CHAPTER 5

Hypothesis Testing and Validation of Conceptual Model for Enterprise Performance Management System Effectiveness

5.1 Introduction

This chapter presents the bivariate and multivariate analysis of the data in terms of correlation analysis and regression analysis, to test the hypotheses of association and to predict the relationship among the macro and micro variables for evolving a validated model for enterprise performance management system (EPMS) effectiveness in upstream oil industry in India. The hypotheses have been identified on the basis of conceptual framework of research given in chapter three (Figure 3.1). The hypotheses have been formulated in terms of macro variables and their micro variables as given in section 3.4.

The hypotheses formulated in chapter three are substantive or relational hypotheses (Kerlinher, 1973), in which conjectural statements of relations between two or more variables are expressed. In the strict statistical sense, a substantive hypothesis itself is not testable. It is tested against an alternative statement called null hypothesis, which essentially means that there is no relation/influence with the second variable. First, the null hypothesis is tested. If it is rejected then it is assumed that the alternate hypothesis is true. In testing of relational hypothesis, generally the significance level of 0.05 (i.e. 5 per cent) is taken, which means that the researcher is willing to take 5 per cent risk in rejecting the null hypothesis, when it happens to be true (Kothari, 1985).

The bivariate analysis is used to determine and verify the degree of association among the variables, as stated in the particular hypothesis.

Multivariate analysis, in terms of step-wise regression analysis, is used to determine the predictor relationships among the variables and validate the EPMS effectiveness model. Based on regression analysis and ANOVA analysis of independent and dependent macro and micro variables, the model has been validated.

5.2 Hypothesis Testing for Macro Variables

The hypotheses of association compare and test the conceptual model framework where it is implied that EPMS effectiveness variables (EFF) are dependent on factors influencing effectiveness such as extent of strategy planning (SP), strategic flexibility (SF), effective strategy implementation (SI), comprehensiveness of EPMS design (SM), performance reporting and feedback (PR), information system flexibility (IF), and EPMS implementation issues (MI) (Refer Table 3.3).

5.2.1 Correlation Analysis of Macro Variables

The independent macro variables and EPMS effectiveness macro variable have been analysed for correlation using Pearson's correlation test for full sample test of 139 responses and result is exhibited in Table 5.1, where the statistical significance of correlation is indicated with double asterisks marks for significance level at 0.01 (strongly correlated).

The independent macro variables are exhibiting strong correlation among the at 99 per cent confidence level. The EPMS effectiveness macro variable is strongly correlated with independent macro variables. The highest correlation observed is between EPMS effectiveness and EPMS implementation issues (0.852), which mean that EPMS effectiveness is not

likely to be achieved significantly without excellence in handling EPMS implementation issues.

Table 5.1: Correlation between Independent Macro and Dependent Macro Variables of EPMS

	SP	SF	SI	SM	PR	IF	MI	EFF
SP	1	.433 **	.814 **	.593 **	.543 **	.516 **	.450 **	**.531** **
SF	.433 **	1	.471 **	.650 **	.662 **	.679 **	.682 **	.725 **
SI	.814 **	.471 **	1	.643 **	.536 **	.589 **	.499 *	.608 **
SM	.593 **	.650 **	.643 **	1	.816 **	.714 **	.802 **	.787 **
PR	.543 **	.662 **	.536 **	.816 **	1	.680 **	.820 **	.759 **
IF	.516 **	.679 **	.589 **	.714 **	.680 **	1	.781 **	.782 **
MI	.450 **	.682 **	.499 **	.802 **	.820 **	.781 **	1	.852 **
EFF	**.531** **	**.725** **	**.608** **	**.787** **	**.759** **	**.782** **	**.852** **	1

** Correlation is significant at the 0.01 level (2-tailed).
Note: For Variable Codes refer Table 4.2

5.2.2 Regression Analysis of Macro Variables

The hypotheses of association for macro variables are tested by regression analysis. Since all the relationships are established through correlation analysis, no variable has been dropped at this stage for carrying out regression analysis. The step-wise regression model has been developed and tested for EPMS effectiveness as dependent macro variable and seven independent macro variables (Annexure VII).

Enterprise Performance Management System Effectiveness as Dependent Variable

Step-wise regression with probability of F, to enter <= 0.05 and to remove >= 0.10 has been carried out. The regression model summary, ANOVA analysis, coefficient summary and summary of hypothesis testing for macro variable is shown in Tables 5.2, 5.3, 5.4 and 5.5 respectively.

**Table 5.2: Regression Model Summary by Taking
EPMS Effectiveness as Dependent Variable**

Model	R	R^2	Adjusted R^2	Std. Error of Estimate
1	0.852 a	0.725	0.723	0.476
2	0.877 b	0.769	0.766	0.437
3	0.891 c	0.794	0.789	0.414
4	0895 d	0.800	0.794	0.410

a Predictors: (Constant), MI
b Predictors: (Constant), MI, SI
c Predictors: (Constant), MI, SI, SF
d Predictors: (Constant), MI, SI, SF, IF
e Dependent Variable: EFF

Table 5.3: ANOVA for EPMS Effectiveness as Dependent Variable

Model		Sum of squares	df	Mean square	F	Sig.
1	Regression	81.826	1	81.826	361.358	0.000
	Residual	31.022	137	0.226		
	Total	112.848	138			
2	Regression	86.821	2	43.410	226.834	0.000
	Residual	26.027	136	0.191		
	Total	112.848	138			
3	Regression	89.609	3	29.870	173.521	0.000
	Residual	23.239	135	0.172		
	Total	112.848	138			
4	Regression	90.321	4	22.580	134.319	0.000
	Residual	22.527	134	0.168		
	Total	112.848	138			

a Predictors: (Constant), MI
b Predictors: (Constant), MI, SI
c Predictors: (Constant), MI, SI, SF
d Predictors: (Constant), MI, SI, SF, IF
e Dependent Variable: EFF

**Table 5.4: Coefficient Summary for EPMS Effectiveness
as Dependent Variable**

		Unstandardized Coefficient		Standardized Coefficient		
Model		B	Std. Error	Beta	t	Sig.
1	Constant	1.337	.149		8.970	.000
	MI	.724	.038	.852	19.009	.000
2	Constant	.577	.202		2.852	.005
	MI	.621	.040	.730	15.364	.000
	SI	.264	.052	.243	5.109	.000
3	Constant	.024	.236		.104	.918
	MI	.510	.047	.599	10.787	.000
	SI	.223	.050	.205	4.443	.000
	SF	.258	.064	.220	4.025	.000
4	Constant	-0.022	.234		-0.095	.924
	MI	.447	.056	.526	8.017	.000
	SI	.188	.052	.172	3.581	.000
	SF	.222	.066	.189	3.371	.000
	IF	.140	.068	.142	2.058	.042

a Dependent Variable: EFF

Table 5.5: Regression Model Summary for
EPMS Effectiveness as Dependent Macro Variable

Dependent Variable	Independent Variables Entered in the Model	R^2	Hypotheses Accepted
EPMS Effectiveness (EFF)	MI, SI, SF, IF	0.800	H_{MI}, H_{SI}, H_{SF}, H_{IF}

