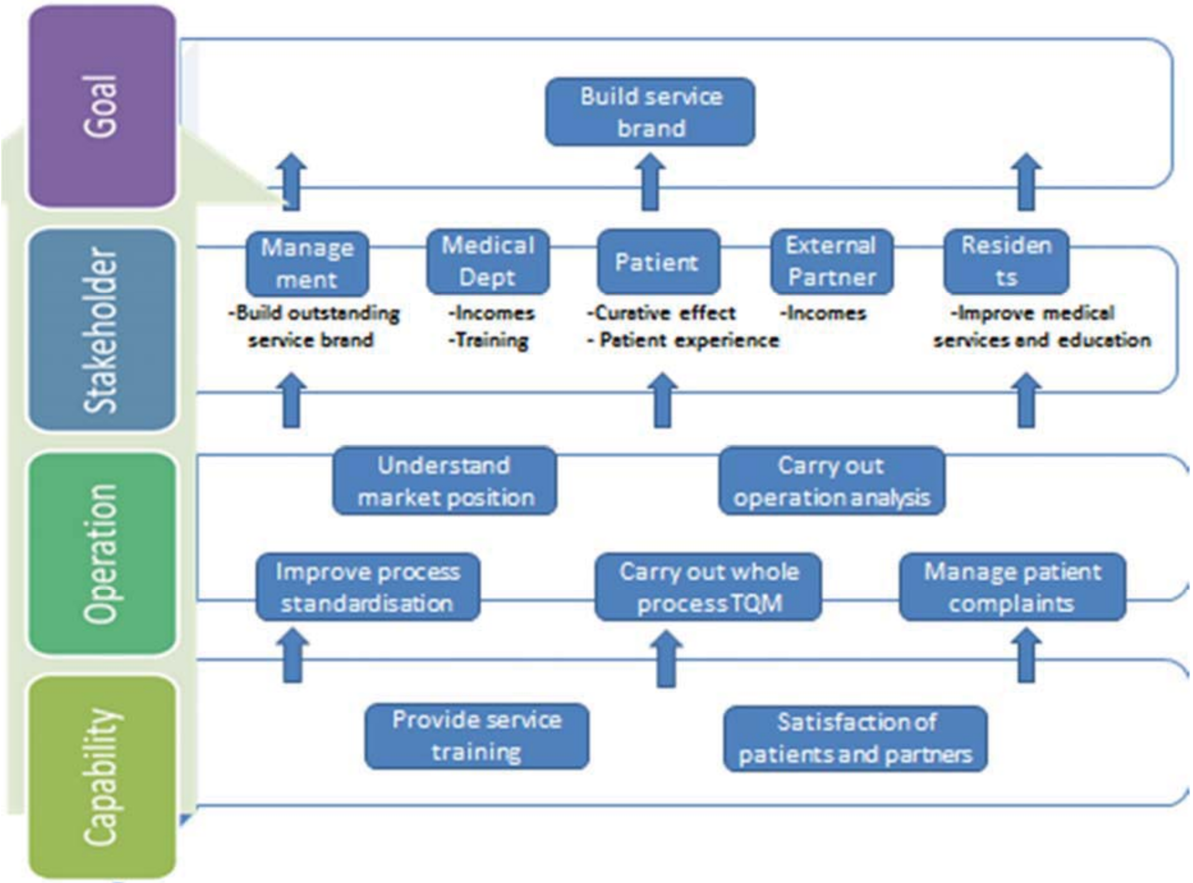

Figure 3 BSM for building service brand

As another example of building the sub-level of BSM we can look at for key activity 3 "Create a selflessly dedicated hospital culture for everyone". We identified the stakeholder groups are: Hospital (management team), Staff, Patients and Local residents. We decomposed the key activity 3 by SSM again. The decomposed stakeholders and key activities are shown in the following Table 8.

Upper level initial stakeholders	Key activities		Relevant initial stakeholders
1. Hospital (Owner), 2. Staff (Actor and Customer), 3. Patients (Customer), 4. Local residents (Wider),	3.1	Carry out the staff culture survey	Hospital(Owner), Staff (Actor, Customer), Administrative department (Actor and Customer), Patients (Wider), Government (Wider)
	3.2	Organise the social cultural events	Hospital (Owner), Staff (Actor), External partner (Actor, Customer), Local residents (Wider), Patients (Wider)
	3.3	Make the external promotion plan	Hospital (Owner), Administrative department (Actor), External partners (Partner), Patients (Customer and Wider), Local residents (Wider),
	3.4	Carry out internal cultural training	Hospital(Owner), Staff (Actor, Customer), Administrative department (Actor and Customer), External institutions (Actor and Wider)
	3.5	Cooperate with external consulting organizations	Hospital (Owner), Administrative department (Actor), External partners (Partner), Patients (Customer and Wider), Local residents (Wider)
	3.6	Make assessment and reward system	Hospital (Owner), Administrative department (Actor), Staff (Customer), Patients (Wider)

Table 8 Key activities, upper level initial stakeholders and relevant initial stakeholders for sub-strategy 3 "Create hospital culture"

And we locate the stakeholders and key activities into BSM again (see Figure 4).

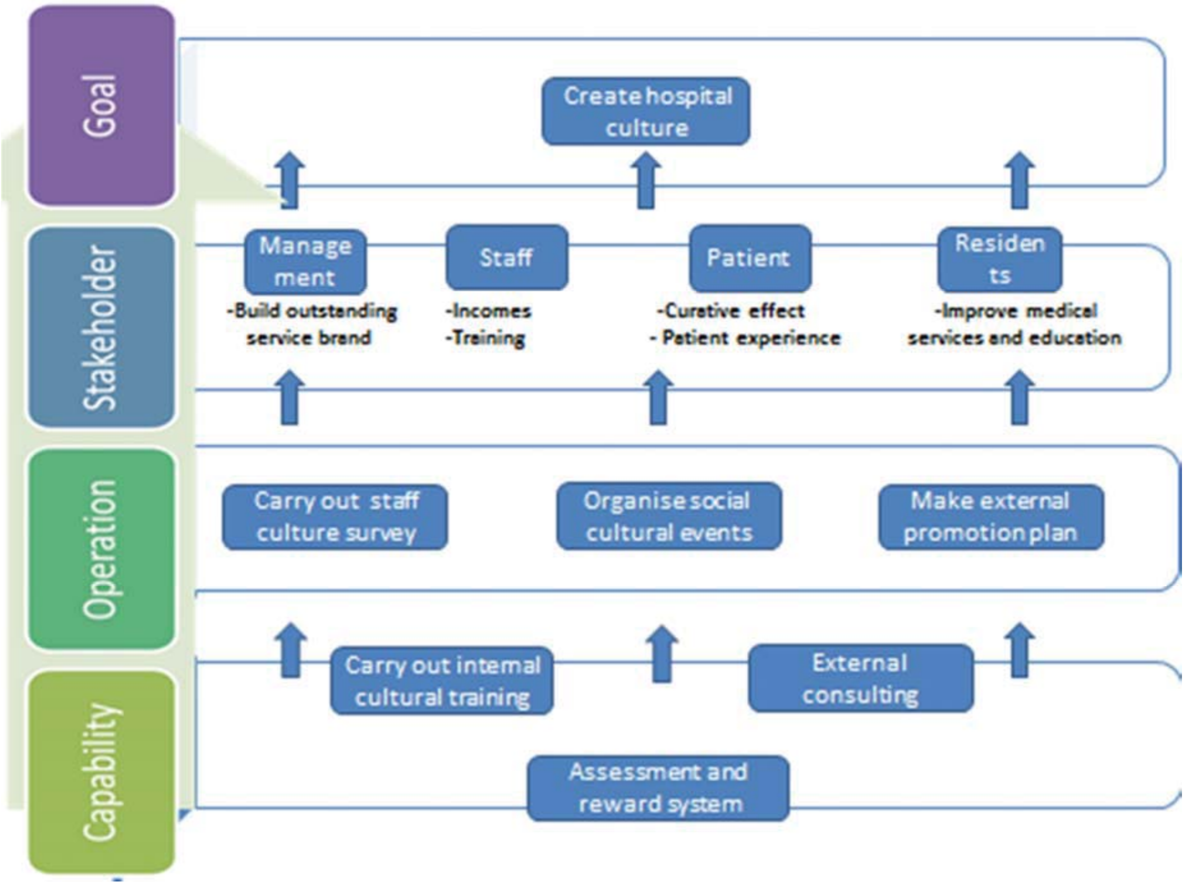

Figure 4 BSM for creating hospital culture

If needed we can apply the BSM to further decompose the above activities as we have discussed. For instance, if we wish to decompose the key process (activity) of '3.4 carry out internal cultural training' under the sub-level of the BSM 'hospital culture', firstly, we need to identify the stakeholders for achieving it.

For the key process (activity): carry out internal cultural training.

The Involved				The Affected	
Owners Hospital Government	**Customers** Patients Staffs	**Actors** Administrative Depts External training institutions	**Environmental** External training institutions Benchmark Hospitals (with good culture)	External groups indirectly affected by the systems activities (e.g. local citizens)	External groups who indirectly affect the systems activities (e.g. government)

Table 9 Stakeholders for activity 3.4 'Internal Training'

The next step is to discuss the key interest of the stakeholders, and how to carry out the cultural training exactly. It is often not possible to have all the stakeholder groups involved in the discussion process. However, we could involve those internal ones at least. Then, a series of the sub-activities could be decomposed and agreed by stakeholders, and their key interests also will be discussed and balanced (see the Figure 5 below).

From the Figure 5 we can see that at this level the key performance indicators (KPIs) can be easily seen, for example, KPIs for measuring the efficacy (E1) (e.g. testing results, training time in total), the efficiency (E2) (e.g. training costs, training time per person) and the effectiveness (E3) (e.g. staff satisfactions). Then we can stop the decomposition when all the key performance indicators, key processes or activities are clearly to be seen.

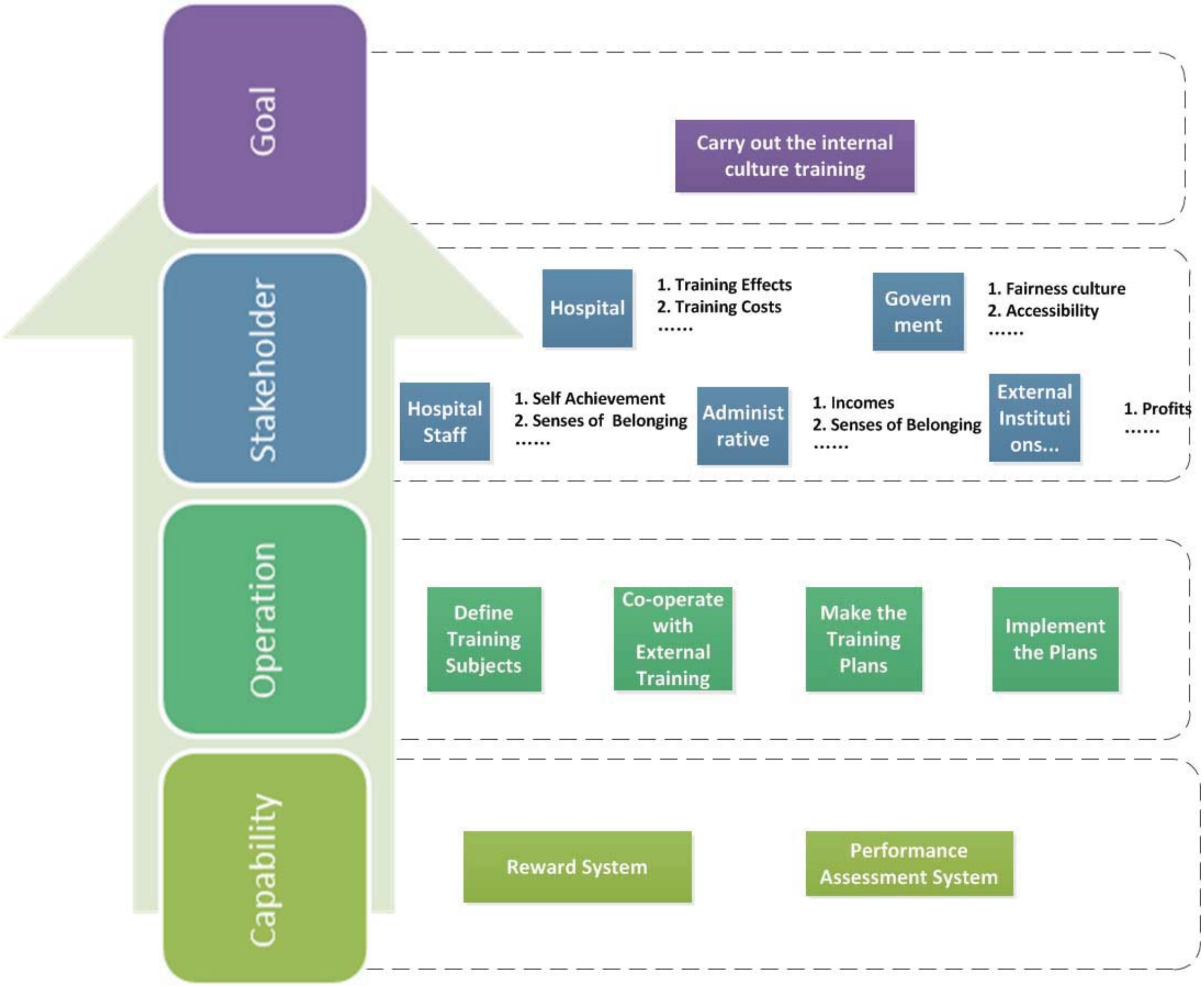

Figure 5 BSM for 'internal cultural training'

Through the same approach, we can break down all key activities level by level, until the Hospital believes that the processes of achieving all key activities are clear enough and we are able to sign the jobs to the specific staff or departments. Once the decomposition has been done, the KPIs for each decomposed key activity can be easily seen.

