Chapter 3

Performance Measurement Framework for Strategic Planning in Supply Chains

The previous Chapter provides a detailed and critical examination of literature related to SC performance, suggests research gaps and develops a roadmap for the present research. This chapter presents integration of Analytical Hierarchy Process (AHP) with Balanced Score Card (BSC) and the Performance Prism. Integration of AHP with BSC is useful to evaluate contribution of each performance indicator in achieving organizational goal, prioritise its resource deployment and comparing performance of supply chains. Using AHP with Performance Prism facilitates managers to track whether the right processes and capabilities are in place and helps to monitor whether strategies are leading to organisation's goals.

3.0 INTRODUCTION

Supply Chain Management (SCM), at the operational level, existed in some form or the other since the beginning of business in way of procuring goods, storing them, processing it and distributing them. However, at the strategic level, SCM is a relatively new discipline (Gunasekaran, Patel, & McGaughey, 2004). Organisations use SCM at strategic level to transform the way they meet the stakeholder's needs. Organisations realise that working cooperatively in Supply Chains (SC) can create a competitive advantage (Beamon, 1999b). So business organisations are abandoning the old incompatible and competing approach to doing business in favour of a more integrative management style focused on coordinating activities along the SC in order to attain or sustain their competitive position (Holmberg, 2000). The way SCs are managed is evolving over time due to ever increasing globalisation, rapid change in technology, higher competition, increased concern on sustainability and need for flexibility (Beamon, 1999b). Therefore, SCs are increasingly depending on Performance Measurement Systems (PMS) as a means to align their processes and resources with strategy and to achieve their organisation objectives (Shepherd & Günter, 2011; Tangen, 2004).

Performance Measurement Systems plays important role in successful SCs by allowing managers to track whether the right processes and capabilities are in place

(Gunasekaran et al., 2001) and to monitor whether strategies are leading to organisation's goals. In addition, Performance Management frameworks are also helpful in organisational goal setting and aligning performance indicators with strategic objectives. A comparative analysis of some most widely cited PMS has been undertaken and it indicates that the Balanced Score Card (BSC) and the Performance Prism (PP) are two most widely cited and popular PMS. However, there are limitations in both the frameworks when they are used for strategic alignment and planning in SC context. The frameworks do not provide weightings to the performance indicators nor does it tell the management the contribution of each performance indicator in achieving organisational goals. Use of Analytical Hierarchy Process (AHP) along with BSC and PP helps in tiding over these limitations. This chapter demonstrates integration of AHP with BSC and the PP. Integration of AHP with BSC is useful to evaluate contribution of each performance indicator in achieving organisational goal, prioritise its resource deployment and comparing performance of supply chains. Using AHP with PP facilitates managers to monitor whether the correct operations and resources are in place and helps in monitoring whether strategies are leading to organisation's goals.

3.1 Performance Measurement Systems (PMS) and Strategy

Strategy helps SC achieve a specific, worthy end goal and objectives. According to Mintzberg & Lampel, (1999), a strategy should explain both the goals of the organisation and a plan of action to achieve these goals. Organisations need strategy to set direction, focus efforts, define the processes and provide consistence (Mintzberg & Lampel, 1999).

A significant impact of implementing PMS in organisations is that individuals who are part of organisations respond to measures. Measures implemented in their organisation communicate strong messages about what is important and what response is expected from them. When the measures are confirming with the organisation's strategies, they support behaviours that are confirming with strategy (Lin, Wang, & Yu, 2010). The right measures then not only offer a means of tracking whether strategy is being implemented, but also a means of communicating strategy and encouraging its implementation. Neely, Adams, & Crowe (2001) argue that strategies should be formulated based on the wants and needs of the stakeholders. A SC performance measure should thus facilitate to analyse and communicate stakeholder's needs and wants and monitor the implementation of organisation's strategy at various levels (Neely et al., 2001).

Study of related literature indicate that Strategy and Measurements are not related in many frameworks of PMS, resulting in measurement initiatives not derived from strategy and therefore not supporting the business goals and objectives (Holmberg, 2000). Lin et al. (2010) analysed the relationships among strategy orientation and SC performance. According to this statistically based study, market orientation is found to positively affect SC performance and contrary to the earlier presumption, resource orientation was not significantly and positively related to SC performance. Comparison of strategic statements of organisations and their PMS framework indicates that many companies do little to measure the variables described in their strategies (Holmberg, 2000). PMS frameworks are focused more on internal functions and less on overall SC performance and stakeholder's needs. The missing connection between strategy and measurements promotes an internal focus, which becomes an obstacle to developing effective SCPM frameworks.

Neely et al. (2001) suggests that some 90% of managers fail to implement and deliver their organisation's strategies. There are many reasons attributed for this failure, but a key one is that strategies contain underlying premises about the drivers of improved business performance (Neely et al., 2001). However, the manager normally does not know how much the contribution of each driver of performance toward achieving organisational goal is. Without this critical data, strategy formulation and revision are largely predicated on 'gut feel' or intuition. Measurement data and its analysis may not entirely replace this executive intuition or the 'gut feel'. Nevertheless, PMS can be used to greatly enhance the making of sound management decisions. The second key reason for strategic failure is that the organisation's processes are not aligned with its strategies. At some instance, it may be found that its processes are aligned to strategic objective; even then the 'capabilities' which are required to operate these processes are not aligned to strategic objective. Hence an important issue that is to be considered while developing SC PMS is to monitor and ensure that strategy is aligned to goals and processes and capabilities are aligned to strategy. Integration of PMS frameworks with multi criteria decision making models like AHP will help in prioritising and quantifying performance indicators in SC.