Note: For Hypotheses Codes Refer Table 3.3 and for Variable Codes Table 4.2
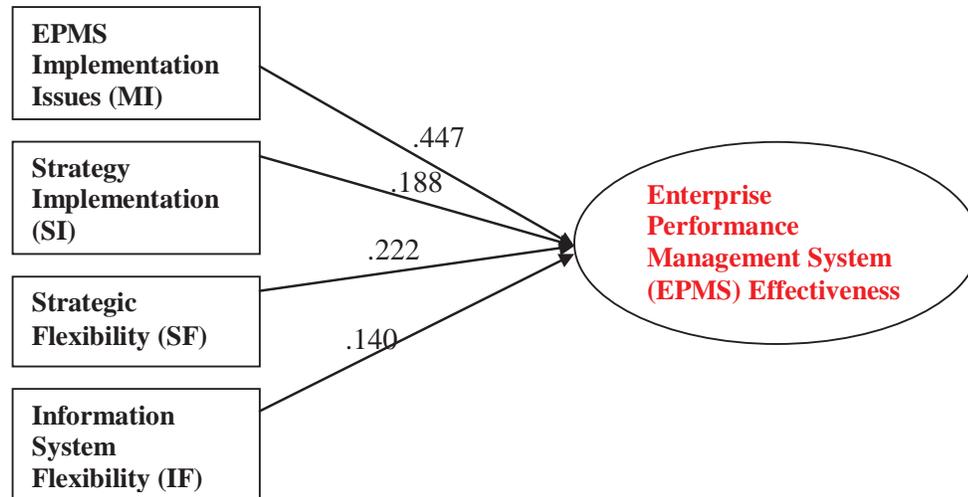
Figure 5.1: Validated Model: Macro Variables
as Predictors of EPMS Effectiveness

The result shows that the hypothesis accepted are H_{MI}, H_{SI}, H_{SF}, H_{IF} i.e. strategy implementation (SI), strategic flexibility (SF), and information system flexibility (IF) are predictors of EPMS effectiveness and the corresponding beta values 0.526, 0.172, 0.189 and 0.142 represent their impact on EPMS effectiveness. The EPMS implementation/management issues (MI) have emerged as the major predictor (Table 5.2). All the four variables together explain 80 per cent of the variance in EPMS effectiveness; the rest is dependent on other variables and spurious variables have not been included in the model. The corresponding ANOVA values for the regression model are shown in Table 5.3 indicating validation at 99 per cent confidence level. The coefficient summary is shown in Table 5.4. The beta values of EPMS implementation issues (MI), strategy implementation (SI), strategic flexibility

(SF), and information system flexibility (IF) are 0.526, 0.172, 0.189 and 0.142 respectively, which are fairly representative of their impact on the EPMS effectiveness (EFF). Thus, the EPMS implementation issues (MI), has emerged as a major influencing variable for EPMS effectiveness (EFF).

The validated model for macro variables as predictors of EPMS effectiveness (EFF) is portrayed in Figure 5.1.

5.2.3 Discussion of Hypothesis Testing of Macro Variables

The summary of the regression model in terms of the independent macro variables acting as predictors, cumulative R^2 and hypotheses accepted is shown in Table 5.5.

There are seven hypotheses of association among macro variables and four have been accepted. The major predictors, as per hypotheses accepted related to independent macro variables EPMS effectiveness, are: EPMS implementation issues (MI), strategy implementation (SI), strategic flexibility (SF), and information system flexibility (IF). The most critical among these variables is EPMS implementation issues.

The importance of implementation issues have been highlighted by various researchers in their studies. The researchers have identified implementation issues such as cultural support (Sink and Tuttle,1989), wrong setting of performance targets (Ittner and larcker, 2003), balanced scorecard non-aligned with strategic planning process (Kaplan and Norton,1992), incentive scheme non-aligned with performance targets (Kaplan and Norton, 1992), sufficient processes and capabilities for strategy implementation (Adams and Neely, 1998) contributing to success and effectiveness of EPMS. Execution excellence model of strategy execution affects various dimensions of enterprise performance (Sushil, 2009). It incorporates four core processes, viz.

align, automate, act and adapt. The strategy is to be aligned with people, processes, technology, budgets, policies and best practices. The 'automate' function requires clear plans and performance management system. The 'act' function is leadership with culture of performance and ethics. The last phase of execution is 'adapt' with changing situation and insights.

Quality, time and flexibility should be part of non-cost measure in EPMS (Toni and Tonchia, 2001). External and internal environment of an enterprise is changing and there should be dynamic performance measurement system to monitor the environment, review strategic objectives and priorities, and deploy system (Bititci, Turner and Begemann, 2000). Flexible strategy framework needs to be adopted to manage continuity and change forces in the enterprise (Sushil, 2005).

Information system flexibility such as flexibility to use and flexibility to change information system have positive impact on performance of business processes in terms of cost efficiency (Gebauer and Lee, 2008).

The results of macro variables are in-line with other research studies as mentioned above. Hence, the organizations intending to implement EPMS should have effective EPMS implementation methodology, strategy implementation, strategic flexibility, and information system flexibility. This will help in performance improvement of the organizations. The hypotheses testing at micro level is presented in the following section.

5.3 Hypothesis Testing for Micro Variables

The hypotheses of association for micro variables compare and test the conceptual model, where it is implied that six EPMS effectiveness micro

variables such as strategic alignment (ESA), strategic monitoring (ESM), financial perspective (EFP), customer perspective (ECP), internal business process perspective (EBP), and learning and growth perspective (ELP) are dependent on sixteen independent micro variables such as vision and mission clarity (SP1), setting of strategic goals (SP2), impact of globalization/liberalization (SF1), in-house capabilities (SF2), external drivers (SF3), e-business impact (SF4), alignment with operational goals (SI1), resources allocation (SI2), selection of dimensions and measures (SM1), customised EPMS (SM2), performance reporting and feedback (PR1), EPMS functionality (IF1), Information technology flexibility (IF2), effective EPMS implementation (MI1), top management support (MI2), and quality of data flow (MI3) (*refer Table 4.*2), which have been derived after applying factor analysis.

5.3.1 Correlation Analysis of Micro Variables

Pearson Correlation analysis has been carried out for 139 responses. The correlation analysis between independent and dependent micro variables of EPMS effectiveness is given in Appendix VI. However, correlation between 16 independent micro variables and 6 dependent micro variables is exhibited in Table 5.6. It has been observed that there is a significant correlation between independent micro variables namely effective EPMS implementation (MI1), top management support (MI2), selection of dimensions and KPI (SM1), and EPMS functionality (IF1) with all dependent micro variables at 99 per cent confidence level.

Table 5.6: Correlation between Independent Micro and Dependent Micro Variables of EPMS Effectiveness

Independent Micro Variable	Dependent Micro Variables of EPMS Effectiveness					
	Strategic Alignment	Strategic Monitoring	Financial Perspective	Customer Perspective	I.B. Process Perspective	L&G Perspective
	ESA	ESM	EFP	ECP	EBP	ELP
SP1	.462 **	.482 **	.391 **	.313 **	.394 **	.402 **
SP2	.394 **	.386 **	.372 **	.341 **	.401 **	.390 **
SF1	.553 **	.598 **	.481 **	.287 **	.572 **	.473 **
SF2	.524 **	.539 **	.431 **	.327 **	.582 **	.528 **
SF3	.547 **	.569 **	.538 **	.573 **	.590 **	.547 **
SF4	.438 **	.403 **	.376 **	.267 **	.347 **	.441 **
SI1	.532 **	.521 **	.492 **	.424 **	.483 **	.579 **
SI2	.453 **	.474 **	.419 **	.379 **	.445 **	.547 **
SM1	.757 **	.810 **	.649 **	.510 **	.675 **	.673 **
SM2	.276 **	.350 **	.239 **	.323 **	.346 **	.248 **
PR1	.757 **	.783 **	.601 **	.426 **	.690 **	.644 **
IF1	.733 **	.796 **	.680 **	.554 **	.735 **	.735 **
IF2	.402 **	.477 **	.379 **	.355 **	.448 **	.435 **
MI1	.817 **	.852 **	.695 **	.497 **	.788 **	.743 **
MI2	.769 **	.775 **	.632 **	.427 **	.747 **	.644 **
MI3	.507 **	.500 **	.550 **	.401 **	.528 **	.540 **

** Correlation is significant at the 0.01 level (2-tailed).
Note: For Variable Code refer Tables 4.2 and 4.9

The result shows that the highest level of correlation is between Effective EPMS Implementation (MI1) with all dependent micro variables, which is logical since effective EPMS implementation is expected to lead to EPMS effectiveness in monitoring and driving performance. The second highest correlation is between selection of dimensions and KPIs (SM1) with all six dependent micro variables, which means that if proper dimensions and measures/ KPIs are selected, it may lead to EPMS effectiveness.