It is very important to discuss and debate with the people in the organization in each decomposition step in order to ensure the key interests of stakeholders have been properly considered and balanced. We should also note that the BSM is an ongoing managing process, the models (objectives, stakeholders and activities) can be changed or adjust according to the changing situation.

5. Conclusion

In this paper we have further developed out performance management system to pay particular attention to the identification of all relevant organizational stakeholders and to ways of ensuring that their varied interests are balanced as much as possible in developing key activities and performance indicators. In comparison with other methods, our approach is much more suitable for the public sector than private sector oriented methods such as the balanced scorecard. And in comparison with other public sector approaches, our method gives more systemic, systematic and detailed guidance to:

- Construct appropriate activities for the organization from top level strategy down to detailed operations
- Identify relevant stakeholders and their interests at each level
- Use this information to assist in balancing stakeholders' interests
- Analyze the activities in terms of the four perspectives – goal, operation, stakeholder, capability
- Where desired, produce detailed KPIs

This methodology was illustrated with a real example of its use in a Chinese hospital.

5.1 Limitation and further research

First, the balancing of the stakeholders' interests is one of the key themes in this research. The BSM provides a feasible way (or procedures) for balancing interests during strategy decomposition and deployment processes. However, the interests could be identified and balanced through many other ways, especially for small groups (even individuals) in the organizations. Therefore, it is necessary to further study how to balance the interests under different situations.

Second, BSM needs the management of organization to identify stakeholder's interests, and to make an alignment (or compromise) with their needs. Both of these activities add transaction costs to the management of the organization. The identification and balancing process (e.g. discussion or survey) takes time and money. Those resources devoted to stakeholder identification and balancing thereby create opportunity costs because they cannot be put in other ways to enhance performance.

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DEVELOPING A DYNAMIC STRATEGIC PERFORMANCE MEASUREMENT SYSTEM THROUGH A PERFORMANCE TREE APPROACH: EVIDENCE FROM CHINA

ABSTRACT

This paper proposes a performance tree approach that can build dynamism into an old and ineffective performance measurement system. The tenet of this tool illustrates how a flexible and adaptive strategic performance measurement system (SPMS) can be used for strategic renewal and strategic alignment. An action research study of a Chinese small and medium-sized enterprise (SME) – HB Company is used to show the benefits of transforming from a stable corporate oriented performance measurement system to a flexible individual –level SPMS for dynamic strategic alignment.

This action research case study provides evidence for association between SPMS and organizational performance in a SME environment.. Senior management and staff felt that the performance tree to be very successful in terms of enhancing performance and altering organizational structure. HB now has a more strategic orientated system and the board members identified another four benefits from the implementation of their PT.

DEVELOPING A DYNAMIC STRATEGIC PERFORMANCE MEASUREMENT SYSTEM THROUGH A PERFORMANCE TREE APPROACH: EVIDENCE FROM CHINA

Yi Zheng, Paul Phillips, Wenbin Liu,

1. INTRODUCTION

After more than three decades, the performance management revolution continues to gather pace with advocates of performance measurement systems (PMS) arguing that they can lead to superior firm performance (De Geuser et al. 2009; Evans, 2004; Hoque and James, 2000; Lingle and Schiemann, 1996, Van der Stede et al. 2006). However, drivers of PMS usage at the managerial level do not always coincide with drivers at the firm level (Wiersma, 2009). Consequently with such a dichotomy, prior research demonstrates that PMS can have both an enabling and constraining effect on organizations (Fried, 2010).

Enabling effects can include: measuring intangible and tangible performance (Kaplan and Norton, 1992), facilitating decision-making and influencing employee behavior (Sprinkle, 2003), alignment with strategy (Chenhall, 2008; Ittner et al. 2003; Kaplan and Norton, 1992), strategic learning (Chenhall, 2005; Fried, 2010; Kaplan and Norton, 1996), communicating information horizontally and vertically (Chenhall, 2003). On the other hand, constraining effects include: coercive expert systems (Ahrens and Chapman, 2004; Wouters and Wilderom, 2008), and needing to shape and control strategy (Robins and Baden-Fuller, 2010). Also, the literature refers to ‘dual role of controls’ (Tessier and Otley, 2012) of PMS, which depicts the classical distinction between the decision-facilitating and decision-influencing roles (Ahrens and Chapman, 2004). The former relates to the provision of useful information to guide decision-making, and the latter considers the role of incentives. In addition, PMS are crucial to the resource orchestration processes and many firms have deployed enormous amounts of capital, time and effort developing and implementing such systems (Koufteros, Verghese, and Luxianetti, 2014). In light of this, settling these key debates may be particularly helpful for the advancement of PMS theory and practice.

These observations require further research efforts to provide definitional and analytical understanding of PMS. During the last decade, the strategic performance measurement system (SPMS) has a significant transformation effect within organizations (Bisbe and Malagueno, 2012), which are a subset of PMS. SPMS can aid strategy implementation (Kaplan and Norton, 1996) and the strategy (re) formulation process (Bisbe and Malagueno, 2012; Gimbert, et al., 2010). Despite the growing number of publications on organizations' PMS, consensus on implementation remain elusive (Marinho and Cagnin, 2014). In the new normal environment together with increasing global competition, examining how organizational strategy in uncertainty conditions influence the design of effective SPMS remains useful. Kolehmainen, (2010) asserts that SPMS need to be flexible and dynamic to ensure strategic alignment of salient processes. Unfortunately, much of prior research on dynamic SPMS was originally conceptual in nature (Kennerley and Neely, 2000). Moreover, recent contributions to the academic literature cast doubt on the success of SPMS in dynamic environments (Bisbe and Malagueno, 2012). Also, the extent to which SPMS have been explored in various contextual settings is rather limited.

For example, SMEs dominant the business landscape, but the focus of many research studies has been on the larger organization. As Franco and Haase (2015) state the SME liability of smallness represents an inherent disadvantage, as they only have access to limited resources. Moreover, the literature and research on PMS in the SME environment is scarce and lacks new approaches (Chalmeta, et al., 2012). In this paper, the aim is to respond to such calls by proposing a new SPMS, which we conceptualize as a performance tree (PT). This study demonstrates how the PT can be dynamic and provide further enabling benefits to firms that operate outside the normal scope of prior research investigations. Specifically, the SPMS case study of a Chinese SME manufacturing firm, highlights the fact that HB Company was facing severe competitive pressure and falling sales after the global economic crash of 2007.

This study illustrates how a dynamic SPMS can be successfully implemented to enhance strategic alignment, and play a prominent role in the (re) formulation process by translating the new strategy into a new set of useful metrics for management and employees. Specifically, this article contributes to ongoing efforts to developing new theories on SPMS by proposing an approach that can be fundamental to organizational success. Then, the results outline a number of enabling benefits, which contributes to Garengo et al., (2005) call for further PMS theoretical and empirical manufacturing SME studies to elucidate ways of overcoming inherent weaknesses. This finding is particularly pertinent, as during times of economic slowdown, SMEs have a crucial role to play in terms of economic development and employment.

The study also takes into account that research evidence suggests that western theories focusing on organizations and their environments are likely to suffer from a weak fit (Boyacigiller and Adler, 1991; Kiggundu et al., 1983) in terms of generalizability to a non-western context. Cultural differences may also limit the ability of management to transfer and operationalize some systems and procedures (Jogaratnam, and Tse, 2006, p. 455). Thus, the western-centric notion of SPMS needs to be overcome, and the Chinese setting of this study will provide some fresh insights. Acknowledging the gap between management academics and practitioners (Bartunek, and Rynes, 2014), this study provides an example of research that is both rigorous and relevant, which we is necessary for the advancement of SPMS theory and practice in both developed and emerging economies.

After the description of SPMS approaches, the paper outlines the general PT framework. Then presents the research design, which includes explanation of the research site and original challenges, Chinese SME context and development of the PT. The results and discussion are proffered and conclusions follow.

2. SPMS APPROACHES

Performance management as a rigorous discipline appears to be in an early state of maturity (Thorpe and Beasley 2004). In particular, lacking a suitably grounded framework for the non-linear relationships and management of performance (Smith and Goddard 2002). Probably the main reason for this unsatisfactory situation is the complex and highly interdisciplinary nature of performance management research, which involves many disciplines of varying states of maturity and methodological practice.

Recent approaches to performance management have identified the inadequacies of solely relying on quantitative and short-term indicators, and have led to the development of SPMS frameworks, such as: performance pyramids and hierarchies (Dixon et al., 1990), intangible asset scoreboard (Sveiby, 1997), SMART (Cross and Lynch, 1988), performance prism (Neely et al., 2002), success dimensions (Shenhar and Dvir, 1996) tableaux de bord (Bourguigno et al, 2004), and balanced scorecard (Kaplan and Norton, 1992). These frameworks provide a way of capturing financial and non-financial performance measures and the concept of SPMS are becoming increasingly part of contemporary practice (Rigby, and Bilodeau, 2011). SPMS operationalize firm strategy with a set of performance measures (Choi, Hecht, and Tayler, 2013), which in today’s economic and competitive environment necessitates explicit links between strategy and performance measures.

Hence, performance management frameworks now need to move beyond the mere collection of financial and non-financial measures and seek to identify causal and nonlinear links among measures, strategies and outcomes. The performance measurement literature emphasizes the importance of these linkages between strategy and such measures (Otley, 1999; Ittner et al., 2003; Chenhall, 2008). For the purposes of this study, and in agreement with Micheli and Manzoni, (2010), the SPMS possesses the following characteristics: integration of long-term strategy and operational goals, evidence of multi-perspective indicators, presence of cause-effect linkages and the inclusion of a sequence of goals-targets-action plans.

Currently, a majority of the SPMS projects are undertaken by organizations applying the BSC. According to Chenhall, (2008) a distinctive feature of the BSC is the identification of financial and non-financial measures covering different perspectives, which provides a way of translating strategy into action. Speckbacher et al., (2003) asserts that the BSC evolves and can assist practitioners by providing three different types of PMS: minimum standard, cause-and-effect, and fully developed. The minimum standard combines financial and non-financial measures. The next evolution is the cause-and-effect, which illustrates the salient relationships between strategies and outcomes. The final evolution is the fully developed, which defines the objectives, outcomes and connecting incentives for the organization. This indicates that the BSC can be used in organizations at different stages of their development of PMS, which broadens the appeal of this research to academics and practitioners.

Furthermore, BSC approaches focus on the specific strategies adopted by an organization, and provides a robust tool to incorporate PM processes. Many approaches exist using the BSC to implementing PM. For example, Speckbacher et al (2003) identify three classes of implementation in practice including: a mere derivation of KPIs (the most widely seen form in the practice) to the BSC-III that has the fullest contents to support action plans and incentives. Other BSC implementation approaches (Letza 1996, Ahn 2001, Brewer 2002, Lohman et al. 2004, Papalexandris et al. 2005) provide integrated methods to combine with existing approaches. Kaplan and Norton (2008) continue to provide further evidence for using the BSC to integrate strategy with operations.

However a number of criticisms of the BSC approach exist. Tapinos et al (2011) employ a large survey of strategy developers to study the effects of using the BSC. They conclude that their results did not support the idea that the BSC was widely used throughout the strategy development process; and that the strategy process of users was neither more efficient nor more effective than non-users. Jackson (2006) points out that the BSC adopts a very machine-like view of the organization. Although, claiming to embrace different viewpoints, BSC imposes the same viewpoint to a range of organizational activities and thus tends to stifle creativity. Unfortunately, the BSC lacks effective procedures to integrate the key soft and culture factors into the PM system, and to encourage bi-way communications between the staff and their managers (Liu et al, 2012). Interestingly, Zeng and Luo (2013) raise some limitations of the BSC in a Chinese context and provide some guidance for overcoming limitations. These include overcoming cultural barriers. Moreover, the widely used BSC is too mechanistic and rigid for many SMEs, which are under constant pressure to cope with uncertainty, and innovate their products and services. Despite recent attempts addressing these issues, SPMS can be too complicated to implement for most SMEs that have only limited resources in general. Furthermore the underlying framework of the SPMS for an SME has to be robust, flexible and easy to understand.