3.2 Analytical Hierarchy Process (AHP)

The AHP is a "general problem solving method that is useful in making complex decisions (e.g. multi criteria decisions) based on variables that do not have exact numerical consequences (Saaty, 2008). The basis of decision-making process in AHP is a system of pair

wise comparisons of attributes and hierarchical representation of complex problems. Pair wise comparison is used to determine the priorities of each pair of criteria, denoting the strength with which one element dominates the other. It helps to quantify non-physical and non-economic factors contributing to an outcome. This is considered a rational and methodical way of decision-making. Weighing can be changed according to different situations, companies or businesses, thus making AHP a flexible method of data analysis and decision-making (Adel El-Baz, 2011).

The three primary functions of AHP are (Hepler & Mazur, 2007; Saaty, 2008):

1. **Structuring complexity**: Structuring complexity is achieved by hierarchical structuring of complexity into homogeneous clusters of factors.

2. **Measurement**: For complex problems with hierarchical structuring, ratio scales would most accurately measure the factors that comprised the hierarchy.

3. **Synthesis:** Although AHP's hierarchical structure does facilitate analysis, a more important function is AHP's ability to help us measure and synthesises the multitude of factors in a hierarchy.

Broad areas where AHP has been successfully employed include: selection of one alternative from many; forecasting; total quality management; business process re-engineering; quality function deployment, ratings to vendors; allocating resources; strategic planning (Forman & Gass, 2001; Saaty, 2008) and in the present work, strategic planning. There have been earlier attempts to prioritise performance measurement indicators in the supply chain context also (Adel El-Baz, 2011; Cho et al., 2012). An overview of the AHP process and the steps involved in AHP modelling is given at Figure 3.1. Detailed methodology on AHP including examples are available in literature (Forman & Gass, 2001; Hepler & Mazur, 2007; Saaty, 2008).

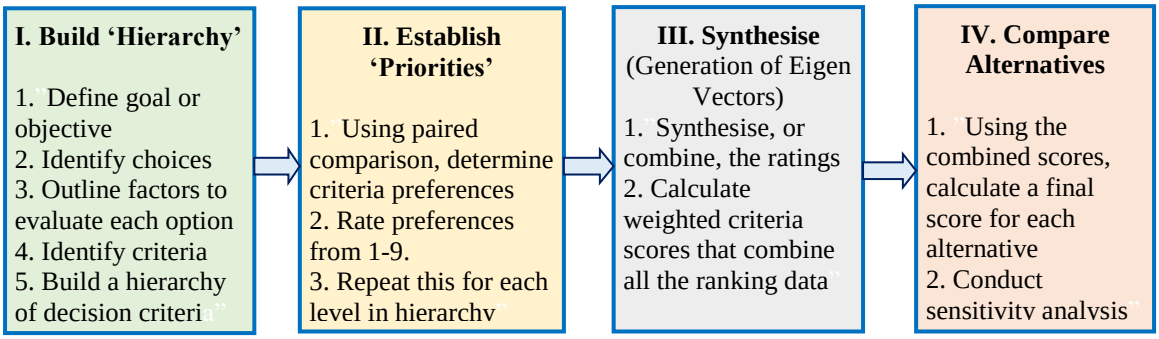

Figure 3.1 Overview of Analytical Hierarchy Process

3.3 The Balanced Score Card (BSC)

The Balanced Score Card (BSC) was developed in 1992 by Robert Kaplan and David Norton, as an innovative approach to performance measurement (Kaplan & Norton, 1992). A brief discussion about BSC is made in chapter 2, section 2.8.1 and Figure 2.2. The BSC complements financial measures of past performance with measures of the drivers of future performance (Paranjape, Rossiter, & Pantano, 2006). An underlying theme of BSC is to tie (integrate) PMS with the firm's goals and strategy (Kaplan & Norton, 1993; Wongrassamee et al., 2003). Many organisations have successfully used BSC for their organisational performance and performance management (Wongrassamee et al., 2003).

BSC proposes four perspectives through which a business organisation should be evaluated and analysed. These perspectives are integrated and give a balanced and comprehensive view to the top managers. These perspectives provide answers to four fundamental questions (Kaplan & Norton, 1992; Tangen, 2004):

1. "*Financial Perspective:* How does the company appear to its shareholders"?

2. "*Internal Business Perspective:* What must the organisation excel at"?

3. "*The Customer Perspective:* How do the customers see the company"?

4. "Innovation and Learning Perspective: How can the organisation continue to improve and create value"?

According to Chavan (2009), the BSC initiated an extension of the traditional financial based performance measures to measures of performance relating to customer, internal processes and learning and growth needs of their people. BSC has brought a broader perspective to PMS by providing it a strategic dimension and considering the overall health of the organisation. The advantage of the BSC framework is that it enables company's long term sustainability by assessing its performance in building future capabilities, required in terms of its strategy to outlive and expand in times yet to come (Chavan, 2009).

There are certain limitations to BSC in terms of its application to SC as seen from literature. A limitation of BSC is that it is primarily designed to provide senior managers with an overall view of performance. Thus, it is not designed for (nor is it applicable to) the factory level operations (Ghalayini & Noble, 1996). Another disadvantage of BSC is that although it is a valuable framework suggesting important areas in which performance measures might be useful, it provides minimum guidance on how the right performance measures can be selected, applied and finally used to improve business (Chavan, 2009; Neely et al., 2000). BSC is more like a strategic management tool, rather than a true complete PMS (Gomes et al., 2004a, 2004b). Another major drawback observed in BSC is that it does not specify any mathematical logical relationships among the individual's scorecard criteria. It is thus difficult to do benchmarking, or do comparison of business organisations using BSC (Soni & Kodali, 2010). According to the Hackett Group's survey (Paranjape et al., 2006), most companies rely on too many metrics and heavily weighted internal finance data, making the scorecards unbalanced. This chapter provides a framework which overcomes these limitations by providing a mathematical and logical relationship within the scorecard criteria.