5.3.2 Regression Analysis of Micro Variables

The hypotheses for micro variables of EPMS effectiveness have been tested using step-wise regression analysis. It has been carried out for six dependent micro variables separately and details are shown in Appendix VIII. Regression model summary for each of the six dependent micro variables are given in the following sub-sections.

(i) Micro Hypothesis Testing-Predictors of EPMS Strategic Alignment

The summary of results of regression model for EPMS strategic alignment as dependent micro variable is shown in Table 5.7 and 5.8. The corresponding ANOVA values for the regression model and the coefficient summary are shown in Appendix VIII. The validated model for EPMS strategic alignment is diagrammatically represented in Figure 5.2.

Table 5.7: Regression Model Summary by Taking
EPMS Strategic Alignment as Dependent Micro Variable

Model	R	R^2	Adjusted R^2	Std. Error of Estimate
1	.817 a	.667	.665	.650
2	.835 b	.696	.692	.623
3	.843 c	.710	.704	.611

a Predictors: (Constant), MI1
b Predictors: (Constant), MI1, SP1
c Predictors: (Constant), MI1, SP1, PR1
d Dependent Variable: ESA

Table 5.8: Summary of Hypothesis Testing by Taking
EPMS Strategic Alignment as Dependent Micro Variable

Dependent Micro Variable	Independent Micro Variables Entered in the Model	R^2	Hypotheses Accepted
EPMS Strategic Alignment (ESA)	MI1, SP1, PR1	0.710	H_{MI1SA}, H_{SP1SA}, H_{PR1SA}

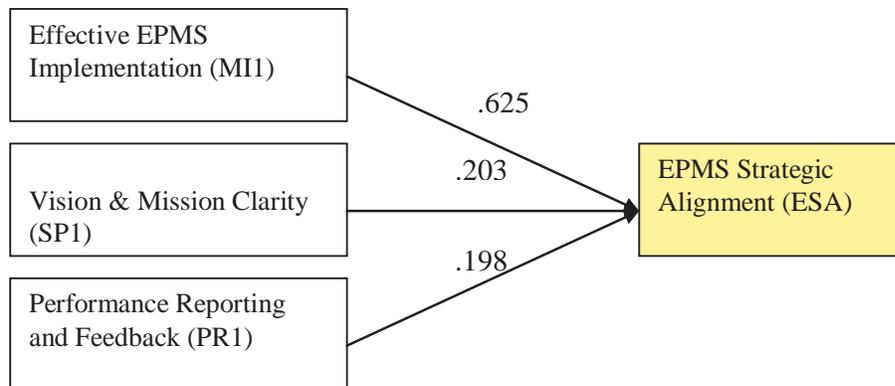Note: For Hypotheses Codes refer Table 3.4 and for Variable Codes Tables 4.2 and 4.9

Figure 5.2: Validated Model: Micro Variables as
Predictors of EPMS Strategic Alignment

The hypothesis accepted are H_{MI1SA}, H_{SP1SA}, and H_{PR1SA} i.e. effective EPMS implementation (MI1), vision and mission clarity (SP1), and performance reporting and feedback (PR1) have come out to be predictor of EPMS strategic alignment (Table 5.7) and effective EPMS implementation (MI1) is the strongest predictor. It means that if EPMS is implemented effectively by taking care of various implementation issues, vision and mission are clear, realistic targets are set and EPMS is able to report performance correctly to the management, it would then lead to strategic alignment of EPMS.

The coefficient of determination (R^2) indicates that all these three variables together explain 71 per cent variance in EPMS strategic alignment (Table 5.8). The regression coefficient 'Beta' shows the degree of association between these independent micro variables and dependent micro variable (EPMS strategic alignment). Here, the linear relationship is highly significant as the associated p-vales are less than 0.01.

(ii) Micro Hypothesis Testing-Predictors of EPMS Strategic Monitoring

The regression model summary for EPMS strategic monitoring as dependent micro variable is shown in Table 5.9 and 5.10. The corresponding ANOVA values for the regression model and the coefficient summary are shown in Appendix VIII. The validated model for EPMS strategic monitoring is given in Figure 5.3.

Table 5.9: Regression Model Summary by Taking
EPMS Strategic Monitoring as Dependent Micro Variable

Model	R	R^2	Adjusted R^2	Std. Error of Estimate
1	.852 a	.727	.725	.571
2	.875 b	.766	.762	.530
3	.885 c	.783	.778	.512
4	.891 d	.793	.787	.502
5	.895 e	.801	.794	.494
6	.899 f	.808	.799	.488

a Predictors: (Constant), MI1
b Predictors: (Constant), MI1, SM1
c Predictors: (Constant), MI1, SM1, IF1
d Predictors: (Constant), MI1, SM1, IF1, SF1
e Predictors: (Constant), MI1, SM1, IF1, SF1, IF2
f Predictors: (Constant), MI1, SM1, IF1, SF1, IF2, SF2
g Dependent Variable: ESM

Table 5.10: Summary of Hypothesis Testing by Taking
EPMS Strategic Monitoring as Dependent Micro Variable

Dependent Micro Variable	Independent Micro Variables Entered in the Model	R^2	Hypotheses Accepted
EPMS Strategic Monitoring (ESM)	MI1, SM1, IF1, SF1	0.808	H_{MI1SM}, H_{SM1SM}, H_{IF1SM}, H_{SF1SM}

Note: For Hypotheses Codes refer Table 3.4 and for Variable Codes Tables 4.2 and 4.9
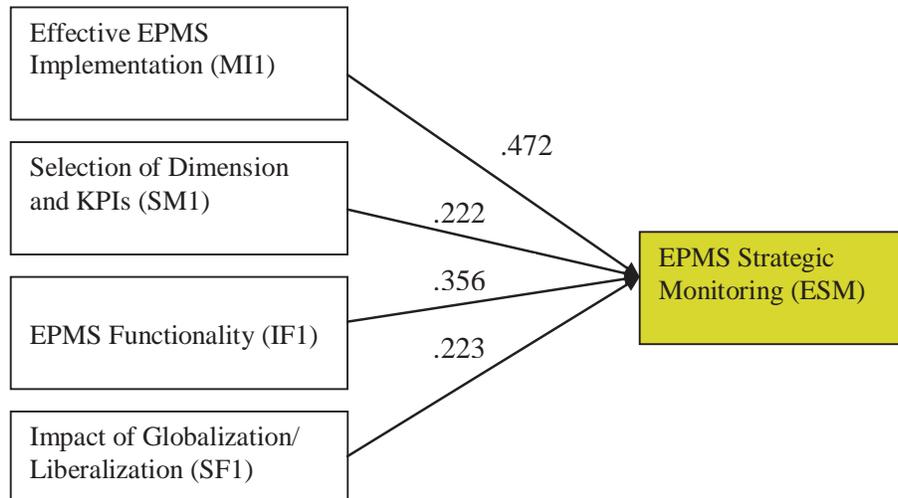

Figure 5.3: Validated Model: Micro Variables as Predictor of
EPMS Strategic Monitoring

From Table 5.9, it is seen that beta values are found to be negative for two the variables namely information technology flexibility (IF2) and in-house capability (SF2) and there is marginal increase of 1.5 per cent in R^2, hence these variables have been dropped and not included in the model. The

hypothesis accepted are From Table 5.10, it is seen that the hypothesis accepted are H_{MI1SM}, H_{SM1SM}, H_{IF1SM}, and H_{SF1SM} i.e. independent micro variables namely effective EPMS implementation (MI1), selection of dimensions and KPI (SM1), EPMS functionality (IF1), and impact of globalization/liberalization (SF1) are predictors of EPMS strategic monitoring (Table 5.9). Among the four, effective EPMS implementation (MI1) is the strongest predictor of dependent micro variable i.e. EPMS strategic monitoring.