3. GENERAL FRAMEWORK OF PERFORMANCE TREE

This section explains the rationale for the Performance Tree (PT), which can be deployed in SME environments. The PT provides the CEO with the opportunity to reconsider the organization structure in a holistic manner, unlike other approaches such as the BSC. One of the primary motivations is to overcome some of the limitations of the BSC, and to create a SPMS that is appropriate for an SME. The PT methodology adopts a lean implementation approach with a constructive modeling function to enhance key processes, create action plans and bi-way communication mechanisms (see Malina and Selto, 2001; Malmi, 2001). The framework evolves through opening dialogue, investigations, discussions, actions, and outcomes, which can operate in dynamic environments. Rapid changes in the SME business environment together with increasingly complexity necessitate greater in-depth analysis for SPMS (Garengo et al. 2005). According to Garengo et al. (2005), SMEs and large firms differ in three central aspects: uncertainty, innovation and evolution. The PT seeks to assist management in coping with this higher level of uncertainty, and to stimulate key processes to innovate products and services, and to sustain evolution and change.

Aggregated performance is the sum of efforts made at the individual, team, group, business and corporate levels. The PT depicts this relationship, which can often be a complex process. A vertex of a PT is a performance unit (a staff or a business unit), and together with supporting processes indicates how performance is aggregated. Individual members of staff are at the bottom, and corporate performance is at the top. From an aggregate perspective, the PT can help identify these key business and managerial processes, which need to be re-aligned with the corporate strategy. The PT framework provides a way for staff at all levels to construct and manage their PT. At each vertex of the PT, focus should be on enhancing and aligning performance, aligning and coordinating the supporting group of vertices, and aggregating performance through direct supporting vertices. The PT needs to ensure, among other things, effective motivation, guidance and monitoring at each vertex. This will enhance performance, communication, coordination, and alignment.

Generally speaking performance indicators are defined from the corporate objectives of the organization. However at the operational level, one can add new performance indicators according to the need of sub-objectives and particular management strategies, build supporting aggregation paths and vertices (units). This presents a much-needed flexibility for PT control and enhancement within an SME environment. In accordance with the contingency approach (Miller, 1981), the PT framework is contextual, adaptive and flexible. This enables the creation of new SPMS to cope with changing internal and external environments and the interdependencies of strategic management. This reduces SME uncertainty, enhances innovation and quickens the tempo for organization evolution. Furthermore this framework can cope with big data and pave the way for introducing a robust database performance management system in the longer term, where the PT may be created by statistical correlation analysis of historical performance flows instead

Also, researchers need to cope with the limitations of previous SPMS frameworks. These can include perverse behaviors of individuals, stifling innovation and learning, which have scant effect on decision-making processes (Micheli and Manzoni, 2010). The BSC can be too mechanistic for coping with the challenges of SMEs, and can be difficult to integrate the implementation of the desired strategy due to organizational structural issues. Unlike approaches such as the BSC that develop and implement resulting KPIs based on existing organization structures, which make process innovations much more difficult, if not impossible. The PT framework enables KPIs to be developed independently of any inefficient organizational structures. The PT approach will reshape the salient inefficient organizational structures, which is supported by a motivated and committed workforce resulting in optimal performance.

Recent studies suggest that Soft System Methodology (SSM) analysis is very useful (Liu, et al 2010, 2012), as implementation only depends on what to do rather than worrying about existing organizational structures. SSM provides a methodology to obtain holistic views on understanding and analyzing problematic situations by considering different stakeholders' perspectives, internal operational issues and external objective influences. As SSM is management-centered and has inherent constructive procedures to introducing innovative changes into the existing processes, the approach is incorporated into the development of the PT. SSM origins emanates from Checkland's (1972) first publication on a system-based methodology for real-word problem solving. The SSM systems-based approach to problem structuring and taking action in messy and complex problems or issues is useful. SMEs operate in uncertain environments, and SSM emerges as a relatively successful approach to understand and analyze messy people-based organizational problems (Checkland and Scholes, 1990; Checkland and Poulter, 2006). Jacobs (2004) goes further by highlighting the wide recognition that SSM has extra and irreplaceable value in complex organization management. Furthermore, SSM can develop indicators for performance management in both private and public sectors (Liu, et al 2010). Two distinctive advantages of using SSM to build the PT are acknowledged. First, the construction of the PT only depends on what to do and how to do in an organization, rather than worry about existing structure. This finding is particularly suitable for SME who undertake frequent adjustments to their management structures.

Full implementation of SSM needs to be carried out by a team including SSM experts in conjunction with the SME senior and middle managers. Frequently being too much of a burden for SMEs, which often have neither the resource nor time for this. In this study by integrating the BSC with SSM can help formulate a simpler procedure that meets SME requirements. Furthermore the KPs identified by this method will be used to create additional indicators and performance plans, which can be subsequently used as foundations for the PT, which is summarized in Figure 1.

Figure 1 about here

4. RESEARCH DESIGN

The findings in this paper are premised on one-year research cooperation between the researchers and representatives of HB Company (a pseudonym). The project commenced during the summer of 2012, when the authors were invited in, as action researchers, to design and implement a new SPMS. This study incorporates action research, which is a valid research method in the social sciences. Van Eynde and Bledsoe, (1990, p27) assert that action research is the touchstone of most good organizational development practice and remain the primary methodology for the practice of organizational development. Action research can assist researchers and practitioners simultaneously to solve current organizational problems while contributing to theory. The benefits of action research are discussed in the academic literature (e.g. Daniel and Wilson, 2004; Thompson and Perry, 2004; Miller and Merrilees, 2013). After discussions between the researchers and HB Company representatives, including the CEO, action research was felt the methodology to pursue. The selection of action research was felt appropriate for five reasons: (i) HB company wanted expert guidance to promptly identify a new PMS, (ii) action researchers could help link, reconcile, elaborate and verify insights across multiple stakeholder groups, (iii) action research is values-laden and interdisciplinary seeking a desirable future, (iv) action researchers role is to actively challenge assumptions throughout the project with the goal to generate change, (v) action research is useful in turbulent environment because of the focus on immediacy of outcomes, futures perspective, and willingness to incorporate practitioners as co-producers of knowledge.

4.1 Research site and initial strategic challenges

Given the limited empirical evidence of Chinese SMEs SPMS studies, this paper adopts a case study approach. Yin (2003) makes a strong argument for supporting single-case studies. He suggests the use of critical, extreme/unique, representative/typical, revelatory and/or longitudinal cases. This study adopts such an approach and sought to establish fact from multiple sources. As highlighted by Eisenhardt (1989), the study presents empirically grounded reflection and new theoretical insight.

The following section explains the case study approach to show how the development of the PT, overhauls an ineffective PMS, and now provides significant long-term benefits to HB Company. The case organization, HB is a privately owned Chinese SME company that manufactures paint and also undertakes painting of trains and ships made by other companies. HB was founded in 1997 and has headquarters located in TaiYuan, the capital of the Shanxi Province, China. The company is a typical “fast track” Chinese company of median size, fast growth, and a market leader. Since HB’s establishment, management introduced advanced paint technology, and developed water based paint for trains, cars, and bridges, fireproof paint and other products. HB’s main products are: water based paint, heavy anticorrosive paint and specialized paint for Chinese high-speed trains. HB is one of the leading players in the Chinese water based industry paint market, with a total annual production capacity of 15,000 tonnes.

Figure 2 about here

HB employs approximately 300 employees with around 35 managers and Figure 2 provides an illustration of the organizational structure. The CEO, who reports directly to a board of directors, controls operations. The management structure and style are typically Chinese: informal, personal and reactive. This fact promotes a culture of learning, ambition, innovation and a win-win (staff and company) ethic. However, after facing intense and fierce competition in China, its growth started stagnating after 2008. During the summer of 2012, management realized that it had to pursue a renewal strategy to reposition the company back on its initial high growth path trajectory and enhance performance.

This study examines how a dynamic SPMS approach can be successfully applied to enhance strategic alignment, by enabling the translation of strategy into a set of useful metrics for stakeholders. This enabling effect illustrates how SPMS can perform specific tasks in order to enhance the processes relating to strategy (re) formulation and ultimately performance of a SME company. Additional, benefits include adjusting objectives, assigning responsibility, developing performance measurements, measuring performance, motivating and guiding staff performance, monitoring feedback of information to decision making, and extending accountability, as suggested by numerous practices and theoretical studies carried (see e.g. LGMB, 1993; the Audit Commission, 1995; Lebas, 1995; Hudson, Smart and Bourne, 2001, Cocca and Alberti, 2010).

The following section introduces the contextual setting of the research, research site and describes the conjoint development of the PT.

4.2 The Chinese SME context

Previous strategy research tends to adopt a western centric theme together with a focus on the larger multinational type service organization. This case study is based on a Chinese manufacturing SME, which broadens the scope of the research setting. China being an emerging economy is very different from the western world's mixed economies. Moreover, emerging economies tend to have relatively weak institutions, infrastructure and public resources to support small businesses (Zhang, et al. 2014). Thus, making the western world's general assumptions of strategic management of limited use. For example, starting from a definition standpoint, quantitative and qualitative characteristics are both used. The first dimension of SMEs' quantitative characters, include turnover, number of employees, and asset size. However, with no universal value to above criteria among non- European countries, both the economic and labor market situations influence countries' answers to the question "how big the small enterprise can be?" The second dimension of qualitative characters includes ownership, control and scope of operations.

Table 1 about here

From a methodological SME definition approach, Europe and China are similar with both using number of employees, annual revenues and asset value. The Chinese government, like Europe, uses a dual dimension system to identify SMEs, and classifies them into five types with corresponding quantitative criteria respectively. If a company meets with any one of the standards in its industry (See Table 1), they can be identified as an SME. A major difference is that the Chinese SMEs' scales are much larger in comparison with European standards. The majority of Chinese enterprises are SMEs, being more than 50 million, contributing 60% to GDP and employing 75% of the urban workforce (Zhang, 2010). In comparison with other countries, Chinese SMEs have their unique internal and external environments. Internally, Chinese SMEs managers need higher levels of cross-department coordination and communication abilities to meet with management challenges (Tan, He and Ma 2011). The widespread family businesses ownership is another differentiated internal characteristic of Chinese SMEs. As a result, Chinese SMEs' operations rely more on nepotism and personal charisma than bureaucratic system and regulations (Song 2012). The high staff turnover rate (three times higher than average level of the other East Asia countries) is another concern for Chinese SMEs, some researchers' indicate that the lower HRM ability and inappropriate PMS system are two of the most crucial factors leading to the aforementioned (Wang and Wang 2012).

Apart from above internal issues, the literatures show a variety of external environmental factors that also influence Chinese SMEs' development. Some researchers state that because of the discrimination from Chinese banking system, Chinese SMEs emphasis more on their cash flow management than their western counterparts (Liu, 2008; Zhao, 2012; Shan, 2012). Wan (2012) and Lin (2014) point out that most of the Chinese SMEs set sales and marketing as their strategic priorities because of large scale and intense homogeneous competitions in all industries. Tang (2011) urges that with the acceleration of globalization, Chinese SMEs need to set targets for institutionalization, informatization and internationalization. More recently, Parnell et al. (2015) stated that the high failure rates among Chinese SMEs is not difficult to understand, due to the information asymmetry in the market, abrupt and changing government policies, and difficultly accessing capability.

4.3 Performance Tree development

During the one-year project, meetings were held with HB senior management team to discuss and explore issues as a participative process. The action research nature of the project meant that the researchers had to get immersed into the everyday activities of HB. Specific care was placed on ensuring that the researchers obtained data from managers, supervisors and subordinates. This finding enables the researchers to ascertain the differing insights into the existing PMS, that helped to shape the empirical evidence to provide a holistic view. The following section provides the detailed steps of the formation and implementation of the PT.

Step 1: Understand objectives, strategies and operations

In the beginning of the PT process, understanding HB's Company's senior management team's vision, mission, objectives, strategies, and salient key business activities is accomplished. This step involves performing primary and secondary research, ranging from interviews, forums, workshops, reading media and internal company documents. Particular attention is paid to the key soft factors such as company culture, and employee's opinions on the current mechanisms for managing performance. More specifically, the essence of this stage is to perform a collaborative analysis of the social and economic situation of HB. This data collected during the primary and secondary research data gathering exercise is essential to developing the proposed SPMS. Many existing approaches can be integrated in this step and the strategy map (Kaplan and Norton, 2004) is deployed, which help identify, visualize and link the key processes from tangible and intangible resources to strategic objectives.

Table 2 about here

Interview data was complemented with salient internal documents, such HB company's planning and performance related documents, group discussion and online sources such as website, and customer reviews (see Table 2). HB's senior management team were interviewed to discuss their long-term aspirations, targets, and strategies in detail. From discussions, it became apparent that HB's core value was to create an ambitious, learning, and innovative environment for their employees to flourish. The underlying philosophy being an all-win organizational culture to successfully compete in the challenging Chinese marketplace that also had to be embedded in the new SPMS. HB's strategic priority was to manage its supply chains end to end and proactively respond to end consumer demand and need. This "end-market strategy", involves creating KP for each market segment and identifying what each operation needs to do to contribute to HB's success. This step necessitates developing strong partnerships and providing not only products, but also painting and decorating services for customers. Intermediaries such as local dealers and construction companies were sought and included in collaborative discussions, it was noted that the coating industry is mature with both quality and costs being very similar across the entire sector. Thus, quality is not the sole differentiating factor among HB's peers. Customers' choices often depend on local dealers and construction companies' recommendation. Hence, liaising with these intermediaries was an imperative for HB.