3.4 Framework for Performance Measurement of Strategic Objectives using Analytical Hierarchical Process and Balanced Score Card (BSC)

There have been many efforts to integrate AHP and BSC. Bhagwat & Sharma (2007) have suggested a method of AHP and BSC integration to prioritise the different performance levels in an organisation. The framework helps in assessment and determining of SCM in a balanced approach (Sharma & Bhagwat, 2007). Clinton, Webber & Hassell (2002) suggested a method of integrating AHP with BSC which facilitate selection of appropriate metrics and how to compare divisions with differing metrics. There are merits and benefits associated with above works as well as some other authors whose contributions are not mentioned here. However, the present work differs from the earlier research in the same field in many ways.

Using the framework of the BSC's four perspectives, generic performance measures were proposed by Kaplan (2005). Based on Kaplan Norton's (1992) work, Chia, Goh, & Hum (2009) evaluated these measures in a supply chain context. These performance measures are grouped as at Table 3.1. The financial perspective describes the real outcomes of the strategy in financial terms. They are return on investment (ROI), shareholder value, profitability, revenue, growth and unit costs. The customer perspective specifies the contributors of revenue growth. The measures which are part of the customer perspective are acquisition, retention, growth and satisfaction. The internal process perspective describes the operating, customer management, innovation, and regulatory process objectives for creating and delivering the customer value proposition and improving the quality and productivity of operating processes. The objectives in Learning and Growth Perspective is to identify which jobs (the human capital), which systems (the information capital), and what kind of climate (the organisation capital) are necessary to contribute to the value addition of internal processes.

Table 3.1 BSC performance objectives and measures (Source: Chia et al., 2009)

<table>
<tr><td colspan="2">"FINANCIAL PERSPECTIVE"</td><td colspan="2">"CUSTOMER PERSPECTIVE"</td></tr>
<tr><td>GOAL</td><td>MEASURES</td><td>GOAL</td><td>MEASURES</td></tr>
<tr><td rowspan="5">"Describes the tangible outcomes of the strategy in financial terms"</td><td>"Return on investment (ROI) "</td><td rowspan="5">Defines the drivers of revenue growth</td><td>Market share</td></tr>
<tr><td>"Shareholder value"</td><td>Number of customers retained</td></tr>
<tr><td>Profitability</td><td>Customer satisfaction</td></tr>
<tr><td>"Revenue growth"</td><td>Loyalty from targeted customers</td></tr>
<tr><td>Unit cost reduction</td><td>Value proposition to generate sales</td></tr>
<tr><td colspan="2">"THE INTERNAL BUSINESS PROCESS PERSPECTIVE"</td><td colspan="2">"THE LEARNING AND GROWTH PERSPECTIVE"</td></tr>
<tr><td>Goal</td><td>Measures</td><td>Goal</td><td>Measures</td></tr>
<tr><td rowspan="2">"Identifies the operating, customer management, innovation, and regulatory and social</td><td>Quality of Service</td><td rowspan="2">"Identifies the intangible assets that are most</td><td>Employee satisfaction</td></tr>
<tr><td>New services implemented per year</td><td>Employee turnover per year</td></tr>
</table>

"FINANCIAL PERSPECTIVE"		"CUSTOMER PERSPECTIVE"	
GOAL	**MEASURES**	**GOAL**	**MEASURES**
process objectives for creating and delivering the customer value proposition"	On time delivery	important to the strategy"	Number of suggestions implemented per employee yearly
	Waste reduction		Money invested in employee training yearly

For the purpose of analysis and developing the current model, the measures considered are depicted in Table 3.2. They are in line with other researchers (Chia et al., 2009). The measures considered in this study is indicative and not comprehensive. As an illustration, Chia et al. (2009) considered Innovation and Learning (IL) from a stakeholder perspective and not essentially from the organization entity perspective. Therefore, employee related aspects are considered as sub criterion under IL and criterions such as 'New Product development', 'Product development lead-time' etc which are significant factors under IL are not included. The present research is thus limited in this aspect.

Table 3.2 List of Measures Used in the Study

Financial Perspective (FP)	Customer Perspective (CP)	Internal Business Perspective (IB)	Innovation and Learning (IL)
1. Return on Investment (ROI) 2. Gross Revenue (GR) 3. Profit (P) Profit is sub divided into: i. Profit Before Tax (PBT) ii. Profit After Tax (PAT)	1. Market Share (MS) 2. No of Customers Retained (CR) 3. Customer Satisfaction (CS)	1. On time Delivery (OD) 2. Waste Reduction (WR) 3. Quality of Services (QS) 4. New Services Implemented (NS)	1. Employee Satisfaction (ES) 2. No of Suggestions implemented (SI) 3. Employee Training (ET)

3.4.1 Building 'Hierarchy'

The first step in solving a decision problem by AHP is decomposing the problem into a hierarchy of criteria and alternatives. The hierarchy modelling for BSC is shown at Figure 3.2. A hierarchy is structured from the top (primary objectives), then intermediate levels that are criteria to the lowest level, which is usually a list of alternatives from which to choose or compare. Based on the criteria selected for performance measurement using BSC, given at Table 3.2, the AHP hierarchy model is prepared. The hierarchy model consists of the '*goal'* at the top, the contributing levels of criteria (depicted as '*Level 1 Criteria', 'Level 2 Criteria', 'Level 3 Criteria'*) and '*alternatives'.*