It means that if EPMS implemented effectively by taking care of various implementation issues, EPMS designed with proper dimension and KPIs, EPMS functionality with flexibility, and globalization and liberalization impacting the enterprise positively, then it may result into strategic alignment of EPMS.

The coefficient of determination (R^2) indicates that all the four variables together explain 79.3 per cent variance in EPMS strategic monitoring (Table 5.10). The regression coefficient 'Beta' shows the degree of association between these independent micro variables and dependent micro variable (EPMS strategic monitoring) is linear and highly significant as the associated p-vales are less than 0.01.

(iii) Micro Hypothesis Testing-Predictors of EPMS Financial Perspective

The summary of regression results by taking financial perspective as dependent micro variable is depicted in Tables 5.11 and 5.12. The corresponding ANOVA values for the regression model and the coefficient summary are shown in Appendix VIII. The validated model for EPMS financial perspective is exhibited in Figure 5.4.

Table 5.11: Regression Model Summary by Taking
Financial Perspective as Dependent Micro Variable

Model	R	R^2	Adjusted R^2	Std. Error of Estimate
1	.695 a	.482	.479	.816
2	.723 b	.522	.515	.786
3	.737 c	.543	.533	.772
4	.747 d	.558	.545	.761
5	.760 e	.577	.561	.748

a Predictors: (Constant), MI1
b Predictors: (Constant), MI1, IF1
c Predictors: (Constant), MI1, IF1, MI3
d Predictors: (Constant), MI1, IF1, MI3, SF3
e Predictors: (Constant), MI1, IF1, MI3, SF3, IF2
f Dependent Variable: EFP

Table 5.12: Summary of Hypothesis Testing by Taking
EPMS Financial Perspective as Dependent Micro Variable

Dependent Micro Variable	Independent Micro Variables Entered in the Model	R^2	Hypotheses Accepted
Financial Perspective (EFP)	MI1, IF1, MI3, SF3, IF2	0.577	H_{MI1FP}, H_{IF1FP}, H_{MI3FP}, H_{SF3FP}, H_{IF2FP}

Note: For Hypotheses Codes refer Table 3.4 and for Variable Codes Tables 4.2 and 4.9
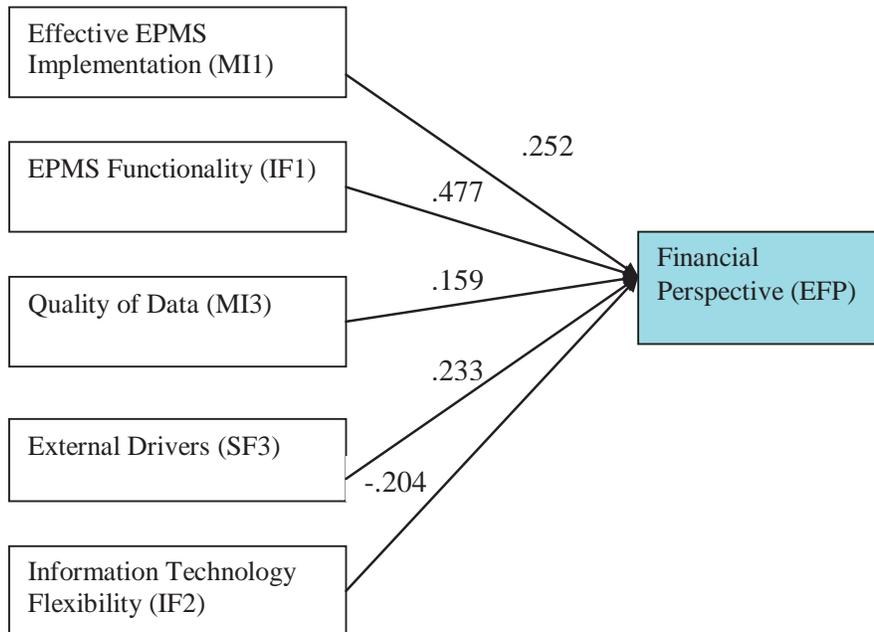

Figure 5.4: Validated Model: Micro Variables as Predictor of
EPMS Financial Perspective

In case of EPMS financial perspective, the hypothesis accepted are H_{MI1FP}, H_{IF1FP}, H_{MI3FP}, H_{SF3FP}, and H_{IF2FP} i.e. five independent micro variables viz. effective EPMS implementation (MI1), EPMS functionality (IF1), quality of

data flow (MI3), external drivers (SF3), and information technology flexibility (IF2) have come up as predictor of EPMS financial perspective (Table 5.11). Among the five, effective EPMS implementation (MI1) is the strongest predictor of dependent micro variable i.e. EPMS financial perspective.

It implies that if EPMS implemented effectively by taking care of various implementation issues, EPMS functionality with flexibility, quality of data flowing in the system and external drivers are favourable, then it is expected to result in achievement of financial perspective. The beta value for information technology flexibility (IF2) is negative, which means that creating more flexibility in information technology (IT) system deployment of EPMS would require more investment and thereby having negative impact on financial perspective, which seems to be true.

As evident from coefficient of determination (R^2), all these five variables together explain 57.7 per cent variance in EPMS financial perspective (Table 5.12). The 'Beta' values show the degree of association between these independent micro variables and dependent micro variable (EPMS financial perspective) is highly significant as the associated p-vales are less than 0.01.

(iv) Micro Hypothesis Testing-Predictors of EPMS Customer Perspective

The summary of regression results, where customer perspective is taken as dependent micro variable, is shown in Table 5.13 and 5.14. The corresponding ANOVA values for the regression model and the coefficient summary are shown in Appendix VIII. The validated model for EPMS customer perspective is exhibited in Figure 5.5.

Table 5.13: Regression Model Summary results by Taking
EPMS Customer Perspective as Dependent Micro Variable

Model	R	R^2	Adjusted R^2	Std. Error of Estimate
1	.573 a	.329	.324	1.096
2	.643 b	.413	.405	1.027
3	.660 c	.436	.423	1.012
4	.678 d	.459	.443	.995

a Predictors: (Constant), SF3
b Predictors: (Constant), SF3, IF1
c Predictors: (Constant), SF3, IF1, SF1
d Predictors: (Constant), SF3, IF1, SF1, SP2
e Dependent Variable: ECP

Table 5.14: Summary of Hypothesis Testing by Taking
EPMS Customer Perspective as Dependent Micro Variable

Dependent Micro Variable	Independent Micro Variables Entered in the Model	R^2	Hypotheses Accepted
Customer Perspective (ECP)	SF3, IF1, SF1, SP2	0.459	H_{SF3CP}, H_{IF1CP}, H_{SF1CP}, H_{SP2CP}