Furthermore, through its organizational culture HB is trying to create an all-win situation for its staff, which means that the company provides a platform for its staff to release their potential and realize their dreams. These core values are developed explicitly in the next decomposition stage. From the data gathering exercise it became apparent that HB had six key operations, which will lead to the development and implementation of a new strategy: marketing, supply chain, R&D, after-sale, painting engineering and HRM. To successfully achieve the 'end-market strategy', HB needs to identify and satisfy their customers. Therefore, marketing should identify customers' needs. The production, painting and after-sale services are the core operations that satisfy those needs. Ultimately, the R&D activity aims to continually produce better products and services to exceed its customers' needs. HB also needs to ensure that all staff are competent and enthusiastic to deliver excellent service. Finally, the main strategies of the six key operations were discussed with HB's CEO and top management team. These are summarized in the next step after the interviews with HB's senior and middle-level executives. Also, the formation of a project management team, which was conjointly led by one of the researchers and one of HB's senior managers included representation of all key stakeholders.

Based on the above information, the key task of building HB's new SPMS is to decompose HB's key activities, while formulating the key operations and management processes (KPs) to ensure that the objectives are achieved. These processes are then monitored and measured by KPIs, and assigned to departments and managers. The relationship between KPs and KPIs is that KPIs provide a mechanism for monitoring the KPs. These KP are used to build an effective bi-directional communication mechanism.

Steps 2-3: Strategy decomposition and deployment– KP tree identifications

In Steps two and three, the researchers decompose and deploy the salient objectives and strategies by applying SSM, to reformulate the KPs that are not in alignment with strategic objectives. During this phase the focus is to introduce the collaborative changes to innovative existing processes. The KPs are those activities that are essential to achieve the objectives– and normally have heretical structures. During the traditional BSC process, one finds key driving processes usually in an unstructured manner, for achieving objectives in order to decompose them. Here for the key tasks by incorporating the SSM, provides a more balanced (hard and soft factors) and a more management-centered approach to identifying the key managerial processes. KPIs are used to measure the performance of the KPs.

The core of the method employed in Steps two and three is to continuously ask the following questions: *What to do*? *Why do it*? *How should it be done*? With the input from all of the key stakeholders, following a carefully structured and constructive procedure as developed by Mingers et al., (2009). However, it is not normally feasible to implement major changes to the whole business activity, such wide scale disruption can create confusion. Thus the decomposition will just follow the existing business processes in the third level (see below). Additionally, it is useful to identify the key stakeholders in each level of the company to discuss soft factors such as culture. The procedure is summarized in the following five sub-steps:

i) Top decomposition: Identify the key processes for each critical operation. Then depict logic relationships to form the main branches of the PT and ascertain the primary focus and overall strategies for these operations. This process can be depicted in a strategy map, from step one, but it is useful to continue to discuss and debate with stakeholders to ensure consensus.

ii) Conceptual decompositions: Each of the key activities (from i above) is broken down into a set of sub-activities or actions, which together should logically ensure that the overall purpose of the activity is achieved (*the how*). At this stage these sub-activities or actions may be not the same as current practices in the company, and consensus needs to be achieved between management and employees. This step tends to involve facilitators having discussions with internal and external stakeholders. These discussions attempt to tackle some of the barriers to successful SPMS implementation, such as organizational structure and culture.

iii) Procedural decomposition: The above sub-activities are further broken down, which should ensure that the overall purposes of these activities are achieved. At this level where the core operations occur, the key driving processes are identified. However if some operations need more in-depth examination, it is possible to reapply the conceptual decomposition procedure. Also, to avoid a silo mentally, the inter-connections with other key functional operations should be considered.

iv) At this point the performance criteria are specified together with their measures/indicators and appropriate standards. It is often the case that the activities need to be further decomposed. When this happens Step three should be repeated for any sub-activity for which this is felt necessary. Then Step four is repeated recursively until all the key processes and their KPIs are clearly seen, or until felt necessary.

v) A complete set of key processes and related KPIs can be produced from the activity models for all necessary levels of the activities. Often the managers will distribute the KPs to their key staff as job assignments. Then KPIs of the KPs will be used to measure performance of the assigned staff.

After the decomposition, the agreed development strategies were as follow:

- End-market oriented marketing based on co-operation and partnership
- After-sale service with quick-reaction and close-to-customers service
- End-market oriented R&D
- Professional, economic and safe painting engineering departments
- Safe, economic and just-in-time supply chain to satisfy customers
- Professional HRM

The breakdown of the second-level strategy (conceptual decomposition) is important. During this stage the core values, the key processes and key experiences of HB Company are emphasized. A logic model describes how an operation such as marketing should be operated and managed to achieve HB's strategic objectives. For example, marketing needs to form an effective sales team and this was discussed with the CEO, senior, and middle management. After these discussions, consensus was agreed for the following:

Marketing sub-actions: End-market strategies

1.1 Establishing the sales teams (for industry and domestic)

1.2 Enhancing the skills, integrity and qualities of sales team (through training, guidance and supervision)

1.3 Perform market and product research to understand customers' needs.

1.4 Expanding painting engineering service (labor, material, engineering, and service, all inclusive) for all key markets, and developing new domestic interior decoration partnerships.

1.5 Maintaining the customer relationship

1.6 Building an information sharing platform for the sales team

1.7 Producing annual sales plans

The key activities and the decomposition of marketing into the KPs of the second level are illustrated in Table 3. These key processes will be used to build the performance planning system. The same procedures were used for the key operations as highlighted in Step one to complete the decompositions for this level.

Table 3 about here

After discussions between the project management team, the researchers and the senior and middle-level managers conceptual decomposition were deploy for reaching consensus. The discussion and feedback in developing these decomposed models are essential for generating ideas and inputs from all levels, and to generate a much greater commitment to the final results. During discussions and feedback, it may be necessary to introduce changes both in operations and management structures. For example, in this project discussions led to the suggestion of the creation of a new HRM department to help operationalize KP at the individual level.

The researchers broke down the conceptual decompositions tasks into the procedural decompositions. After discussions with the CEO, senior and middle management about process optimization and the necessary adjustments were ascertain and linked tasks with HB's redesigned KP and KPI. These indicators were in alignment with the supporting processes, operation and departments. For example, Table 4 illustrates the supply chain management tasks in the conceptual model and existing supporting process decomposition. How far decomposition activity occurs depends at what stage KP and KPI for middle managers are made explicit.

Table 4 about here

Step 4: specifying targets and performance indicators

In Step four, the researchers utilize the KPs in sub set five of Steps two and three to formulate performance indicators for each of the KPs. The 3E indicators methodology is beneficial for each KP, for measuring efficacy, efficiency, and effectiveness to extract three groups of indicators (see Liu, et al, 2010). The overall approach is to construct, after debate and discussion, top-level root definition and conceptual model of the primary activities of the firm. Often too many indicators are identified, and it is necessary to reduce these to between five and nine. These indicators have to be discussed and agreed with the line managers, and their key staff.

HBs indicators consist of : E1 – *efficacy;* E2 - *efficiency*, and E3 – *effectiveness*, being the extent to which the outputs contribute to the objectives of the wider system. It is also possible to use quality, cost, speed, safety and quantity to derive and classify the KPIs. Then, after the project management team gaining approval of the CEO and his senior management team with input with appropriate line managers, the KPIs are determined.

Table 5 about here

Table 5 and 6 present the relevant KPIs for supply chain and supply chain director respectively. The indicators developed using the 3E methodology for each level of KP decompositions are varied. They will not be solely used as an operational metric, but for qualitative monitoring purposes during the HR staff appraisal process. In accordance with the underlying philosophy of an all-win organizational culture, promotions are dependent upon performance as set out in the SPMS. Innovative managers are able to create and individually distribute their KPIs to their subordinate staff.

Table 6 about here

Step 5: Planning and communication

For higher levels of performance management, the SPMS must have documentation that enables supervisors and their key staff to have two-way effective communication. The performance planning system is based on the KPs and KPIs, which had been developed in the previous phase, and thus the contents for communication and discussion are quite specific and systematic. The performance plans have two objectives, the coordination plans for groups, and the personal plans for individuals. At this stage, they will clearly articulate KPIs and supporting KPs.

The performance plans outline what specific tasks must be carried out for fulfillment of each KPs and KPI. Then, plans are agreed between the supervisor and their key staff for procedures for completing each task. *This can include: when, in what order, for what purpose and what task must be fulfilled? What specific method will be used in order to finish the task? What support from the supervisor and what resources are needed? When will the supervisor and their staff have the next face-to-face meeting for the fulfillment of each task?* These actions ensure that each supervisor is well aware of the likely difficulties that each staff member encounters.

This stage involves the design of performance plans based on the KPs and KPIs already formulated. These plans enable HBs managers, supervisors and key staff within the hierarchical structure to communicate and negotiate effectively. The communication process can be iterative with top-down and bottom-up processes, which can occur several times prior to the final agreement of the performance plans.

The performance plan analyzes what specific tasks must be carried out for each KPs so that the KPIs can be fulfilled. Afterwards, supervisors and their subordinates should reach consensus on specific methods and procedures. Then the supervisor and their subordinate have the next face-to-face communication about the fulfillment of each task? To determine any necessary adjustments to the target, or new procedures required in light of any internal or external changes affecting HB. The whole process is broken down into smaller parts and these are tracked. Thus, the supervisor is well aware of the difficulties that the subordinate encounters in the progression of their work. The promotion team developed the specific contents for the performance plan for each operation, in accordance with the KPs derived in the third phase. Each performance plan is agreed jointly by managers and subordinates in terms of: tracking their subordinates' progress; providing proper guidance; keeping records of their tracking and guidance.

This practical management planning approach is useful. It ensures the supervisors should promote, through proper planning, the idea of sufficient communication between the supervisor and the subordinate. Ensure that they have full knowledge of the subordinate's tasks and their progress, and that the subordinate is clear about the supervisors' possible support and guidance. This procedure contributes to fulfillment of effective collective performance driven by individual performance.

Step 6. Assessment and Feedback

All of the face-to-face meetings, difficulties and progress should be recorded in the '*KP Adjustment and Tracking Record'*. Suitable assessment and feedback is needed with suitable in built mechanisms for rewards or corrective interventions

HB provides training for its staff to help managers' work effectively with the PT and help explain the new system to their subordinates. This process includes providing a booklet on the "ABC "of performance management (which includes main tasks, tools, objectives) which is given to senior management and every line manager, to learn and maintain basic knowledge on the PT. Simulation based training sessions (which include performance plans, and assessments) are provided for each department, so that the nuances of each department can be incorporated. HB staff have individual SPMS in their performance plans. Heads of departments have SPMS for their departments within their performance plans, and then their staff have their own more detailed ones, which are derived from the department SPMS. The performance evaluation and reward process consists of two parts. The assessment for routine tasks given by line managers being (60%) and their supporting KP (40%).

Assessment will vary for different levels of staff. For example, assemble line workers' assessment is performed by interviews conducted by supervisors. However, the assessment for middle level managers incorporates a 360-degree method. The reasons for these differences are work complexity, and span of control. The middle managers' job are much more complex and flexible, with increased uncertainty. HB assesses operational staff monthly, and annually for managers and R&D staff.

5. RESULTS AND DISCUSSION

5.1 Performance Tree outcomes

At the start of project HB senior management wanted to address the strategic issues of severe competitive pressure and falling sales by developing a renewal strategy that would enhance strategic alignment. Then develop a dynamic SPMS that would play a prominent role in the (re) formulation process by translating the new strategy into a new set of useful metrics for management and employees. The PT offers a flexible framework that enables all staff to plan pro-actively to achieve their targets, and anticipate and cope with external shocks. The SME environment necessitates that HB has internal processes that translates strategic goals right down to KPIs at low levels of activity. Implementation of the PT was judges by senior management and staff to have been very successful, and HB now has a more strategic orientated PMS.

From a strategy perspective, the implementation of the new SPMS was successful. A key strategic objective was a sales target for signed contracts of £100 million for the period 2013-2016; this was achieved one year in advance. HB's board members identified another four benefits from the implementation of their PT:

- The rational and strategy decomposition approach helps HB Company identify new niche expanding markets, such as water-based industrial paint research, and high-end decorating. Their strategic analysis led to HB Company withdrawing from the low margin shipbuilding, and low-end civil decorating markets. In terms of market positioning, the HB brand is now market-leader in Chinese water-based industrial paint market, and the high-end civil decorating market. Both of these business segments contribute more than £30 million annual profits in the past two years.