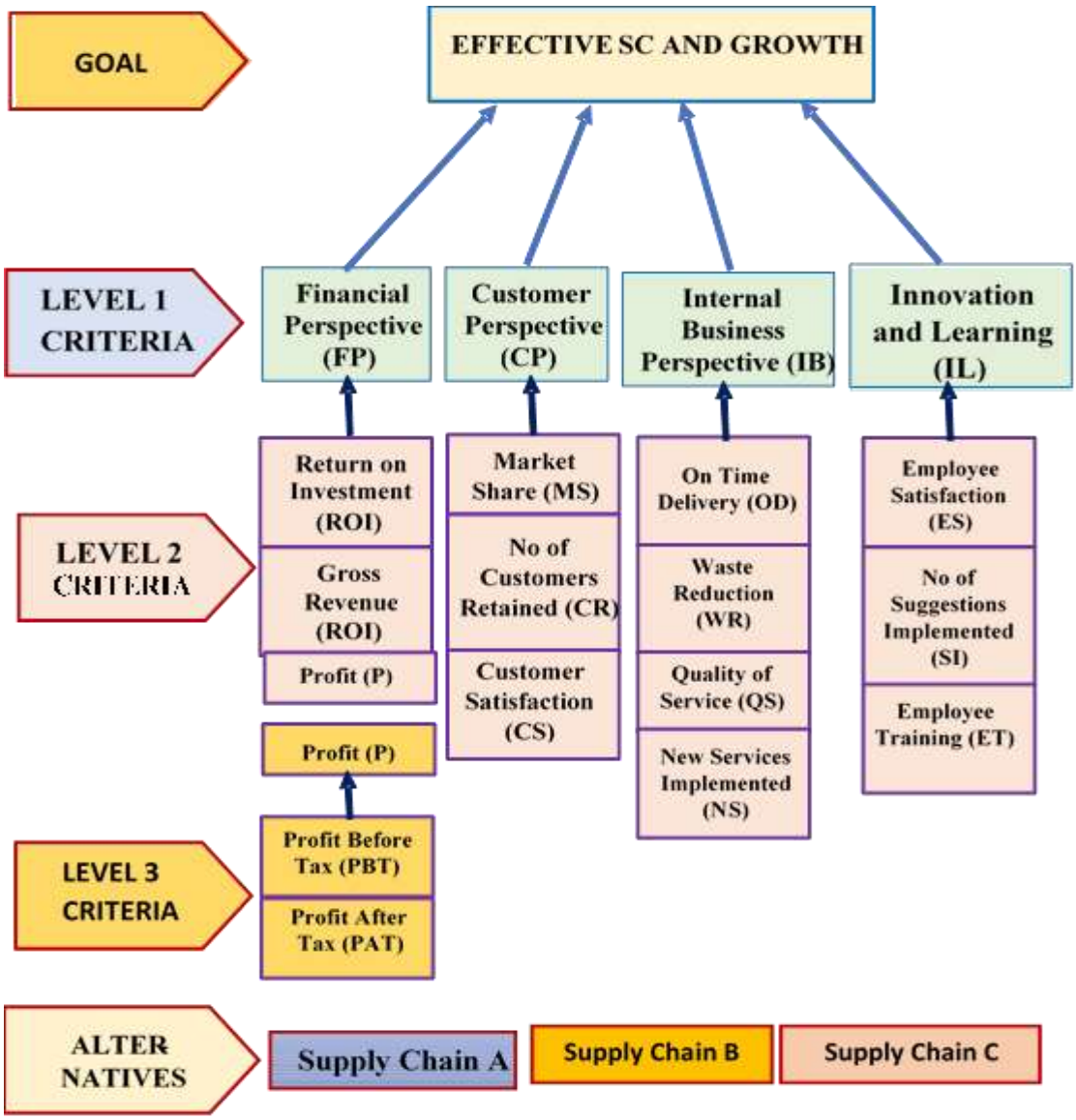

Figure 3.2 AHP Hierarchy Scheme for Performance Measurement using BSC

3.4.2 Establishing priorities and preparing comparison matrix

After decomposing problem into levels of criteria and building the hierarchy, the next step is generating the priority matrix for each level of criteria. AHP uses pair-wise comparison of the same hierarchy elements in each level (criteria) using a scale indicating the importance of one element over another with respect to a higher-level element. The importance of scale between elements is shown in Table 3.3.

Table 3.3 The fundamental scale of absolute numbers (Saaty, 2008; Sharma & Bhagwat, 2007)

Intensity of relative importance (Comparison values)	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance of one over another	Experience and judgment slightly favor one activity over another
5	Essential or strong importance	Experience and judgment strongly favor one activity over another
7	Demonstrated importance	An activity is strongly favored, and its dominance is demonstrated in practice
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation
2, 4, 6, 8	Intermediate values between the two adjacent judgments	When compromise is needed
Reciprocals of above non-zero numbers	"If an activity has one of the above numbers compared with a second activity, then the second activity has the reciprocal value when compared to the first"	

For each level of Criteria, by 'Paired Comparison' and by using 'Comparison Values', 'Comparison Matrix' is generated. The relative weights (comparison values) of comparison matrices are obtained through discussion with selected representatives of the organisation. The group includes managers who have overall exposure to SC functions of the organisation. For obtaining the relative weights, the scale of 1-9 provided by Saaty (2008) as shown in Table 3.3 is used. In order to obtain the relative weights, several questions are asked. A sample question

asked to obtain the comparison table for level 1 criteria is: “With the aim of maximising effectiveness and growth of SC, what is the relative importance (referring to Saaty’s scale of absolute numbers), when Financial Perspective (FP) is compared with Customer Perspective (CP)?”. Thus, for obtaining comparison matrix for level 1 criteria, questions can be generalised as: “With the aim of maximising effectiveness and growth of SC, what is the relative impact when Criterion A is compared with Criterion B?”. For Level 2 Criteria, a sample question is: “With the aim of improving Financial Perspective (FP) and consequently maximising effectiveness and growth of SC; what is the relative importance of ‘Return on Investment (ROI)’ when compared to ‘Gross Revenue (GR)’?. Thus, for obtaining comparison matrix for level 2 criteria, questions can be generalised as: “With the aim of improving ‘level 1 Criteria A’ and consequently maximising effectiveness and growth of SC, what is the relative impact when ‘Matrix A under level 1 Criteria A ’ is compared with ‘Matrix B under level 1 Criteria A’? The ‘Comparison Matrix’ forms part of the ‘Eigen Matrix’ which are shown at Table 3.4.

