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THESIS

PRODUCTIVITY/PERFORMANCE MEASUREMENT WITH AN
INTEGRATION OF TIME-LAG EFFECTS
CASE APPLICATION AT RIGID PLASTIC FILM
PRODUCTION PLANT

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The purpose of this thesis work was to study key performance measurement in rigid plastic film production plant (RPP) with an integration of mathematics analysis. According to ISO ISO9001 version 2000 requirement 8 was released methods of analysis to general production and design company, the RPP is under that regulation of ISO, this thesis work has enhance existing policy on quality management and internal development to use in further as a requirement Of ISO9001 version 2000 requirement 8. On the other hand, this work has design to carry out the performance and benefit of R&D in point of financial index on new products to end customers.

The data which used to determine the relationship of mathematic models based on balance scorecard frame work. It is 4 parameters in this study; financial perspective, customer perspective, internal process perspective, and innovation and learning perspective. In general before this thesis work carried out the internal relationship in terms of mathematic with time lag analysis. Those parameters have look in single point of view with no inter linkage. Normally, most the top managements have relied on financial data or cost and benefit issues to monitor and control the business with less consideration of other factors such customer analysis, internal process, and innovation and learning. As a results from this research work, it was found crucial factors that able to improve the financial statement of RPP. The results in terms of mathematics index were confirm the believing of management such over time benefit to RPP, labor cost control, maximized production output lead on benefits, and etc. On the quality of work life, it was found the innovation and learning has reflect to company social quality and derived the by positive product of earning before interest and tax (EBIT). In the end, thesis result has capability to be standard tools of quality and control for RPP management.

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LIST OF ABBREVIATIONS

BSC	=	Balanced Scorecard
DMU	=	Decision making unit
EBIT	=	Earning before interest and TAX
EBITD	=	Earnings before interest, tax, depreciation and amortization
EFQM	=	European Foundation for Quality Management BRG_P
ISO	=	International Organization for Standardization
MBNQA	=	Malcom Baldrige National Quality Award
MIS	=	Management information system
MSM	=	Management system model
PM	=	Performance Measurement
R&D	=	Research and development
RPP	=	Rigid Plastic film production plant
R ²	=	Coefficient of determination
SME	=	Small and medium enterprise
TQA	=	Total quality assurance
VIF	=	Variance inflation factor

**PRODUCTIVITY/PERFORMANCE MEASUREMENT WITH AN
INTEGRATION OF TIME-LAG EFFECTS
CASE APPLICATION AT RIGID PLASTIC FILM
PRODUCTION PLANT**

INTRODUCTION

Since the earlier of the year 2008, the oil price was increasing sharply and plastics business is under the effect of raw material from products. Absolutely, Any Plastic film production affected directly by this phenomenon. Where, the selling price can not much adjust to the end user such packaging provider, card supplier, advertisement business, and others who use a rigid plastic film as an intermediate. So the role of Key Performance Measurement becomes an important role to monitor and control each of involved facility to; meet the plant optimality; and meet the global customer requirement.

Most organizations now face opportunities, threats, and change on an unprecedented scale. Decision making is seen as synonymous with management (Simon, 1977). It affects the actions through the whole operational process and determines the level of management success in any organization (Kurstedt, 1992).

The quality of a decision is based on the experience of the decision maker and supporting information. According to Kaye (1995), a decision is made on the basis of hunch and intuition, but is legitimated by dressing it up with supporting facts and data. Longbottom (1672) and Mintzberg (1976) advocated that effective decision making occurs where managers actively select situations which require decisions and seek information regarding those decisions. Forrester (1961) also suggests that the level of success in decision making primarily depends on information since decision making is the process of converting information into action. Therefore, good information is necessary for decision making. If an organization is to survive and prosper, it must understand both its own internal workings and the nature of the

environment to which it has to adapt and respond (Kaye, 1995). Thus, good information should reflect both internal processes and external agencies such as governments, competitors, and social groups.