- The PT analysis led to an organization reorganization, which by the end of 2012 created a new HR department and a more effective R&D department. The new HR department recruited new sales managers by using local headhunting companies. In 2013, this led to HB Company winning a large contract from Rio Tinto Austria. The more professional HR department enhanced the skill-set of the R&D and sales team by bespoke training programs, which contributed to a growth in sales.
- The new KP and KPIs based performance measurement and management system ensures the key supply chain operates more efficiently. The manufacturing manager described the system as "I can fix current or potential problems easily by changing KP/KPI or their scale range. The new system is like a "kommandoflagge" holding in my hand – where I am pointing to, where my subordinates are running to." Now, with two manufacturing bases thousands of miles apart, the HB Company can now serve a broader range of customers with its high-quality products.
- The flexible performance plan system provides explicit guidance on operational issues, which reduces conflict among managers. This plan allows senior management to focus on more holistic matters. The CEO explained the benefits by using the example that he had more time to lobby government to help them issue a new standard - The water-based railway paint industrial technical standard. Then he said with a smile, "Currently, HB is the only company that meets all criteria in the standard, which guarantees a leading position for us in railway paint market."

5.2 Discussion

This action research project has shown the importance of looking beyond traditional PMS. The usage of new knowledge and techniques can create new technical system attributes. The PT incorporates salient KP/KPI construction with quantitative and qualitative analysis. At the heart of any change management initiative is organizational human resources, which is of critical strategic importance. The new skills, behaviors and cross-functional processes provide the foundations for SME strategy implementation. Furthermore, the evidence suggests that successful SMEs place increased emphasis upon the development of new ways to reduce uncertainty, enhance innovation and cope with evolution in a dynamic environment. New employee and customer-focused techniques together with the maintenance of knowledge can help identify new gaps in the marketplace. Previously, failure to address such issues led to management destructing rather than enhancing SME economic value.

This study demonstrates the usefulness of action research. Creating real understanding of HB's strategic challenges is only halfway to solving them. The development of a dynamic SPMS using the PT approach helps develop alternative solutions. The collaborative manner of the project dealt with understanding sources of resistance to change. Developing a successful SPMS involves appreciating resistance to organizational change. Given the uncertainty SME environment some staff were uncomfortable, but needed to engage in new processes. The project management team was responsible for ensuring that all staff had the opportunity to voice their concerns, but then presented sometimes through staff development activities the reasons why changes had to be made. HB's senior management welcomed the opportunity to use the scientific results of the interplay between management research and management practice, but were worried about making mistakes.

In the editorial article of the SPMS special issue of Long Range Planning, Robins, and Baden-Fuller, (2010) suggest that myopia may cause strategy mistakes: measurement issues should shape strategy as well as control it. This study shreds light on the connection between SPMS and SME strategy making. This paper presents an in-depth examination of the implementation of a new SPMS for a Chinese SME paint manufacturer. Then unpick some of the nuances of creating SPMS for SMEs. The balance between financial and non-financial measures needs to complement the organizational context. HB was in need of a renewal strategy as it was facing a rather difficult future operating in a mature and competitive market. The PT illustrates how a dynamic SPMS can enhance strategic alignment, and play a prominent role in the (re) formulation process by translating the new strategy into a new set of useful metrics for management and employees. This project contributes to ongoing efforts to developing new insights into the SPMS literature and by proposing an approach that can be fundamental to SME organizational success.

Practitioners and researchers face a challenge in recognizing that PM may not be aligned with strategy. When attempting to enhance strategic alignment, the SPMS may become rigid and reduce adaptiveness to changing circumstances (Bititci, Turner and Begemann, 2000). As Kolehmainen (2010) mentions building substantial dynamism into SPMS requires a combination of management practices that seek a balance between empowerment and alignment. This research provides evidence of achieving this too via empowerment and alignment. One of the basic concepts of this paper is that the SPMS is constructed according to the various perspectives of key internal stakeholders. Within a SME context collaboration among staff at all levels is crucial. The PT evolves through open dialogue, investigations, discussions, actions and outcomes, which can operate in dynamic environments and cope with uncertainty, innovation and evolution. Despite SMEs not having scale to possess highly differentiated internal labor markets, each group of staff needs to be empowered and have a distinctive set of HR policies and practices.

The project presents a study that can help inform policy and practice, which can enhance socio-economic climate in China. The PT can illustrate a model of action that is participative and empowers certain members of staff within HB. Given the number of SMEs within China and also their size, which can be much larger than their western counterparts, the improvement in quality of life for staff can bring additional benefits. These benefits will accrue to all stakeholders and as the business expands, the socio-economic impact can move in a favorable manner. For example, HB may see: changes in local demographics which may enable them to employ better quality staff, increased demand for retail and housing, which together with enhancements in the aesthetic quality of the local environment will make HB a company where people want to work.

6. CONCLUSION

Post implementation discussions with HB staff suggest that the PT provides a number of internal benefits. For example, when comparing the PT with the old PM, HB management felt the former offers a variety of enhancements. Table 7 provides a summary of HB's old PMS and new SPMS. The old PMS process only involved a small number of senior managers who were actively involved in strategic decision-making. Unfortunately, this led to a lack of buy-in from other employees and no strategy initiative could sustain for a period of more than one year. The strategic planning exercise became an annual ritual. Now the PT involves a broader range of stakeholders (e.g., line-workers, line-managers, distributors, and customers) in the strategy making process. New strategic initiatives remain in existence beyond a twelve-month period. Moreover, strategic initiatives are now derived directly from the top strategy decomposition exercise, which ensures the company's operational tasks are in alignment with the strategy.

Table 7 about here

The old PM procedures paid too much emphasis on the KPI results, which only reflect historical events, while the new system focuses more on the performance plan, which keeps managers and their staff fully engaged to analyze strategic performance. Measuring contribution to strategic performance at the individual level enhances the level of staff motivation, with staff being able to translate action plans into individual action-oriented targets. The PT enables HB to adjust KPs; KPIs proactively to cope with unexpected market changes and engage the organization in strategic thinking. As Gimbert, et al., (2010) assert when the PM is integrated into setting the renewal strategy, then it will make a real difference to strategy. Consequently, HB was able to quickly create renewal strategies, in order to maintain a leadership position in their key markets. The PT developed and elaborated here details the salient steps in developing a SPMS for a Chinese SME.

Prior studies illustrate that SPMS can have a beneficial impact on performance (Bisbe and Malagueno, 2012; Crabtree and DeBusk, 2008). With this success being attributable to the successful implementation of a renewal strategy (e.g. Garengo et al, 2005). In accordance, with the above expectation, and in line with the HB aspirations this study support prior research performed in different contextual settings. The tree structure approach captures a visual depiction of a complex and time-consuming process. The PT can be used as a tool for strategic management for a manufacturing oriented SME. When used in a practical context, the scope of PT analysis can be flexibly differentiated depending upon the SME context and strategy. In agreement with observations by Melynk, et al., (2010), HB management realized that their old PM system actually constrained creative thought and felt they had to undergo fundamental change, by dismantling blockages which had led to the removal of the inappropriate measurement system.

6.1 Limitations and future research

Despite the contribution mentioned previously, this action research study is still subject to some limitations. It focuses on a single case in a single country. In this instance, the study might have been affected by some of the Chinese peculiarities in terms of SME context and culture. Hence, as stated by Franco and Haase (2015) this potential “culture effect” arising from the geographically research context, may affect the generalization of observations inherent in this study.

In addition to the challenges raised in the study, a paucity of SMEs SPMS studies that consider the actual impact of their research. This paper makes a rigorous and relevance contribution for academics and practitioners, and is useful for both for the academic discipline, and SME practice. However, the single organization used in this case study may also affect the generalization of the findings. Future studies should pursue further qualitative research in order to investigate SPMS in other real-life contexts. These studies could cover the application of dynamic SPMS in other business settings, with consideration of the formation of new business drivers. Eisenhardt's (1989) provides some clarity on case study strengths, which can be deployed by future research to generate novel theories, test emergent theories or hypotheses and seek empirical validation.

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TABLES

Table 1 Chinese SME definitional characteristics

Industry	Number of Employees	Annual Revenues (Million China Yuan)	Overall Assets (Million China Yuan)
Manufacture	2000	300	400
Construction	3000	300	400
Wholesale & Retail	500	150	***No requirement***
Transportation	3000	300	***No requirement***
Hotel & Restaurant	800	150	***No requirement***

Table 2. Description of data used

Type of data		***Contents***	***Purpose***	***When gathered***
Interviews	*First line employees*	*Interview with the first line employees in the product, marketing, sales and administration departments*	*To obtain opinions about pros and cons of current PM system and practices.*	*The first week of the case study*
	Middle-level managers	*Interview with core and assistant departments managers*	*To clarify the practice situation of HB company's current PM system and how managers' lead and manage their departments (special focus on the unique ways they operate their departments).*	*The second week of the case study*
	Top-managers	*Interview with top-managers who draft strategy and conduct overall management.*	*To gain comprehensive understandings about HB company's current objectives and strategies, also the tops' expectations for the PM system.*	*The third week of the case study*
Internal documents		· *Strategy planning documents* · *Business planning documents* · *Organization handbook, including organization structure, department structure, jobs description* · *PM related management documents (including training, assessment, reward and salary etc.)*	*To provide a general view about strategy implementation, performance management and departments' cooperation in HB company. Furthermore, compare above approaches in the documents with their practices.*	*The first and second week of the case study*
Group discussion		*Organize group mid-level managers' discussions relating to key information about HB company's strategy and PM procedures*	*To deepen understanding of HB's strategy and PMS, then clarify why gaps exist between documents and practices.*	*The fourth week of the case study*
Open-access information		· *Official website* · *Customers online reviews* · *The other online sources*	*To provide a complementary angle to HB company's internal & external environment, strategy implementation and the use of current PM system.*	*Overall case study*

Table 3 Conceptual Decomposition of the six key activities

Development strategies					
Marketing	**After-sale Services**	**Research and Development**	**Painting Engineering Departments**	**Supply Chain Management**	**Human Resource Management**
Building sales teams	Handling customers' feedback promptly	Understanding and anticipate needs for key markets, in terms of production innovation and development	Improving safety, quality and speed of engineering processes	Collecting information about quality and price of the materials and building information database	Setting up the HRM department
Cultivating talents and raising the skills;	Improving customer services processes	Organizing R&D efficiently and timely.	Improving process cost assessment	Formulating production plan based on sales plan	Achieving the routine HRM jobs
Carrying out the market research and understanding customers' needs	Building the 'work-score' job system.	Cultivating talents and raising the skills for R&D staff	Constructing a regional engineering department management system	Economic, reliable and timely purchase of materials	Establishing monitoring and management regulations
Expanding painting engineering service for the key industry markets, and developing domestic interior decoration partnerships	Enhancing the communication with customers and collecting their feedback	Enhancing quality of products and controlling costs through innovation and cost management	Improving quality management based on benchmarking, from reactive management style to a more proactive management style	Safe timely and economic production processes	Understanding concepts of performance management and deploy the performance assessment
Maintaining the customer relationship	Developing training programs for customers and relevant internal units	Effective motivation for R&D staff	Cultivating talents and raising the skills for managers of engineering departments by setting benchmarks	Total quality management	Cultivating organizational culture
Building the Information Sharing System for sales	Cultivating talents and raising the skills through training	Enhancing the process management of R&D, and shortening the R&D period.	Reporting the customers' feedback and requirements in time	Safe and lean stock management and logistics	Establishing the communication channel for mangers and employees
Making the sales plan				Cultivating talents and raising the skills through learning and training	Understanding organizational and personnel requirements and making career plans

Table 4 Supply chain management procedural decomposition

Key perspective	**Internal operation perspective**	**Tasks in conceptual model (2nd level processes)**	**Existing support process (3rd level processes)**	**Relevant departments**
Internal Process	5 Supply Chain Mgt	5.1 Collecting information about quality and price of materials and building database.	5.1.1 Collecting suppliers and materials information by internet, phone call, etc. 5.1.2 Record and update the information	Purchase Department
		5.2 Formulating production plan based on sales plan	5.2.1 Verifying the sales order 5.2.2 Timely price evaluation 5.2.3 Check level of storage 5.2.4 Timely production plan	Sales Department Production Department Stock Department
		5.3 Economic, reliable and timely purchase of materials	5.3.1 Economic, reliable and timely purchase of materials	Purchase Department
		5.4 Safe, timely and economic production processes	5.4.1 Safe, timely and economic production processes	Production Department
		5.5 Total quality management	5.5.1 TQM for materials in-stock, production process, product in-stock, out stock. 5.5.2 Quality checks by two inspectors 5.5.3 Product segmentation 5.5.4 Learning and training 5.5.5 Motivation	Quality Control Department Human Resource Management Department
		5.6 Safe and lean-stock management and logistics	5.6.1 Delivery by HB for local customers, 5.6.2 Delivery by external co-operators for non local customers	Stock Department Production Department
		5.7 Cultivating talents and raising the skills through learning and training	5.7.1 Cultivating talents and raising the skills through learning and training	Production Department Human Resource Management Department