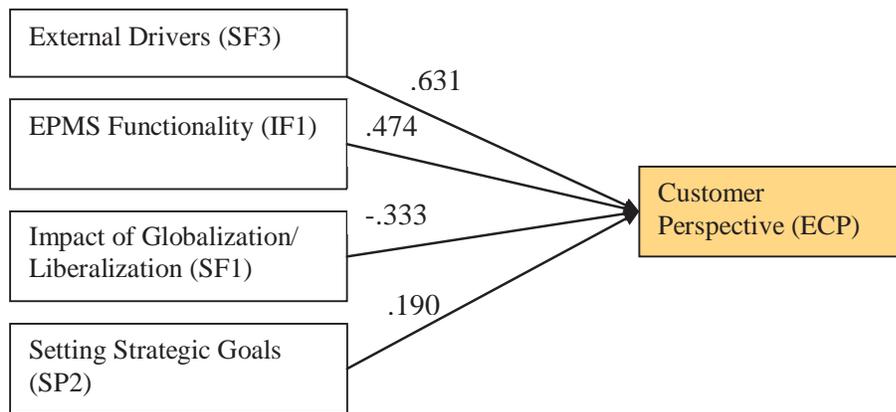Note: For Hypotheses Codes refer Table 3.4 and for Variable Codes Tables 4.2 and 4.9

Figure 5.5: Validated Model: Micro Variables as Predictor of
EPMS Customer Perspective

It is evident from the Table 5.14 that the hypothesis accepted are H_{MI1FP}, H_{SF3CP}, H_{IF1CP}, H_{SF1CP}, and H_{SP2CP} i.e. the independent micro variables namely external drivers (SF3), EPMS functionality (IF1), impact of globalization/liberalization (SF1), and setting strategic goals (SP2) have been are predictor of EPMS customer perspective and external drivers (SF3) is the strongest predictor of dependent micro variable EPMS customer perspective.

It is inferred that if external drivers are favourable to the enterprise, EPMS functionality with flexibility, and strategic goal setting is realistic and consensus based, then it will lead to achievement of customer perspective. The beta value for Impact of globalization/liberalization (SF1) is negative, which means globalization and liberalization in oil industry is putting cost pressure in terms of product pricing of petroleum products and gases to customers and thereby negative impact on customer perspective, which is true.

The coefficient of determination (R^2) indicates that all these four variables together explain 45.9 per cent variance in EPMS customer perspective (Table 5.14). The regression coefficient 'Beta' shows the degree of association between independent micro variables and customer perspective as linear and highly significant as the associated p-vales are less than 0.01.

(v) Micro Hypothesis Testing-as Predictors of EPMS Internal Business Process Perspective

The summary of regression model for EPMS internal business process perspective as dependent micro variable is shown in Tables 5.15 and 5.16. The corresponding ANOVA values for the regression model and the coefficient summary are provided in Appendix VIII. The validated model for EPMS internal business process perspective is diagrammatically shown in Figure 5.6.

Table 5.15: Regression Model Summary by Taking
EPMS Internal Business Process Perspective as Dependent Micro Variable

Model	R	R^2	Adjusted R^2	Std. Error of Estimate
1	.788 a	.621	.619	.593
2	.806 b	.650	.645	.573
3	.818 c	.669	.662	.559

a Predictors: (Constant), MI1
b Predictors: (Constant), MI1, SF1
c Predictors: (Constant), MI1, SF1, IF1
d Dependent Variable: EBP

Table 5.16: Summary of Hypothesis Testing by Taking
EPMS Internal Business Process Perspective as Dependent Micro Variable

Dependent Micro Variable	Independent Micro Variables Entered in the Model	R^2	Hypotheses Accepted
Internal Business Process Perspective (EBP)	MI1, SF1, IF1	0.669	H_{MI1BP}, H_{SF1BP}, H_{IF1BP}

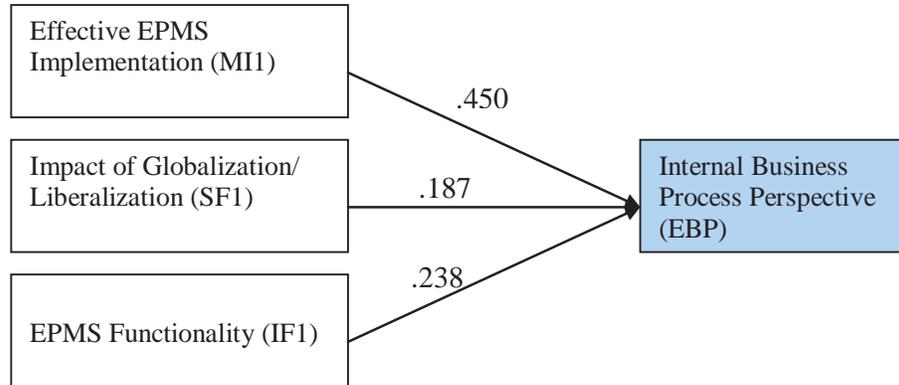Note: For Hypotheses Codes refer Table 3.4 and for Variable Codes Tables 4.2 and 4.9

Figure 5.6: Validated Model: Micro Variables as Predictor of
EPMS Internal Business Process Perspective

Three independent micro variables namely effective EPMS implementation (MI1), impact of globalization/liberalization (SF1), and EPMS functionality (IF1) have entered the regression model (Table 5.15) and are major predictors of EPMS internal business process perspective. Among the three, effective EPMS implementation (MI1) is the strongest predictor of dependent micro variable i.e. EPMS internal business process perspective.

It implies that if EPMS is implemented effectively by taking care of various implementation issues, impact of globalization and liberalization is realized with by adopting competitive strategy and focusing on core competence, and flexibility adoption in EPMS functionality, then it would result in achievement of internal business process perspective.

The coefficient of determination (R^2) indicates that all these three variables together explain 66.9 per cent variance in EPMS internal business

process perspective (Table 5.16). The regression coefficient 'Beta' shows that the degree of association is highly significant as the associated p-vales are less than 0.01 between independent micro variables selected and EPMS internal business process perspective.

(vi) Micro Hypothesis Testing-Predictors of EPMS Learning and Growth Perspective

The regression model summary for EPMS learning and growth perspective as dependent micro variable is shown in Tables 5.17 and 5.18. The corresponding ANOVA values for the regression model and the coefficient summary are shown in Appendix VIII. The validated model for EPMS learning and growth perspective is portrayed in Figure 5.7.

**Table 5.17: Regression Model Summary by Taking
EPMS Learning and Growth Perspective as Dependent Micro Variable**

Model	R	R^2	Adjusted R^2	Std. Error of Estimate
1	.743 a	.552	.548	.599
2	.791 b	.626	.621	.549
3	.801 c	.642	.634	.539

a Predictors: (Constant), MI1
b Predictors: (Constant), MI1, SI2,
c Predictors: (Constant), MI1, SI2, IF1
d Dependent Variable: ELP

**Table 5.18: Summary of Hypothesis Testing by Taking
EPMS Learning and Growth Perspective as Dependent Micro Variable**

Dependent Micro Variable	Independent Micro Variables Entered in the Model	R^2	Hypotheses Accepted
Learning and Growth Perspective (ELP)	MI1, SI2, IF1	0.642	H_{MI1LP}, H_{SI2LP}, H_{IF1LP}