Table 3.4 Tables for calculated Eigen Vectors (E.V.), C.I and CR

Eigen Matrix for level 1 Criteria					
	FP	**CP**	**IB**	**IL**	**E.V.**
Financial Perspective (FP)	1	2	5	7	0.5267
Customer Perspective (CP)	0.5	1	3	5	0.3005
Internal Business (IB)	0.2	0.333	1	2	0.1098
Innovation and Learning (IL)	0.142	0.2	0.5	1	0.0630
λmax = 4.0201; C.I.=0.006; CR=0.0074					

Eigen Matrix for level 2 Criteria (Financial Perspective)				
	ROI	**GR**	**P**	**E.V.**
Return on Investment (ROI)	1	4	0.5	0.3234
Gross Revenue (GR)	0.25	1	0.166	0.0890
Profit (P)	2	6	1	0.5876
λmax = 3.0092; C.I.=0.0046; CR=0.0079				

Eigen Matrix for level 2 Criteria (Customer Perspective)				
	MS	**CR**	**CS**	**E.V.**
Market Share (MS)	1	0.333	0.142	0.0925
No of Customers Retained (CR)	3	1	0.5	0.2922
Customer Satisfaction (CS)	7	2	1	0.6153
λmax = 3.00264; C.I.= 0.0013; CR=0.0023				

Eigen Matrix for level 2 Criteria (Innovation and Learning)				
	ES	**SI**	**ET**	**E.V.**
Employee Satisfaction (ES)	1	3	5	0.6267
Suggestions implemented (SI)	0.333	1	4	0.2797
Employee Training (ET)	0.2	0.25	1	0.0936
λmax = 3.08577; C.I. = 0.0429; CR= 0.0739				

Eigen Matrix for level 2 Criteria (Internal Business Perspective)					
	OD	**WR**	**QS**	**NS**	**E.V.**
On time Delivery (OD)	1	0.5	0.25	3	0.1413
Waste Reduction (WR)	2	1	0.333	5	0.2458
Quality of Services (QS)	4	3	1	7	0.5555
New Services Implemented (NS)	0.333	0.2	0.1428	1	0.0572
λmax = 4.06739; C.I.=0.0224; CR=0.025					
Eigen Matrix for level 3 Criteria (Profit)					
	PBT		**PAT**		**E.V.**
Profit Before Tax (PBT)	1		0.2		0.1667
Profit After Tax (PAT)	5		1		0.8333
λmax = 2; C.I.=0; CR = 0					

3.4.3 Generation of Eigen vectors and Sample Calculation

Based on the 'comparison matrix', Eigen vectors are calculated for each level of criteria. The sample calculation is given at Section 3.4.3.1 below. The Eigen vector represents the Priority Measure of each criterion. Sample calculation for calculating Eigen Matrix for

Level 1 Criteria is addressed in this sub section. The paired comparison matrix obtained through expert opinion is reproduced as Table 3.5 (this is same as the first part of Table 3.4).

Table 3.5 Paired Comparison Matrix for Level 1 Criteria

	Financial Perspective (FP)	Customer Perspective (CP)	Internal Business (IB)	Internal Business (IB)
Financial Perspective (FP)	1	2	5	7
Customer Perspective (CP)	0.5	1	3	5
Internal Business (IB)	0.2	0.333	1	2
Innovation and Learning (IL)	0.142	0.2	0.5	1
Column Total	**1.842**	**3.533**	**9.5**	**15**

Steps in calculating the Eigen Values:

Step 1: Add each column in the paired comparison matrix

Example: The first Colum total = 1+0.5+0.2+0.142 = 1.842

Step 2: Divide each entry by the total of its column. This provides the standardised matrix in Table 3.6.

Example: The first Colum values for Colum under FP are calculated as: 1 ÷ 1.842 = 0.5429; 0.5 ÷ 1.842 = 0.0.2714; 0.2 ÷ 1.842 = 0.1086; 0.142 ÷ 1.842 = 0.0771;

Table 3.6 Standardised Matrix for Level 1 Criteria

	Financial Perspective (FP)	Customer Perspective (CP)	Internal Business (IB)	Internal Business (IB)
Financial Perspective (FP)	0.5429	0.5661	0.5263	0.4667
Customer Perspective (CP)	0.2714	0.2830	0.3158	0.3333
Internal Business (IB)	0.1086	0.0943	0.1053	0.1333
Innovation and Learning (IL)	0.0771	0.0566	0.0526	0.0667
Column Total	**1.842**	**3.533**	**9.5**	**15**

Step 3: Calculate Eigen Values. The average of each row of the standardized matrix is calculated to get the Eigen Values. Table 3.7 shows the Eigen Values calculated.

Example: For Financial Perspective (FP); the Eigen Value is calculated as average of corresponding row values = (0.5429 + 0.5661 + 0.5263 + 0.4667) ÷ 4 = 0.5255

Table 3.7 Eigen Matrix for level 1 Criteria

	FP	CP	IB	IL	E.V.
Financial Perspective (FP)	1	2	5	7	0.5267
Customer Perspective (CP)	0.5	1	3	5	0.3005
Internal Business (IB)	0.2	0.333	1	2	0.1098
Innovation and Learning (IL)	0.142	0.2	0.5	1	0.0630
Column Total	**1.842**	**3.533**	**9.5**	**15**	λmax = 4.0201

Step 4: Calculation of Principal Eigen Value (λmax)

$$\lambda_{\max} = \sum (Sum\ of\ column\ values\ of\ comparison\ matrix \times Eigen\ vector\ element) \quad \text{(Eq. 3.1)}$$