Table 5 KPI for supply chain

HB Supply Chain KPI													
KPI weight 60%													
Indicators		Index definition	Weight	Period	Assessment Grade （% ）						Examiner	Remark
					0	20	40	60	80	100		
General KPI	Staff turnover rate	No of staff turnover/Total staff	5%	Month	4%	4%	/	3%	/	2%	CEO	
	Job instruction coverage rate	Completing each work and following the job instruction	5%	Month	10%	10%	15%	20%	25%	30%		
	Completeness, and normative of the records	Records/records required	5%	Month	96%	96%	/	98%	/	100%		
	The time for making meeting decisions	Based on minutes of meeting	5%	Month	95%	95%	/	98%	/	100%		
	Staff learning and growth	Training times and effectiveness	5%	Month	85%	85%	88%	90%	93%	95%		
	Internal satisfaction	Satisfaction survey	5%	Month	85%	85%	88%	90%	93%	95%		
	Implementation of regulation	Implement regulations effectively	5%	Month	80%	80%	85%	90%	95%	100%	CEO	
Production Management	Production cost control	Input/output	15%	Month								
	Production quality control	POP of product and package	10%		85%	85%	87%	90%	92%	95%		
	Production management	Complete rate of the production plan	10%		90%	92%	94%	96%	98%	100%		
Purchasing Management	Purchase cost control	Average % increasing on purchase cost	10%		≥1	1	97%	95%	93%	90%		
	Purchase quality control	QC passed batches/Total batches	10%		90%	92%	94%	96%	98%	100%		
Stock Control	Storage regulation implementation	Passing rate of the storage spot check	5%		90%	92%	94%	96%	98%	100%		
	Inventory management	Delivery accuracy Storage deviation	5%		90%	92%	94%	96%	98%	100%		
Events leading to reduction of score	Safety accidents	each_grade, reduce_points										
	Equipment trouble led to stop production	Stop production every hour ，reduce_points										
	Out of stock rate	Out of stock rate reduce_point										
	Fire-equipment perfectness	100%-perfectness										

Table 6 KPI for Supply Chain Director

KP for HB Supply Chain Director							
Key Processes	**Description of KP**	**Expected outcomes**	**Key tactic**	**Monitoring Indicators**	**Weighs (%)**	**Deliverable & Assessment period**	**KP Weighs: 40% Self-assessment**
Purchase Process Management	1. Building supplier evaluation system 2. Understanding material market trend, establishing price comparison system. 3. Standardizing purchasing processes, based on supplier evaluation system 4. Ensuring the quality of purchasing material 5. Reducing evaluation purchasing prices			1. Effectiveness of price comparison system of material 2. Effectiveness of supplier evaluation system 3. Number of purchasing accidents 4. Volatility of material price year-on-year			
Enhancing Quality Stock Management	1. Improving storage undamaged rate for material and product 2. Monitoring the level of storage 3. Improving the accuracy and promptness of receiving, issuing of goods			1. Damaged materials and products 2. Rate of storage level that is reaching the standard 3. Accuracy and promptness of receiving, issuing of goods			
Production Quality Management	1. Improving quality of products 2. Co-operating with Quality Control department			1. Finishing rate of quality control of production process 2. Number of quality problems that caused by production process			
Production Process Management	1. Planning and Scheduling the production 2. Maintaining			1. Number of times that break the production regulations 2. Number of			

	equipment 3. Enhancing units management 4. Enhancing production regulation management 5. Enhancing safety management, reducing work injury, end safety accident			production accidents 3. Input/output ratio for production units			
Production Cost Control	1. Reducing production costs			1. Input/output ratio for single product			

Table 7. Comparision of HB Company'sold PM and new SPMS approach

	The HB company's former PM approach	The HB company's improved SPMS approach
Strategy clarification	Based on the tops' overall understandings to the company internal and external environment. The final strategy may contain several scattered strategic points, but their connections and cooperative relationships were still blurred.	The departments' managers give their formal reports about the internal and external environment they meet with and their initial plans for the further development. Furthermore, the company tops integrate information streaming from down departments, and then mix with their opinions to generate the performance map of this strategy-term, which contains several crucial strategic aspects – the performance trees.
Strategy decomposition	Mostly depending on the tops' assignment.	**Top decomposition**: Following the performance map to identify which departments play essential roles in the performance tree and which of the rest departments should assist and cooperate with essential departments. **Conceptual decomposition**: Furthermore, the general role and task of essential departments in the performance trees are further decomposed into sub-objectives and key activities to clarify how to achieve above role and task. **Procedural decomposition**: decomposing sub-objectives and key activities in above step until they are detailed into practical actions and steps.
Strategy deployment	The deployment step was not very clear in HB company's PM system. The mid-level managers deployed the strategic tasks by their understandings. However, their understandings were not always correct or entire enough.	The strategy deployment is accomplished in the last step to a large extent. If the departments' managers still have doubts, they can obtain more clear knowledge about deployment by meeting with the tops or cross-department discussion.
Indicators extraction	The most of the key performance indicators were financial criteria and their connections were not systematic enough.	The key performance indicators deduce from key performances, which derive from the strategy. Furthermore, the applying of 3E method ensures the indicators are comprehensive and systematic enough.
Performance plan formation	The hypothesis in the HB company's past PM system is "when employees know their KPIs, they should also know how to achieve them." Therefore the performance plan is not an independent step.	The company tops will discuss with departments heads about how they will accomplish their departmental KPIs and extra helps they need. Then, the similar discussion will carry out in the department until everyone involved fully understand how to conduct.
Assessment and feedback	Assessing against KPIs and feedbacks mostly are inadequacies of employees' work.	Assessing against KPs, KPIs and Non-KPIs, and the performance feedbacks are about helping employees' improve their performance in the next term.

FIGURES

Figure 1 SPMS development process of performance tree

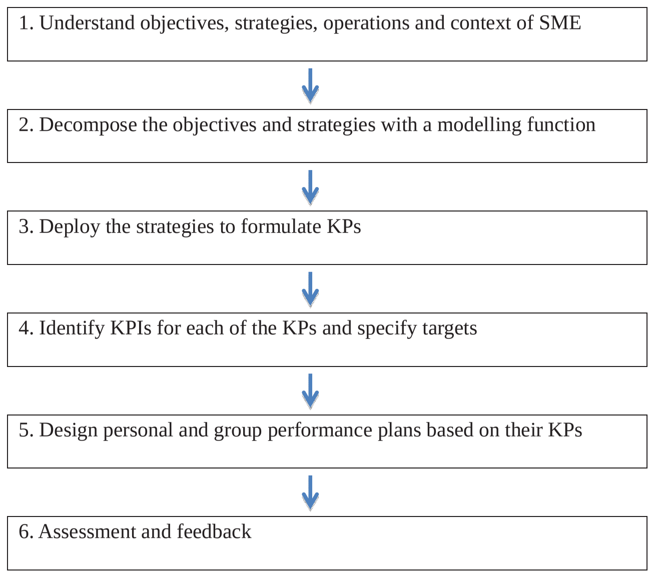
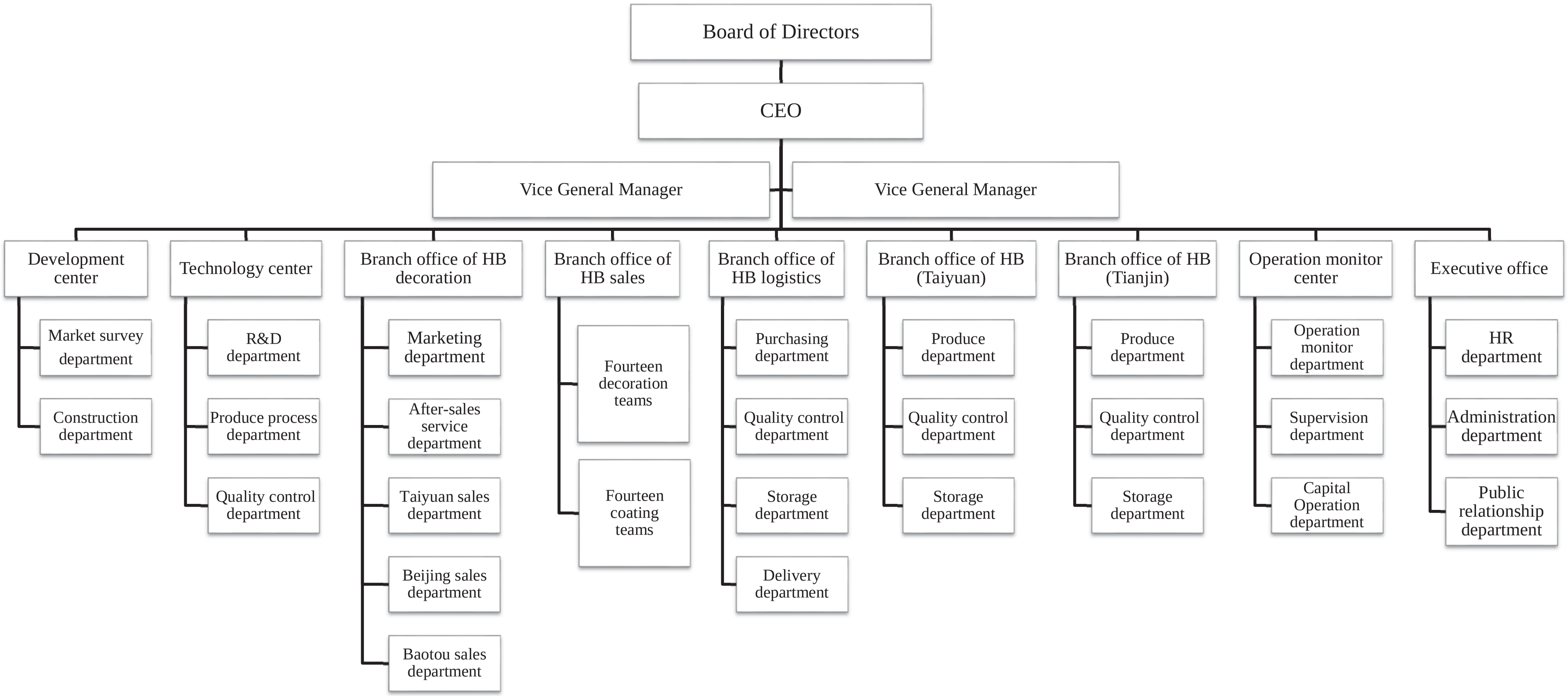


Figure 2. HB Organizational chart



Performance Tree: A Performance Process-Oriented Management Framework

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Abstract: In this paper we introduce several new concepts and set up a performance tree framework based on these new concepts. With them we can systematically elaborate our new theory and develop examples from the real business cases.

The performance tree framework is designed for improving organization's performance by constructing and adopting a performance management system based on building and managing the performance tree. From the view of the PT framework, which has five basic elements: stakeholder, objective/strategy, performance set, performance tree and performance unit, performance management is continual improvements delivered on the performance tree.

Specifically speaking, in an organization, the performance processes in its performance tree are determined by the key stakeholders against the objectives and strategies. Then the performance goals and metrics in the performance set will be developed to guide and monitor the activities from its performance tree. Finally, depending on the cooperative relationships in the processes, they are grouped to form performance units for the sake of specialization and managerial convenience.

One case is illustrated to explain how to build up a PT system in a commercial bank. Several advantages of the PT framework will be discussed, such as facilitating organizational innovation, higher flexibility, wider applicability and data-friendly.

1. Background

With progressing of globalization and digitalization, the internal and external environments for organizations are changing rapidly. For instance, the "big-data" thinking is reversing traditional business models and the emerging "Web of Things (WoT)" makes goods, services and capitals flowing with a speed never seen before (Bughin, Chui et al. 2010, Roman, Zhou et al. 2013).

Above changes bring both pros and cons to organizations. On the one hand, the markets emerging with new technology offer tremendous opportunities to organizations – only the "big-data" related business created a $32.4 billion-worth market and its annual rate of growth is 27% (IDG 2015). On the other hand, from 2010 to 2015, the mortality rate for SMEs in the US market was 53%, which increased 16% in the past ten years (World Economic Forum 2015).

Facing up to above challenging environment, a satisfactory PM system needs to ensure the organizations reacting swiftly by adjusting managerial factors in time (Den Hartog, Boselie et al. 2004). Furthermore, it should help organizational transformations by optimizing performance-generation processes independently from organizational structure.

What is more, the stakeholder anticipation is another important aspect for organizations to handle the changing environment. Wider involvement of key stakeholders in building up the performance management system not only improves operational processes, but also reduces organizations' risks in implementing the system by balancing interests of key stakeholders (Bourne, Franco et al. 2003, Harrison, Freeman 1999).

In addition, the operational and managerial data is viewed as a strategic resource for an organization nowadays. Therefore, a satisfactory performance management system should be data friendly (Rabl, Gómez-Villamor et al. 2012).

However, the existing performance management methods can hardly meet above requests. The existing PM approaches can be classified into three types based on their different internal logic and characteristics:

The first approach manifests as empirical guidelines or key practical points in performance works, such as Otley (1999), Smith & Goddard (2002), Fitzgerald et al. (1991), O'Hanlon & Peasnell (1998). The methods in the first approach set some principles for the modern performance management research. However, because of their personal experiences based nature and loose internal logic, they are confronted with multiple criticisms about their efficacy and stability.