Note: For Hypotheses Codes refer Table 3.4 and for Variable Codes Tables 4.2 and 4.9

```
┌──────────────────────┐
│ Effective EPMS       │╲
│ Implementation (MI1) │ ╲ .384
└──────────────────────┘  ╲
                           ╲        ┌──────────────────┐
┌──────────────────────┐    ╲       │ Learning and     │
│ Resource Allocation  │ .225─────→ │ Growth Perspective│
│ (SI2)                │   ╱        │ (ELP)            │
└──────────────────────┘  ╱ .217   └──────────────────┘
                         ╱
┌──────────────────────┐╱
│ Impact of Globalization/│
│ Liberalization (IF1) │
└──────────────────────┘
```
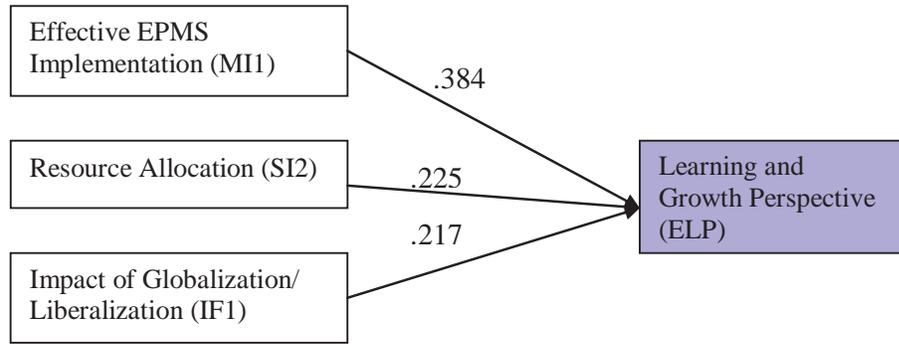
**Figure 5.7: Validated Model: Micro Variables as Predictor of
EPMS Learning and Growth Perspective**

In the validated model depicted in Figure 5.7, EPMS learning and growth perspective is considered to depend on three independent micro variables namely effective EPMS implementation (MI1), resources allocation (SI2), and EPMS functionality (IF1) as per hypothesis accepted $H_{MI1LP,}$ $H_{SI2LP,}$ and H_{IF1LP} (Table 5.18). Among the three variables included in the model, effective EPMS implementation (MI1) is found to be the strongest predictor of dependent micro variable i.e. EPMS learning and growth perspective.

This clearly implies that learning and growth perspective of EPMS can be enhanced through effective EPMS implementation, commitment of sufficient budgetary resources, and to derive maximum advantage of globalization and liberalization by selecting appropriate strategies related with mergers and acquisitions, and core competencies.

The coefficient of determination (R^2) indicates that 64.2 per cent variance in EPMS learning and growth perspective is explained by these three variables (Table 5.18). The degree of association between these independent micro variables and dependent micro variable (EPMS learning and growth perspective) is also highly significant as the associated p-vales are less than 0.01.

5.3.3 Interdependence of Variables of EPMS

To study the interdependence of independent variables of EPMS, stepwise regression analysis with probability of F, to enter <= 0.05 and to remove >= 0.10 has been applied. The result and interpretation is given in following sub sections.

5.3.3.1 Interdependence of Independent Variables of EPMS

Taking one variable as dependent and rest as independent out of independent macro variables of EPMS effectiveness, regression analysis has been carried out and result is summarized in Table 5.19.

**Table 5.19: Regression Results showing Interdependence
of Independent Macro Variables**

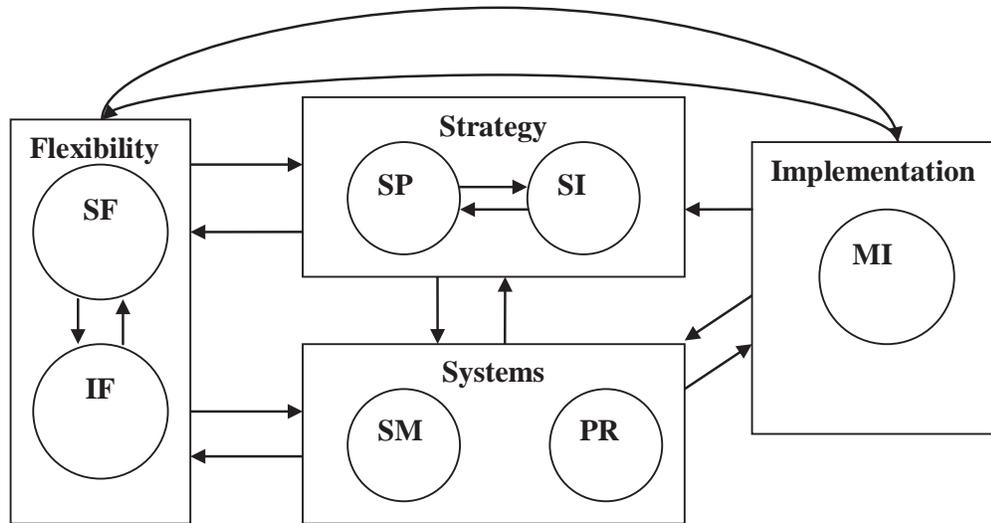| Independent Variable Taken as Dependent	Independent Variables Entered in the Model	R^2	Values of B
Strategy Planning (SP)	SI, PR	0.679	.703, .101
Strategic Flexibility (SF)	IF, PR	0.536	.357, .245
Strategy Implementation (SI)	SP, SM, IF	0.712	.676, .130, .130
EPMS Design (SM)	PR, SI, MI	0.766	.325, .310, .339
Performance Reporting and Feedback (PR)	MI, SM, SP	0.750	.521, .438, .162
Information System Flexibility (IF)	MI, SI, SF	0.687	.448, .251, .259
EPMS Implementation Issues (MI)	PR, IF, SM, SP	0.791	.370, .427, .300, -.172

It can be seen from Table 5.19 that the coefficient of determination (R^2) is more than 0.536, which indicate that variables entered into the model explain more than 53.6 per cent variance in the respective independent variables. It is evident that strategic planning is inter-dependent on strategy implementation, and performance reporting and feedback. Similarly strategic flexibility is inter-dependent on information system flexibility, and performance reporting and feedback. Strategy implementation is inter-dependent on strategic planning, enterprise performance measurement system design, and information system

flexibility. Enterprise performance measurement system design is inter-dependent on performance reporting and feedback, strategy implementation, and EPMS implementation issues. Performance reporting and feedback is inter-dependent on EPMS implementation issues, enterprise performance measurement system design, and strategic planning. Information system flexibility is inter-dependent on EPMS implementation issues, strategy implementation, and strategic flexibility. EPMS implementation issues are also inter-dependent on performance reporting and feedback, information system flexibility, enterprise performance measurement system design. The interdependent of Independent macro variables of EPMS can be seen from Table 5.20 and Figure 5.8.

Table 5.20: Interdependence of Independent Macro Variables

	SP	SF	SI	SM	PR	IF	MI
SP			✓		✓		
SF					✓	✓	
SI	✓			✓		✓	
SM			✓		✓		✓
PR	✓			✓			✓
IF		✓	✓				✓
MI				✓	✓	✓	

Note: For Variable Codes, refer Table 5.19

Note: For Variable Codes, refer Table 5.19
Figure 5.8: Interdependent of Independent Macro Variables

The macro independent variables of EPMS are strongly correlated and their inter-dependent is presented in the model (Refer Figure 5.8). There are four major groups such as strategy, flexibility, systems, and implementation, which are inter-dependent with each other in EPMS model. Strategy group consisting of strategy planning and strategy implementation are inter-dependent with each other. There is also interdependent between strategic flexibility and information system flexibility. Performance measurement system and performance reporting are also found to be inter-dependent with each other as shown in the model. EPMS implementation is inter-dependent with flexibility as well as systems.

5.3.3.2 Interdependent of Dependent Variables of EPMS Effectiveness

A stepwise regression analysis has been carried out by taking one variable as dependent and rest as independent variables out of dependent variables of EPMS effectiveness, to study the interdependence of dependent macro variables. Regression summary is exhibited in Table 5.21.