= 1.842 x 0.5267 + 3.533 x 0.3005 + 9.5 x 0.1098 + 15 x 0.0630 = 4.0201

Step 5: Calculation of Consistency Ratio (CR) and Consistency Index (CI)

Consistency of comparative matrices are checked to see whether the 'paired comparisons' are logical and whether the paired comparisons made are consistent. The condition for consistency is that Consistency Ratio (CR) < 10% (Forman & Gass, 2001; Saaty, 2008). CR is calculated based on equations given at Eq. 3.1 to Eq. 3.3.

$$CR = \frac{CI}{RI} \quad \text{(Eq. 3.2)}$$

$$CI = \frac{\lambda_{\max} - n}{(n-1)} \quad \text{(Eq. 3.3)}$$

$$\lambda_{\max} = \sum (Sum\ of\ column\ values\ of\ comparison\ matrix \times Eigen\ vector\ element) \quad \text{(Eq. 3.4)}$$

Where:

CR – Consistency Ratio

RI – Random Consistency Index

n – Order of the matrix

λ_{max} – Principal Eigen Value

Random Consistency Index (RI) values are taken from the *Random Consistency Index Table* (Table 3.8).

Table 3.8 "**Random Consistency Index Table** (source: Saaty, 2008) "

ORDER OF MATRIX	1	2	3	4	5	6	7	8	9
RI value	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45

From Eq. 3.3 and Eq. 3.4:

$$CI = \frac{\lambda_{max} - n}{(n-1)} = \frac{(4.0201-4)}{(4-1)} = 0.0067$$

$$CR = \frac{CI}{RI} = \frac{0.0067}{0.90} = 0.00744$$

Consistency Ratio (CR) less than 10% is a test to indicate the consistency of the paired comparisons.

The AHP Calculation software by CGI has been used to generate the Eigen vectors ("AHP Calculation software by CGI," n.d.). Eigen vectors generated and the Priority Matrices for all levels of criteria are calculated and shown at Table 3.3. The calculated CI and CR values are also shown at Table 3.3.

3.4.4 Aggregate priority vectors

The aggregate priority vector table is obtained by normalizing individual Eigen Matrices. The Normalized Priority Matrix values are calculated such that the values of Sub Criteria are within the weight of its corresponding higher criteria (Parent Criteria). Table 3.9 shows the Normalized Priority Matrix.

This result, i.e. Normalized Priority Matrix itself will be a useful tool to evaluate importance of each criterion (Measure) in achieving organizational Goal. Management can know how much each criterion will contribute to the organizational goal. For example, from Table 3.5 we can infer that Return on Investment (ROI) contributes 17.03% to achieve

organizational goal and Quality of Services (QS) contributes 6.10 % to achieve organizational goal.

Table 3.9 "**Aggregate Priority Vectors Including All Criteria**"

Criteria	"Eigen Value"	"Normalized Eigen Value"	% Contribution		
			Level 1	Level 2	Level 3
Financial Perspective (FP)	0.5267	0.5267	52.67		
Return on Investment (ROI)	0.3234	0.1703		17.03	
Gross Revenue (GR)	0.0890	0.0469		4.69	
Profit (P)	0.5876	0.3095		30.95	
Customer Perspective (CP)	0.3005	0.3005	30.05		
Market Share (MS)	0.0925	0.0278		2.78	
No of Customers Retained (CR)	0.2922	0.0878		8.78	
Customer Satisfaction (CS)	0.6153	0.1849		18.49	
Internal Business (IB)	0.1098	0.1098	10.98		
On time Delivery (OD)	0.1414	0.0155		1.55	
Waste Reduction (WR)	0.2459	0.0270		2.70	
Quality of Services (QS)	0.5555	0.0610		6.10	
New Services Implemented (NS)	0.0573	0.0063		0.63	
Innovation and Learning (IL)	0.0630	0.0630	6.30		
Employee Satisfaction (ES)	0.6267	0.0395		3.95	
Suggestions implemented (SI)	0.2797	0.0176		1.76	
Employee Training (ET)	0.0936	0.0059		0.59	
Profit Before Tax (PBT)	0.166667	0.0516			5.16
Profit After Tax (PAT)	0.833333	0.2579			25.79
TOTAL	6.0000	2.3095	100.0000	100.00	30.95

3.4.5 Overall performance index

"Based on the 'measures' or 'percentage contribution' of each Criterion, the 'Overall Performance Score' of the organization can be calculated. The overall Performance Score is calculated based on the tabulation given at Table 3.10. The scores at various scales are brought to a uniform scale of 0 – 100 and weighted scores calculated. The aggregate of Weighted Score at each level of criterion is calculated to obtain the Overall Performance Index. This numerical

performance index will help in comparing SCs and retain the calculated Performance Measure Index value for future reference and monitoring. ”

Table 3.10 Overall Performance Index

”Level 1 Criteria”	”Level 2 Criteria”	”Level 3 Criteria”	Original Scale		Score	”Normalised Score in Scale of 0 - 100”	Normalised Eigen Vector	Weighted Scores		
			Lower Limit	Upper Limit				”Level 1 Criteria”	”Level 2 Criteria”	”Level 3 Criteria”
Financial Perspective (FP)	ROI		0	10	6	60.00	0.1703	34.392	10.2202	
	GR		1	1000	700	69.97	0.0469		3.2795	
	P	PBT	0	100	80	80.00	0.0516		20.892	4.1270
		PAT	0	100	65	65.00	0.2579			16.765
Customer Perspective (CP)	MS		1	50	20	38.78	0.0278	19.875	1.0782	
	CR		1	10	7	66.67	0.0878		5.8545	
	CS		-10	10	4	70.00	0.1849		12.942	
Internal Business (IB)	OD		0	1	0.8	80.00	0.0155	4.8791	1.2413	
	WR		20	50	40	66.67	0.0270		1.7992	
	QS		-1	1	-0.5	25.00	0.0610		1.5243	
	NS		0	10	5	50.00	0.0063		0.3143	
Innovation and Learning (IL)	ES		0	10	9	90.00	0.0395	5.3749	3.5527	
	SI		0	1	0.8	80.00	0.0176		1.4094	
	ET		100	200	170	70.00	0.0059		0.4128	
Overall Performance Index								**64.521**		