The second approach is represented by the European Foundation for Quality Management Excellence Model (EFQM model) and Malcolm Baldrige National Quality Award Model (MBNQA model). Some organizational factors are organized by operational or business logics in the methods of this approach to exhibit a "generalized correct way" for enterprises. Comparing with the first approach, the second type approach is more comprehensive both on theory construction and application effectiveness. However, the PM factors in the methods of second approach are over-abstracted, as the expense of its general applicability pursuing (Gómez-López, Concepción López-Fernández et al. 2015).

The third approach is represented by scorecard methods, which contains several PM methods widely used today, such as the balanced scorecard (BSC) and the public sector scorecard (PSSC). These methods decompose organizations' objectives or strategies stepwise by their pre-fixed logical or operational procedures to construct a performance management system, and then establish corresponding key performance indicators (KPIs) to manage the system (Kaplan, Norton 1995, Moullin 2009).

Several deficiencies can be identified from the existing PM methods against above requests. Currently the third approach is by far the mostly used. To take the scorecard methods in the third approach as an example, following issues can be pointed out:

1) Hinder organizational structure innovation

The scorecard methods' implementation highly relies on the existing organizational structure. The decomposition processes of the scorecard methods are conducted according to the organization's existing organization chart, operation flow and bureaucratic system. In above process, scorecard methods potentially constrain users to solve the faced problems under organizations' current formal structure. The performance management system generated in above way will further solidify organizations' current configuration and hinder potential organizational structure innovation.

2) Difficulty to express or balance comprehensive stakeholders' interests

The stakeholder factor has not fully embodied in most of the scorecard methods. For some methods, which represented by the BSC, only limited catalogs of stakeholders are considered (such as customers and employees). Some the other scorecard methods, such as PSSC, consider stakeholders' role in an isolated manner. For instance, there is an independent factor "service users/ stakeholders" in the PSSC framework, but how to embody this factor in the operational remains a key problem. Therefore, the value of stakeholder factor in most of the existing scorecard methods is more symbolic.

3) Inadequate flexibility

The scorecard methods are designed for organizations' global managerial needs, by adopting pre-fixed global business logics. However, these logics may not applicable inside a department. It is difficult to apply the methods to a department alone.

Therefore it is necessary to have a satisfactory PM framework that can help organizations managing performances from a perspective of performance generation processes in order to assist enterprises to adapt to changing environment swiftly and efficiently. To this end, a new performance management framework is introduced below.

2. The performance tree framework

In order to introduce the PT framework, some basic concepts will be discussed here firstly.

There are three basic dimensions to describe an organization's performance, which are outputs, processes and (potential) influences (Al-Turki, Duffuaa 2003).

Therefore at the macro level, performance measures how well the organizational and sub-level objectives are being achieved, the required processes for the achievement, and their expected impacts.

Performance structure: In any organization, personal performance converts and aggregates into sub-level performance, then finally integrates to the top organizational performance, and above process is defined as the organization's performance structure. Because the structure is continuous and dynamic, it is very difficult to describe an organization's performance structure fully. Instead, depending on the organization's managerial capability, we often sample the performance structure from certain strategic and managerial perspective to extract a simplified performance network as describe below.

At a micro level, an organization has a set of activities (action sets), which carry out the strategies of the organization, and lead to the satisfactory completion of organization objectives. For each of the activities, there is a corresponding performance to measure theprocess; achievement and influence of it. Clearly, according to the needs of deployment and implementation these activities may need to be further split into sub-activities which detail how the superior activity is to be achieved. The resolution of these activities and their sub-activities largely depends on organizational strategy and the level of detail in management.

Performance network: Based on the activities in the action sets, we can form the performance network. If we consider performance of each of the activities as a node, a performance network can be formed by performance nodes and aggregation paths between nodes; it describes performance at all managerial levels and how the performance is aggregated.

The aggregation paths indicate how the performance is aggregated. Simply speaking, these paths show the relationships between each of the activities in the process of performance generating. The top nodes of the performance network should be the overall performance of the organization, and the bottom nodes should be the nodes that represent the performance of the finest activities limited to the managerial resolution (how detailed the organization wants to manage).

The performance network in an organization can be formed in different ways: one is to sample the performance structure according to certain strategic and managerial perspective. For instance, the scorecard methods can form a performance network by following the organization's strategies and the existing operation processes according to pre-fixed logical frameworks. The other way is to build new business procedures by applying some approaches (like SSM) and discussing with key stakeholders (Liu, Meng et al. 2012). In practice, the two approaches can also be mixed. Nevertheless, the key stakeholders are important in developing an organization's performance generation and management processes. The internal & external stakeholders provide indispensable resources and form environmental factors for the performance generation.

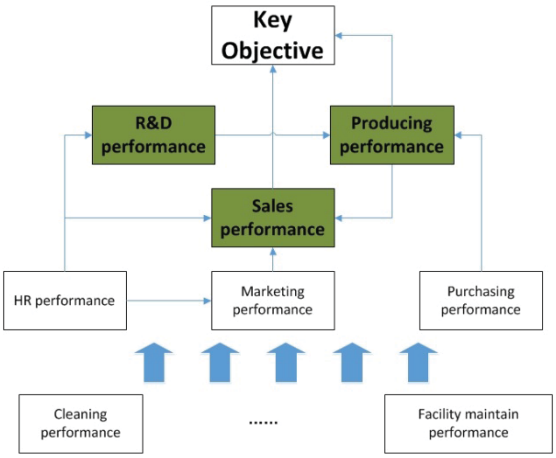
Based on the key stakeholders and the performance network, we can identify the performance tree of an organization, which is the key part of a performance network.

Performance tree: An organization often has different performance; some are more important than others. The organization could identify some key performance, and then those activities which are necessary to achieve key performance are called key activities. Correspondingly, we can identify key performance nodes and paths from the performance network, which form the key performance network; we call it as the performance tree since it often has a tree structure.

The performance tree is the crucial part in our method. Performance management concentrates mostly on key activities and key performance. In our method, we try to identify and form the performance tree, and then develop suitable ways to manage it in order to improve the organizational performance.

The structure of the performance tree is dynamic, and will be updated and adjusted according to the current strategy and objectives. Clearly, management preferences are reflected in the performance tree. In fact, a PT likely consists of not only physical business processes, but also key management processes, which then become formal managerial procedures. Therefore, to some extent, a performance tree reflects the managerial styles of the organization.

Let's take a company as the example to elaborate. Assuming one of the company's critical objectives is to improve profit rate by product innovation. Under above goal, the performance-generation actions from the R&D and producing departments are critical, because they determine whether the top objective is accomplishable or not. However, some the other actions, such as market information collection, HR supporting, even workplace cleaning, also contribute to the top performance indirectly. All above actions with different importance form a part of the company's performance network. However, considering the resources constraint, the management will focus on the indispensable actions to ensure the top objective being met, and these actions form a part of the company's performance tree (green part):



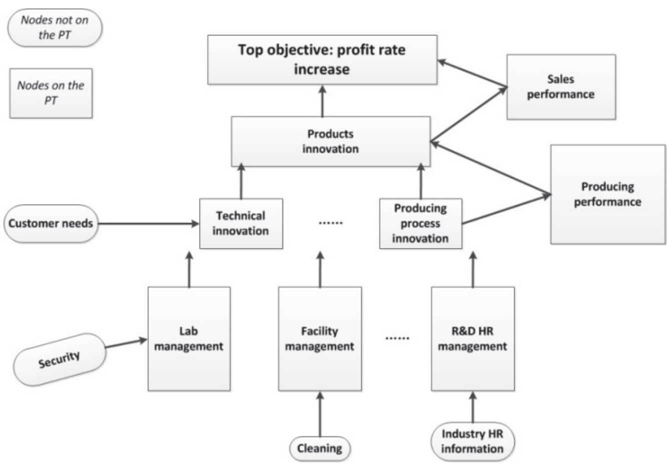
Performance network and tree are dynamically updated with the technology, operation and strategy of a company. For instance, if the company added another key objective: "improving the products quality by strict dust controlling in the workplace", then the cleaning performance, a marginal performance in the former case, and its aggregation nodes will be brought into the performance tree. Furthermore, the company's performance management ability will also affect the detailization of the performance tree. Before giving more illustrative examples we introduce two more key concepts:

Performance set: The performance set contains serials of performances goals and corresponding metrics. Under ideal conditions, contents of performance sets have a hierarchical structure: Contents of a lower level performance set should include a subset of that of its immediately upper sets, although they are usual different. For example, some local managerial requests can be added into the lower level sets to reflect local managerial preferences.

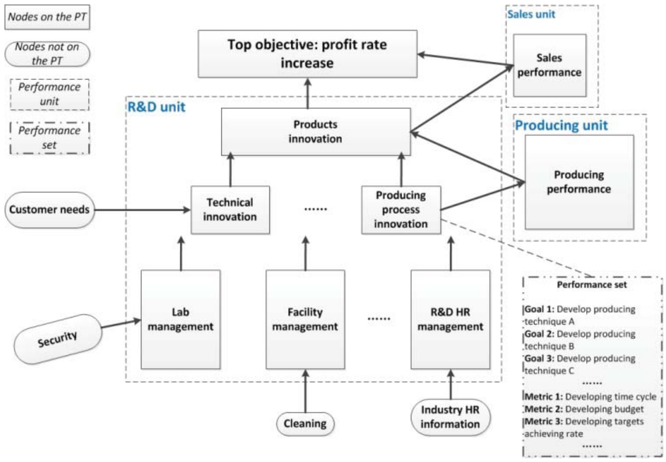
Performance unit: It contains performance sets, performance nodes and stakeholders to achieve comprehensive performance targets. If a performance unit only contains indispensable nodes and stakeholders, it is referred to as a "lean performance unit".

In a performance unit, stakeholders and their activities, plus necessary environmental factors form its formal organizational structure. A performance unit's formal structure could, but not necessary, be coincident with the organization's existing organizational chart. When this happens, it is an actual performance unit; otherwise it is a virtual one. In practice, the virtual performance units can shed lights on the organization's other possible configurations, thus present scenarios to organizational structure changes. The hierarchical relations exist amongst performance units, which are organized by their successions in the organization's strategy implementation plan.

Here we deliver another example to further explain above concepts. Still, let's take above company, whose key objectives include "*increasing 15% profit rate by products innovation*", as the case again. Obviously, the R&D and production performances are the crucial ones under current strategy. Therefore, the performance tree should be formed around them to support these strategic performance generation.

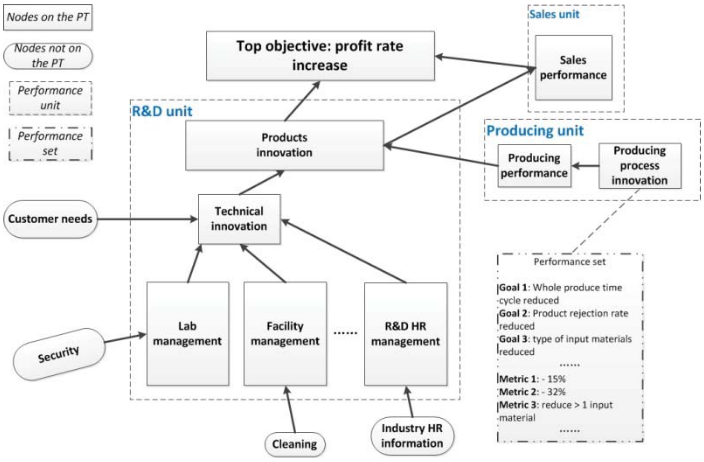


It is can be seen that above PT is mainly made from the R&D and production related nodes, although there are other nodes in the performance network. Accordingly, the performance set against each node contains performance goals and metrics under the same themes. There are two main sources to decide the set's contents: performance inherited from the upper level and performance from local management needs, as showed below.

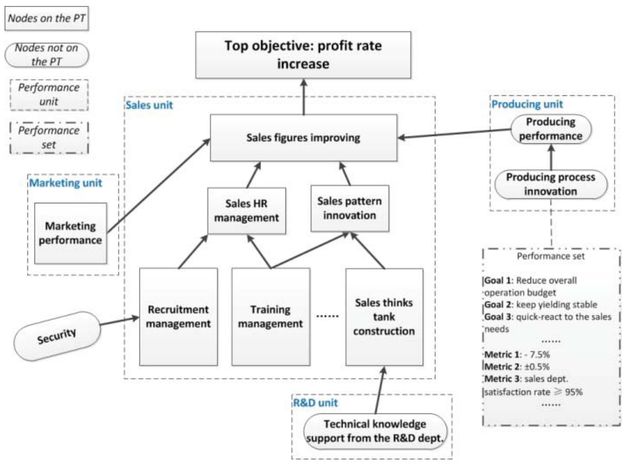


Formulation of performance units depend on, interactively, that of performance nodes, sets and stakeholders. In this case, most important R&D performance-related nodes have been kept in one unit. The works as HR and facility maintaining are conducted by the other independent departments under the normal circumstances, but in this case all of them are included in the new R&D performance unit, in order to decrease coordination hazards in the strategic performance generation process. Let's emphasize that the performance units can be actual or virtual, in the latter case they are not coincidence with current managerial structure. The virtual performance unit can shed lights on the organization's possibly improved configurations, and hence may deliver scenarios on the organization diagnosis or transformation. This is very useful for the PM in the case where organizational structure is rapidly changing, which will be elaborated later.