Table 5.21: Regression Model Summary showing
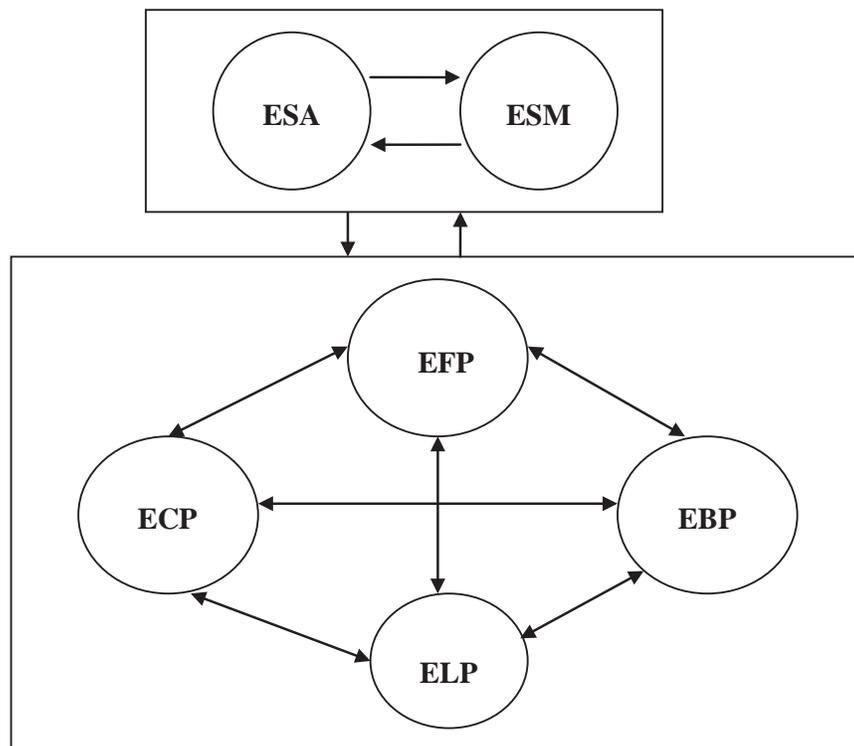**Interdependence of Dependent Micro Variables of EPMS Effectiveness**

Dependent Variable Taken as Dependent	Dependent Variables Entered in the Model	R^2	Values of B
Strategic Alignment (ESA)	ESM, EBP	0.792	.704, .286
Strategic Monitoring (ESM)	ESA, EBP, EFP	0.805	.623, .227, .119
Financial Perspective (EFP)	EBP, ECP, ELP	0.639	.430, .292, .276
Customer Perspective (ECP)	EFP, EBP	0.456	.626, .254
Internal Business Process Perspective (EBP)	ESM, EFP, ELP, ESA	0.745	.200, .217, .239, .231
Learning and Growth Perspective (ELP)	EBP, ESM, EFP	0.628	.340, .244, .161

The coefficient of determination (R^2) is by and large more than 0.5, which means that variables entered the model cover more than 50 per cent variance in the dependent micro variable (Table 5.21). It is seen from regression analysis that strategic alignment is inter-dependent on strategic monitoring, and achievement of internal business process objectives. Strategic monitoring is inter-dependent on strategic alignment, achievement of objectives of internal business process, and financial. Achievement of financial objective is inter-dependent on achievement of objectives of internal business process, customer, and learning and growth. Achievement of customer objectives is inter-dependent on achievement of objectives of financial and internal business process. Achievement of Internal business process objectives is inter-dependent on strategic monitoring, strategic alignment, achievement of financial objectives, and learning and growth objectives. Achievement of learning and growth objectives is inter-dependent on strategic monitoring, achievement of internal business process, and financial objectives. The inter-dependent of dependent micro variables of EPMS effectiveness is shown in Table 5.22 and Figure 5.9.

Table 5.22: Interdependence of Dependent Micro Variables of EPMS Effectiveness

	ESA	ESM	EFP	ECP	EBP	ELP
ESA		✓			✓	
ESM	✓		✓		✓	
EFP				✓	✓	✓
ECP			✓		✓	
EBP	✓	✓	✓			✓
ELP		✓	✓		✓	

Note: For Codes, refer Table 5.21

Note: For Codes, refer Table 5.21

Figure 5.9: Interdependence of Dependent Micro Variables of EPMS Effectiveness

The dependent micro variables of EPMS effectiveness are strongly correlated and Inter-dependent (Refer Figure 5.9). Strategic alignment and strategic monitoring are inter-dependent. There is close inter-dependence among all four perspectives of financial, customer, internal business process,

and learning and growth. Achievement of these four perspectives is also dependent on strategic alignment and strategic monitoring.

5.3.4 Discussion of Hypotheses Testing of Micro Variables of EPMS

This section presents the summary of regression results between micro dimensions of effectiveness, acting as independent variables, and the enterprise performance management system (EPMS) effectiveness, acting as dependent variables.

The micro level results reported in Tables 5.8, 5.10. 5.12, 5.14, 5.16, and 5.18 indicate that 11 out of 16 identified micro variables are influencing the EPMS effectiveness. However, effective EPMS Implementation (MI1) is most dominant predictor.

The synthesis of learning from bivariate and multivariate analysis at macro and micro levels is given in Table 5.23. The final validated model for EPMS Effectiveness is exhibited in Figure 5.10.

Table 5.23: Syntheses of Learning from Bivariate and Multivariate Analysis of EPMS Effectiveness

	Independent Macro Variables	Independent Micro Variables
EPMS Effectiveness	Strategy Planning (SP)	Vision and Mission Clarity (SP1)
		Setting Strategic Goals (SP2)
	Strategic Flexibility (SF)	Impact of Globalization/ Liberalization (SF1)
		External Drivers (SF3)
	Strategy Implementation (SI)	Resources Allocation (SI2)
	EPMS Design (SM)	Selection of Dimensions and KPI (SM1)
	Performance Reporting and Feedback (PR)	Performance Reporting and Feedback (PR1)
	Information System Flexibility (IF)	EPMS Functionality (IF1)
		IT Flexibility (IF2)
	EPMS Implementation Issues (MI)	Effective EPMS Implementation (MI1)
		Quality of Data Flow (MI3)

From Table 5.23 and Figure 5.10, it can be observed that four macro predictors of EPMS effectiveness namely EMPS implementation issues (MI),