3.5 The Performance Prism (PP)

The PP was developed by researchers at the Centre for Business Performance at Cranfield School of Management, England and Accenture for measuring organisation's performance (Neely et al., 2001). The framework takes account of the two-way relationships between a business organisation and its stakeholders. The PP has five interrelated facets – the top and bottom facets are *Stakeholder Satisfaction* and *Stakeholder Contribution* respectively . The three side facets are "*Strategies, Processes and Capabilities"*. The five facets of PP are depicted at Figure 2.3 (Chapter 2). The PP framework suggests that a PMS should be organised around these five different but linked perspectives of performance. These distinct, but logically interlinked, perspectives on performance have been identified together with five key questions for measurement design (Neely et al., 2001; Ryan, 2015):

1. *"Stakeholder Satisfaction*: Who are the key stakeholders and what do they want and need"?
2. *"Stakeholder Contribution:* What contributions does the organisation require from their stakeholders to maintain and develop organisational capabilities"?
3. *"Strategies:* What strategies does the organisation have to put in place to satisfy the wants and needs of the stakeholders"?
4. *"Processes***:** What critical processes does the organisation require to execute these strategies"?
5. *"Capabilities:* What capabilities do we need to operate and enhance these processes"?

The PP has a broad and comprehensive view of different stakeholders (e.g. investors, customers, employees, regulators and suppliers). All the stakeholders can have a substantial impact on the performance and success of an organisation. The strength of this framework is that it first questions the company's existing strategy before the process of selecting measures is started. In this way, the framework ensures that the performance measures have a strong foundation. It checks what strategies are required to be put in place so that stakeholder's needs and wants are satisfied. The PP also considers new stakeholders (such as employees, suppliers, alliance partners or intermediaries) who are usually neglected when forming strategies and performance measures.

3.6 Aligning Performance Measurement Indicators with Strategic Objectives using Analytical Hierarchical Process and Performance Prism (PP)

Analysis of the PP framework brings out the following issues:

1. *Prioritization of Stakeholders*-Different stake holders contribute in different ways and in varying amounts to organization's needs and goals. Therefore, there is a need to identify and prioritize stakeholders based on their contribution to the organization's needs and wants.

2. *Prioritise Stakeholder Needs*-There are different stake holders in any organisation whose needs and wants are required to be identified and satisfied. Organisation's goals and strategies are to be formulated to satisfy the Stakeholder needs and wants. Prioritisation of stakeholders and prioritisation of stakeholder needs will help in formulation of Goals and Strategies.
3. *Quantification of Contribution of Processes and Capabilities*-Processes and Capabilities are developed to accomplish the strategy. Quantification of the contribution of different processes and Capabilities towards achieving strategic goals will help in aligning Performance Indicators with Strategic Objectives in SC.

PP methodology does not offer a framework for the above mentioned three significant issues; viz. (i) Prioritising of Stakeholders; (ii) Prioritise Stakeholder Needs and (iii) Quantification of Contribution of Processes and Capabilities. Following section of this chapter suggests a methodology of using AHP to incorporate these significant issues and therefore enhance the PP model to align performance indicators with strategic objectives.

3.6.1 Identification of stakeholder's and organization's needs

Organizations require (expect and need) certain things from their stakeholders for sustenance and progress. Similarly, organizations are also responsible for delivering certain things to all their stakeholders. A list of Stakeholders along with Stakeholder Needs and Wants and Organization's Needs and wants are given at Table 3.11. Stakeholders can be prioritized based on 'Stakeholder Contribution' towards fulfilling the needs and wants of the organization. Table 3.12 gives a simplified list of stake holders and organization's needs and wants which is considered for demonstration of integration of AHP with PP. Even though 'employee' is a major stakeholder of the organization, they are an internal stakeholder and the human resource

function of the organization normally attends to ‘employee’ related issues. From a supply chain management perspective, more focus is given on external stakeholder management like ‘Suppliers’, ‘Customers’ etc. rather than ‘employees’.

Table 3.11 Stakeholder Satisfaction and Stakeholder Contribution (Neely et al., 2001)

Stakeholder satisfaction (stakeholder needs and wants)	Stakeholders	Stakeholder contribution (organisation needs and wants)
Fast, Right, cheap and Easy	**Customers**	Trust, Unity, Profit, Growth
Purpose, Care, Skills, Pay	**Employees**	Hands, Hearts, Minds, Voices
Trust, Unity, Profit, Growth	**Suppliers**	Fast, Right, Cheap, Easy
Legal, Fair, Safe, True	**Regulators**	Rules, reason, Clarity, Advice
Return, Reward, Figures, Safety	**Investors**	Capital, Risk, Credit, support

Table 3.12 Organisation’s Needs and Wants from Stakeholders (Simplified List)

Ser. No.	Stakeholders	Organisation Needs and Wants
1.	Customers	Trust, Profit, Support,
2.	Suppliers	Response, Dependable
3.	Investors	Risk, Capital

3.6.2 Generation of comparison matrix of organisation needs and wants

The first step in AHP is to ignore the stakeholders and decide the relative importance of the objectives (Organisation Needs and Wants). This is done by generating the priority matrix for each level of criteria. By using “*Paired Comparison”* and by using “*Comparison*

Values", "*Comparison Matrix"* is generated for organisation needs and wants and is shown at Table 3.13.