The interactive relationships exist amongst the performance node, set and unit, which mean if one of them changed the rest may need to change accordingly. Moreover, the configuration of above three elements is fundamentally determined by an organization's objective and corresponding goal-achieving path. For instance, if one of the elements in above chart changes (e.g. "Producing process innovation" node is allocated to the "producing unit", which is outside of "R&D unit") the other two basic elements may change accordingly. In this case, clearly the R&D unit lost one node, which is gained by the "producing unit". Moreover, because of this change, performance set of "producing process innovation" node may change too. The goals and metrics in the set shifted from R&D project-oriented contents before, to the new requirement focused on production-process improvement, as shown in the new chart below.



More dramatically, if the company's key objectives are modified, the whole nodes, sets and units configuration may have a revolutionized change. For instance, the chart below shows the company's structure under the key objective of "increase the profit rate by innovative sales methods".



Solid-line

3. PT based performance management

Various attempts are conducted to define the performance management, such as Armstrong & Baron (2000), Aguinis (2009), Lebas (1995).

Based on the new concepts above, we describe our PT performance management as: ***Enhance organizations' performance by firstly developing the performance tree according to its key objectives/strategies, and then properly managing performance tree, e.g. through performance units and KPIs.***

Comparing with above existing efforts, the meaning of performance management in our framework has the same objectives at the macro-level – to promote enterprises' performances. However, from the micro perspective, the PT framework's network view is more focused on the generation of performance, which ensures its advantages as discussed above compared with the existing linear frameworks ([Otley 1999]).

The performance tree framework contains the following five basic elements: ***objective/strategy, stakeholder, performance set, performance tree and performance unit.*** Their functions and connections are explained below.

In an organization, performance tree is largely determined by its objective and strategy. Meanwhile, we need to discuss and develop the goals and corresponding metrics for the nodes in the PT to form the performance sets. Then, the nodes will be clustered under certain logics to form the performance unit. In this framework stakeholders play a critical role in all above processes – they will decide the construction of the rest four basic elements and their configurations.

Above constructing process can be conducted in a top-down manner by decomposing primary objectives hierarchically, or otherwise. For instance, the tree can also be built in a bottom-up manner by aggregating from the basic performance operations to the top performance. The best approach to construct a performance tree depends on the needs from organizations with different contexts.

Building up the performance management system is an iterative process. In practice, because of interactive relationships between performance sets and hierarchical performance units, their configurations will be adjusted several rounds by stakeholders before its finalization, to be seen later in detail.

Once the performance management system has established, the manager can apply the usual performance tools, such as KPIs or the performance plan through performance units, to carry out comprehensive performance management, to be seen later in detail. In our framework, the KPIs tool is not merely a measuring tool but also a strategy expressing/driving instrument. By adjusting performance sets, the organization's latest strategic preferences can be delivered and implemented dynamically. Let's emphasize here that building up of the performance management system can be made independent of the organization's existing formal structure, and therefore to promote potential organization structural innovations.

4. The performance tree framework case study

There are three main stages to construct a PT performance management system, which are: preparing, designing and implementing. In the preparing stage, a performance promotion team should be established firstly, and then comprehensive information about the company needs to be collected to support further work. In the second stage, the team will carry out massive dialogues based on the collected information to build and configure the five basic elements in the PT framework. In the last stage, managerial procedures, regulations and rewards should be intergraded with the new PM system.

However at early stages, users should pay a great attention to clarify three principal questions to construct a tailored PT PM system:

Question 1: The organization will largely maintain the formal structure status quo or carry

out significant structural transformation (and to what extent)?

For users who wish to establish a comprehensive performance management system without reforming its current formal organizational structure, they can simply apply the PT framework in the top-down or bottom-up manner. It is not necessary to take virtual performance units into account, and this will much simplify the building up of the system.

Other organizations may prefer improving their performance process through transforming current organizational structure, and in this case, the virtual performance units (especially lean units) will be fairly critical.

The virtual performance units help the organization reviewing its current structure to optimize its performance management procedures. Organizational structure transformations reorganize the company's current performance generation and management procedures. Therefore, the virtual performance units should be considered from the initial stage of the construction -- virtual departments could be added, departmental boundaries could be adjusted and cross-department performance collaborations could be established. In this way, the five elements in the PT system will be reconfigured following the optimized performance generation procedures. However above subversive changes rarely happen in an enterprise, instead, some limited changes are more common. The performance tree framework can also meet these limited improvement needs by applying the virtual performance units approach locally.

Comparing with the existing scorecard methods, the performance tree framework has very significant advantages on promoting organizational transformation. In the BSC practice, the strategy map is based on managerial process, instead of performance generation process, and further its implementation highly relies on the organization's current formal structure. Hence it may hinder organizational structure transformation. The other fixed logic scorecards have similar problems.

Question 2: What is the stakeholders' role in the PT performance management?

The PT framework can assist organizations with different setting of stakeholder to construct their PT systems. In the PT performance management system, the stakeholders' influences can be limited or comprehensive. In the first case, only limited parts or/and levels of the stakeholders are involved in building the system. For example, one can concentrate only on companies and their external customers as in the BSC. The comprehensive way is commonly seen in the public sectors or private organizations with complex operation cores. In this case, interests of each key stakeholder will be balanced at all levels. For instance, the levels of stakeholders are balanced stepwise in the Balanced Stakeholder Scorecard for hospital (Moullin, Soady et al. 2007). Comparing with the PT framework, the existing PM frameworks can hardly offer users a comprehensive and practical way to balance the stakeholders' influences. According to ownerships and managerial capacities, PT users should adopt a suitable way to handle the stakeholder factors, since more managerial challenges will emerge with increasing stakeholder considerations.

Question 3: What are the user's preferences to contents of performance sets (balanced contents or those emphasizing certain aspect)?

Depending on the organizations' ownerships and preferences, they will adopt unique ways to achieve their key objectives and strategies. The most obvious embodiment about above differences is the organization's performance sets. For instance, because of the profiting impulse, private enterprises tend to configure more financial related goals and metrics in their sets. In contrast, the public sectors do not have strong earning motives, so they prefer balanced contents of performance sets to satisfy multiple demands from stakeholders. Therefore, it is necessary to take above features into account in constructing a performance tree.

In practice, users' answers to above three questions are tightly related: a company with strong short-time profiting impulse may pay extra attention on its customers, and set them as the core stakeholders. Correspondingly, under the short-time pressure, the company would avoid turbulence in operation, so the organizational transformation is a less likely choice. It is crucial for the organization to fully clarify the three principal questions at early stages of PT system construction. Influences of the answers will be discussed in due time below.

The performance management practices by employing the PT framework in D bank

When an organization is willing to reform its formal structure, then virtual performance units should be taken into account in the PT PM system building procedures.

D bank is a commercial bank with regional influences, and its business pattern is similar with the most of commercial banks in China: obtaining profits from interest margins, investments and intermediary businesses. However, facing up to fast-changing technologies and market environment in recent years, D bank wishes to reform its ways to generate and manage the performance to better meet the challenges. Moreover, D bank holds an open attitude to all formal structure reformations if they are necessary and feasible. It is well known that in the banking sectors, setting up a suitable PM system in headquarter is a challenging problem. Considering there is no significant problem in the performance management of the branch level, so above project is mainly carried out in the headquarter departments of D bank.

A performance promotion team is established at the ***preparing stage*** to lead the project and decide key contingencies in the procedures. The initial members of the team include performance consultants and key stakeholders, and the team will change dynamically with progressing of the project. The team carries out interviews firstly among the shareholders to clarify the company's top objectives, which are: profit, risk control and innovation. Then, the relevant background information against the top goals is collected and comprehended to support the further work.

The second stage is to build the PT PM system. ***The initial step*** in the stage is to clarify the company's strategies and managerial preferences in achieving above objectives. Questions such as:

"Should the new PM system be designed with modules corresponding to the three goals straightforwardly?"

"Would the resources and managerial powers be reallocated accordingly?"

are asked to the tops to understand their ideas to the new system. For instance, the tops of D bank wish to achieve the objectives by reforming the company's operations from division-oriented to procedure-oriented. Then the team fully comprehends the ideas and expectations from the tops, in order to develop key performance and main achieving strategies as the start point of the stage.

Then, more detailed dialogs are conducted hierarchically in departments to decompose the top strategies to form the initial PT by clarifying D bank's current performance-generating approaches and their potential improvements. Here, the Soft system methodology (SSM) can be applied to promote innovation (Liu, Meng et al. 2012). For instance, targeted to the "profit" goal, the team interviews relevant key stakeholders by questions as:

"How do your works contribute to the profit?"

"What are the key procedures in your works?"

"How to further improve your works?"

The dialogs not only clarify information about the situation of current performance generation, but also drive the interviewees and the team to rethink about their performance practice and suggest improving actions. What is more, due to the fact that PT building does not necessary to rely on the formal structure, so when deciding the most suitable performance-generating processes, the formal structure should not be much considered. For instance, many staffs suggest a new way for loan crediting business report but involving more than three departments in the present structure, and staffs worry about potential interferences. However, in our approach, this worry is undue because we will consider different scenarios of virtual performance units later to optimize the performance, which do not depend on the current formal structure.

When all above questions have been clarified in departments and hierarchies, the initial PT for the objective of "profit" can be build up. For example, the five nodes of the top level of the PT are: loan node, deposits node, intermediary business node, investment node and cost-control node. Sometimes, brand new performance nodes may appear in the initial PT to support top objective or optimized procedures, and then, the team may need to build new sub-processes in the "top-down" or the "bottom-up" manner to support it.

The next step in this stage redesigns and builds the company's performance units to better manage the initial PT. In practice, many factors affect the forming of actual performance units, such as strategy, resources and management span etc., and there exist fruitful researches on the topic already (Ghani, Jayabalan et al. 2002, Pfeffer, Leblebici 1977, Hammond 1986). Here, only two principles are emphasized, which are: reducing the situation of dual-management and integrating similar nodes in the existing units, since they are tightly related with our framework.

For instance, the credit checking and ranking are increasingly relying on the online information in the D bank. However, currently they need heavy cooperation of two departments. Therefore, parts of the works in the two departments may form a new "online credit" performance unit. Another case here is about building a virtual unit by assembling similar nodes in different units. Currently the decision on crediting is made by the branches, and headquarters departments only deliver supportive works. Above structure may lead to inefficiency in HR and possible poor crediting quality due to unqualified local staffs. Therefore, the team suggests centralizing the crediting power by establishing a new crediting department in the headquarter.

When all above steps complete, the initial PT PM system has been built and the overall plan need to be further discussed by the key stakeholders and then finalize it (they need to discuss to take the new plan overall or limited here). In this procedure, the company needs to decide whether to adopt the proposed plan gradually or in an aggressive way, because it will affect the way to implement the plan. After discussing, the tops adopt the second way at the moment, because they plan to use three years to fully carry out the managerial and organizational reforms proposed in the project.

In the third stage, managerial components like regulations and reward system are integrated with the newly-designed PT PM system to ensure its implementation. In this case, the bank implements the new PT PM system by adopting majority of its existing departmental structure, which means the most of KPIs and the performance plan are assigned to the existing departments to manage. However, if a company wishes to immediately implement the changes, the implementations, such as KPIs and performance plans should be undertaken by the newly-formed actual units.

5. Conclusions

Comparing with existing performance management methods, the performance tree framework has several merits in the application:

1) ***High flexibility***: In the PT framework, the objectives and goal-achieving way of an organization can be expressed flexibly by building the sets and units upon its performance-generate processes. In addition, under the performance tree framework, soft managerial factors (such as organization culture or ethics) can be integrated with the performance management by using the stakeholder-grounded KPIs tool. All above features increase the flexibility of this framework even under the complex managerial contexts.

2) ***General applicability:*** The performance tree framework does not have a pre-fixed logic, so it suits for organizations with various ownerships and operation patterns. Moreover, the PT framework does not need to be applied from the top level – departmental objectives or specific needs can also be the start point of PT building.

3) ***Innovation-friendly:*** As mentioned above, the existing approaches to implement the

scorecard methods highly rely on organizational structures, and hence weaken the methods' effectiveness under a transformational context. In the contrary, the performance generation processes are set as the first concern in the performance tree framework, which means it could shed lights on the organizational transformation by leading it with the optimized performance processes.

4) ***Balancing stakeholder interests:*** The PT framework takes stakeholder as an important internal driving factor in the overall managerial process. The buildings of performance nodes, units and even the whole tree highly rely on the stakeholders' opinions, and further ensure the interests of stakeholders will be cared and balanced in the entire operation process.

5) ***Data friendly:*** The behavior-based PT construction process ensures all managerial information can be converted into data easily (by behavior sensors for instance). What is more, the elements in the PT are natural data port to feed further analyses – the performance node supplies data on the job position level, the performance unit feeds data for departmental management.

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