strategy implementation (SI), strategic flexibility (SF), and information system flexibility (IF) came out from macro analysis and three additional macro predictors namely strategy planning (SP), EPMS design (SM), and performance reporting and feedback (PR) from micro analysis. Even though all the seven macro variables are strongly correlated with EPMS effectiveness but EPMS implementation issues, strategic flexibility (SF), and information system flexibility (IF) are more dominant. The micro predictors of EPMS effectiveness are summarized in Table 5.24. Explanation of various predictors is given below.
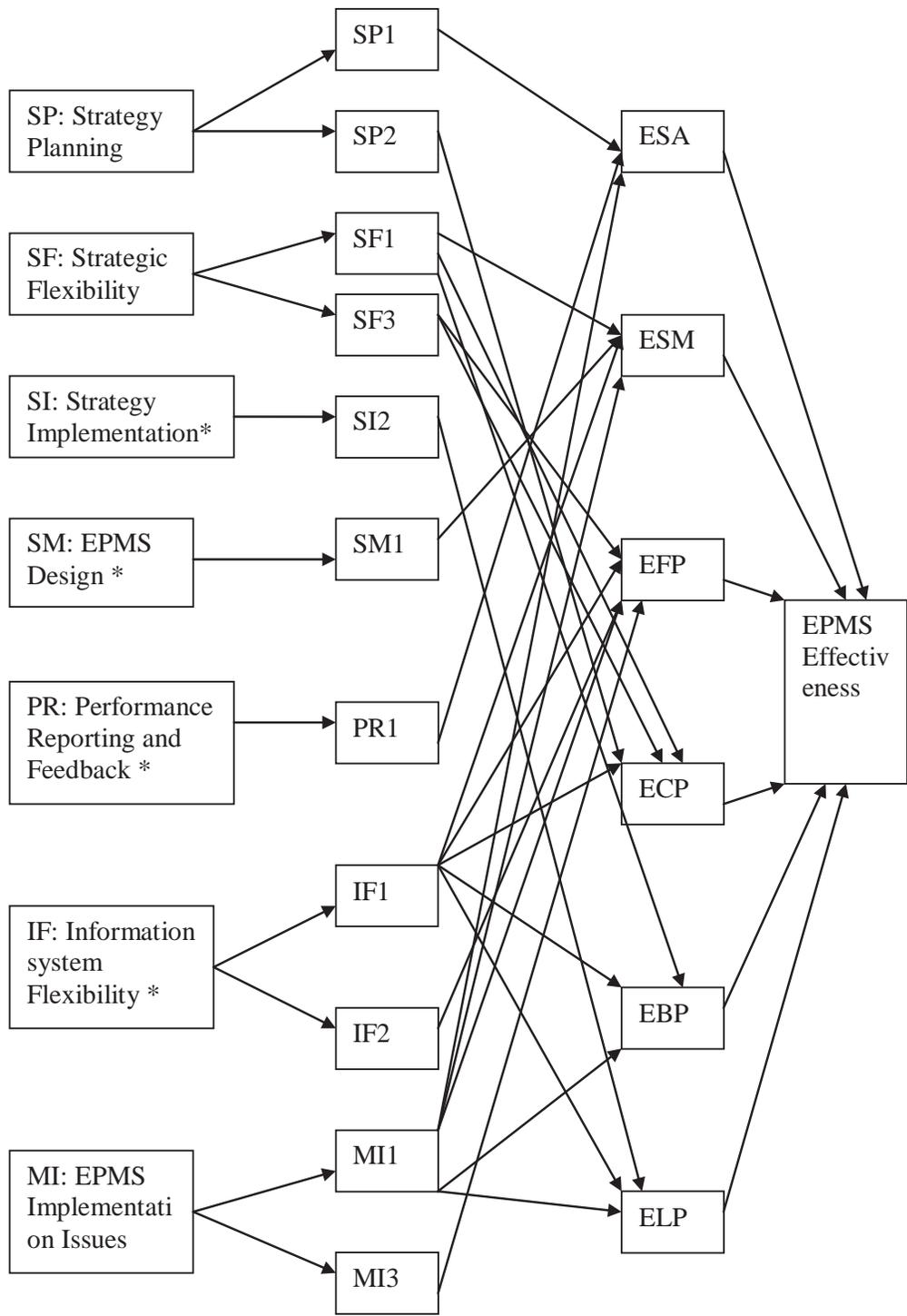
* Macro predictors from Micro Analysis. For variables codes, refer Tables 5.21 and 5.23

Figure 5.10: Validated Model: Micro Variables as Predictor of EPMS Effectiveness

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Table 5.24: Micro Predictors of EPMS Effectiveness

Micro Predictors	Micro Variables of EPMS Effectiveness					
	Strategic Alignment (ESA)	Strategic Monitoring (ESM)	Financial Perspective (EFP)	Customer Perspective (ECP)	I.B.P. Perspective (EBP)	L and G Perspective (ELP)
Vision and Mission Clarity (SP1)	✓					
Setting Strategic Goals (SP2)				✓		
Globalization / Liberalization Impact (SF1)		✓		✓	✓	
External Drivers (SF3)			✓	✓		
Resources Allocation (SI2)						✓
Dimension and KPI Selection (SM1)		✓				
Performance Reporting and Feedback (PR1)	✓					
EPMS Functionality (IF1)		✓	✓	✓	✓	✓
Information Technology Flexibility (IF2)			✓			
Effective EPMS Implementation (MI1)	✓	✓	✓		✓	✓
Quality of Data (MI3)			✓			

Note: For Codes, refer Tables 5.21 and 5.23

From the summary of bivariate and multivariate analysis presented in Tables 5.23 and 5.24, following observations and interpretation of micro predictors of EPMS effectiveness are highlighted.

Strategy Planning

(i)   Vision and mission clarity leads to better strategy planning and hence better strategic alignment of EPMS.

(ii) Setting strategic goals to meet the quality and quantity of customer requirements fulfils customer perspective.

Strategic Flexibility

(i)   Impact of globalization and liberalization has provided global competition as well as opportunities and forced organizations to adopt

competitive strategy and core competence and thus influences strategic alignment, customer and internal business process perspectives.

(ii) External drivers such as markets forces, government policies and mergers and acquisitions are influencing financial and customer perspectives.

(iii) Due to liberalization, competition has started and In-house capability could not be visualised and benefit could not be gained at this stage in upstream oil industry and therefore this hypothesis is dropped. But with passage of time and increase of global competition, in-house capability is expected to provide competitive advantage.

(iv) E-business impact hypothesis is dropped as most upstream organisations under study are not doing e-business and so assessment of e-business impact could not be done. Once e-business improves in these organizations, its impact will be visible and is likely to influence EPMS effectiveness.

Strategy Implementation

(i) Adequate resources allocation helps to meet strategic targets and this supports fulfilment of learning and growth perspective.

(ii) Alignment with operational goals hypothesis is rejected as survey was carried out at Senior and middle management and not at operational level, where operational goal alignment might be out of focus.

EPMS Design

(i) Identification of dimensions and key performance indicators in EPMS is very important. What is being measured and how it is being measured leads to strategic monitoring by EPMS.

(ii)   Customised EPMS item was probably not understood clearly by the respondents and thus could not figure out in the validated model.

Performance Reporting and Feedback

(i)   Performance reporting and feedback is an important aspect of EPMS and if EPMS is properly designed and implemented, it would lead to strategic alignment of EPMS.

Information System Flexibility

(i)   Flexibility in EPMS functionality design and computerization including ERP use affects almost all effectiveness areas of EPMS.

(ii)   Information system flexibility would need more investment in terms of IT resources and IT personnel and would thus influence financial perspective.

EPMS Implementation Issues

(i)   EPMS implementation with due care and taking care of key success factors are critical to its ultimate success and thus influences almost all areas of EPMS effectiveness.

(ii)   Quality and timely smooth flow of data into EPMS system is again an important aspect like any other MIS. This requires additional efforts in term of time and money and thus influences financial perspective.

(iii)   EPMS in organizations under study is largely being handled at middle level and not having full top management support and hence its potential benefit and usage has not yet been realised. Consequently it could not be appreciated in the organizations under study.

5.4 Summary and Concluding Remarks

The survey data has been analyzed through correlation and regression analysis to test the macro as well as micro hypotheses evolved for the study. Hypotheses testing are based on the strength of correlation among the variables. Regression analysis gives useful results regarding model validation. The results of the study have been presented and discussed in this chapter. The key issues have been identified. These results also provide useful deep insight into the parameters impacting the effectiveness of enterprise performance management system (EPMS).

The survey brings out the positive influence of strategy planning, strategic flexibility, strategy implementation, EPMS design, information system flexibility, and performance reporting and feedback, and EPMS implementation issues on EPMS effectiveness to drive performance improvement of upstream oil companies in India. EPMS implementation issues have emerged to be playing a dominating role in EPMS effectiveness.

Indian upstream oil companies appear to lack in understanding the importance of top management support, alignment with operational goals and in-house capability in influencing the effectiveness of EPMS.

The findings of survey are planned to be corroborated by carrying out case study of two upstream oil companies, which is presented in next chapter.

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