Table 3.13 Comparison Matrix of Organisation Needs and Wants

	Trust	**Profit**	**Support**	**Risk**	**Capital**	**Response**	**Dependable**
Trust	1	1/6	2	3	1/4	2	1
Profit	6	1	3	4	2	7	4
Support	1/2	1/3	1	3	1/3	2	1/2
Risk	1/3	1/4	1/3	1	1/4	3	1/3
Capital	4	1/2	3	4	1	5	2
Response	1/2	1/7	1/2	1/3	1/5	1	1/3
Dependable	1	1/4	2	3	1/2	3	1

3.6.3 Prioritising of organisation's needs and wants

Based on the comparison matrix of Organisation *Needs* and *Wants*, Eigen vectors are calculated. The Eigen vector represents the Priority measure of each criterion. The preferences (weighting) of needs and wants of the organisation obtained through the Eigen Vectors is given at Table 3.14. The result indicates that out of the seven needs and wants considered, *'Profit'* is the highest priority need (weight of 0.360) followed by '*Capital'* (weight of 0.2346) and *'Response'* has the least weight age.

Table 3.14 Weighting of Organisation's Needs and Wants

Organisation's Need / Want	Trust	Profit	Support	Risk	Capital	Response	Dependable
Calculated weighting (Eigen Vector)	0.102	0.360	0.0867	0.0572	0.2346	0.0391	0.1196

3.6.4 Evaluation of stakeholder's preference for each of the organisations need

The next step is to evaluate all the Stakeholders on each objective. For Instance; for *Trust* need, evaluate all stakeholders. Then evaluate all the stakeholders for *Profi*t and so on. Priority matrix and Eigen vector for '*Trust'* is shown at Table 3.15. In the similar way, Eigen

vectors are calculated for other 'Needs'. These Eigen Vectors generated gives a measure of Relative value of each 'Need', stakeholder wise.

Table 3.15 Priority Matrix and Eigen Vector for 'Trust'

Trust	Customers	Suppliers	Investors	Eigen Vector
Customers	1	1/3	1/5	0.10945
Suppliers	3	1	1/2	0.30899
Investors	5	2	1	0.58155

3.6.5 Evaluating stakeholder value

Based on the Preferences (weighting) of needs and wants of the organisation and the relative value of each Need, stakeholder wise obtained by using AHP, aggregate Stakeholder value can be calculated using the relation:

$$\text{Stakeholder Value} = \sum(\text{Weighting } of\ need \times \text{Re}\, lative\, Score\, of\ Stakeholder\ for\, that\ need)$$

The summary of weighting of Organization's Needs, Relative Score of stakeholder (Need wise) and the calculated Stakeholder Value is given at Table 3.16. The result indicates that as Stakeholder, '*Customers'* have the highest value (38.34%) followed by '*Investors'* (36.59%).

Table 3.16 Tabulation for Assessment of Stakeholder Value

	Trust	**Profit**	**Support**	**Risk**	**Capital**	**Response**	**Dependable**	**Stakeholder Value**
Customers	0.1095	0.7959	0.2402	0.1166	0.1884	0.0810	0.0879	**38.34%**
Suppliers	0.3090	0.0830	0.3732	0.5107	0.0810	0.7306	0.6694	**25.07%**
Investors	0.5816	0.1211	0.3866	0.3727	0.7306	0.1884	0.2426	**36.59%**
Eigen Vector of Needs	0.1025	0.3604	0.0867	0.0572	0.2346	0.0391	0.1196	

3.6.6 Prioritisation of stakeholder needs (stake holder satisfaction)

Similar AHP methodology can be extended to calculate Prioritisation of Stakeholder Needs and its weights. The steps involve identification of 'needs' and wants' stakeholder wise;

calculation of the weightings of the 'Needs' and 'Wants' of each stakeholder; Calculation of *Stakeholder Needs Value* based on *Stakeholder Value* and *Need weightings*. Organisational goals and strategies can then be formulated based on *Stakeholder Needs Value*. Prioritisation of Stakeholder Needs and its quantification will help in aligning strategies, processes and capabilities.

3.7 Results and Discussion

The present work demonstrates the use of AHP along with BSC and PP in Performance Evaluation of organisations. The data used is of a hypothetical firm, therefore the numerical value of the result is not important. The significant contribution of this study is the development of a method of integrated Performance Evaluation using multiple tools such as AHP, BSC and PP and demonstration of the suggested framework using sample data set.

The Normalized Priority Matrix (shown at Table 3.6) provides percentage contribution of each criterion (performance indicator) in achieving organisational Goal. Decision makers can thus evaluate how each performance indicator will contribute to achieving the organisational goal and prioritise its resource deployment. Overall Performance Index derived through AHP - BSC integrated model (shown at Table 3.7) quantifies overall performance of an organisation. This quantified performance index will help in comparing similar SC, comparing performance of sub units of a SC and in comparing with earlier performances of the same SC or sub unit. These measures can also be used for target setting and as a feedback for mid-course correction and monitoring.

The integration of AHP with PP directly provides the following: (1) Assessing Stakeholder Value (2). Prioritisation and assigning weighting of organisation's needs (Stake holder satisfaction) (3). Prioritisation and assigning weighting of organisation's needs (Stake holder contribution). The procedure can be further extended to evaluate the contribution (in terms of weighting) of individual processes and capabilities in achieving organisation goals and strategy.

3.8 Conclusion

The limitations of BSC viz. that it is difficult to make comparisons within and across firms using BSC and that the measurements making the scorecards unbalanced have been overcome by incorporating AHP with BSC. Integration of AHP with PP helps in aligning

processes and capabilities to strategy and evaluating stakeholder value and prioritises their needs and wants. PMS and AHP integration plays a crucial role by allowing managers to track whether the right processes and capabilities are in place and to monitor whether strategies are leading to organisation's goals. In addition, to help plan, monitor and review strategy, processes and capabilities, integrated PMS and AHP frameworks are helpful in organisational goal setting and aligning performance indicators with strategic objectives.