According to Forrester (1961), the manager receives information from management tools to make decision and generate actions from the decisions to affect the work flow. Of all the management tools, Performance Measurement (PM) has received the most attention and study. PM gives information to stimulate appropriate action and organizational learning at the right level of the organization and stage of the decision-making process (Brignall and Ballantie, 1996). Organizations adopt PM systems mainly to achieve control over the organization in ways that traditional accounting systems do not allow (Kellen, 2003). The importance of PM is embodied in requirements and reward recognitions, such as the ISO 9001: 2000 standard, the European Foundation for Quality Management (EFQM) and Malcom Baldrige National Quality Award (MBNQA) Models for Business Excellence and Performance.

Refer to Phusavat K. *et al.*, (2007), the organization data was study in terms of internal relationship of productivity, quality of work life on each accounting parameter finally the data were kept as a data base to monitoring and control the business. Statistics and mathematics model were applied for analysis. The study is conducted to help address the concern of the company's top management and the FG management team on how to demonstrate their ISO 9001:2000 compliance and TQA commitment. The lessons from the impacts from the existing customers, as well as the potential benefits from new customers, are summarized. The changes in the company paradigm on the roles of the existing customers and its sales workforce have emerged.

Appropriate PM need to be aligned with the organization's strategy. It should lead to attainment of strategic goals and impact on the goals and strategies needed to achieve them (Dixon *et al.*, 1990). Among the most popular PM systems is the balanced scorecard (Yeniyurt, 2003). The Balanced Scorecard Concept (BSC), developed by Kaplan and Norton (1996), is a widely used management framework for

the measurement of organizational performance which evaluates both financial and non-financial perspectives. It suggests that the state of process of an organization can be best assessed by taking a “balanced” view across a range of performance measures. This paper studies the relationship between financial and customer perspectives as suggested in the BSC in an attempt to provide analyzable information for management to improve the quality of decisions. In this study, the case study business unit is the plastic resin conversion factory which locates in Thailand. This plant may call Rigid Plastic Plant or RPP. It’s organization is consisted of production, ware house, and logistics department; technical department (R&D); and maintenance department. All departments are under plant manager, general manager, and top management of plastic business group.

There are two critical problems facing the management team at the RPP. The first one is the management want to know how is the time lag effect of new products which derived by R&D department to out put such new revenue from a new customer. Second, the data which related to ISO 9000 version 2000 item 18 does not much fit to a current system. So the RPP managements want to know in depth of the detail to improve the quality objectives. Over the past few years, the term performance-based management has gained more attention among SMEs, manufacturing, trading, and government sectors in Thailand due to the need to comply with Requirement 8 of ISO 9001:2000. This requirement stresses the explicit linkages among performance measurement, analysis and improvement. Complying with this Requirement 8, especially between measurement and analysis, cannot simply be achieved through technical investment alone. It is important to note that the certification of ISO 9001: 2000 is recognized as a necessity for enterprise development, customer acceptance and market access in the globalisation period.

During the time of study, the RPP management givens financial information and R&D information collected by the accounting department and R&D department but they never did analysis on it. Refer to financial information as represent in Table 1. And R&D Data in Figure 1, there are no other intangible factors such as product satisfaction or service quality, customer satisfaction, or employee morale, collected.

The lack of information assessment and the failure to collect the information aligned to the organization's goals result in many unsolved strategic problems as mentioned above. Table I shows the financial information used by the RPP management team. As can be seen from the table, there is no relationship between the information and policies to increase revenue R&D effort the company productivity, and customer networks. It simply tells the information from the past but suggested nothing about the future. Therefore, the accounting information is worthless.

The concern is that, if the RPP has an effective PM system, how could the performance information have been utilized or analyzed in a way to improve the executive decision-making quality and drive policies into actions, event the results is gain or lost? This study chooses to use the BSC PM system and mathematically analysis because it enables organizations to clarify their vision and strategy and translate them into action. It provides a clear prescription to the companies for how to measure both financial and non-financial perspectives. The relationship between the financial, roles of R&D, and customer perspectives of the RPP is to be analyzed.

In manufacturing system, variation always happens in every process, even though manufacturing companies would like to eliminate it from their manufacturing process. We cannot remove it from the process, but we can control it. In order to reduce the variation in manufacturing processes, we have to investigate the cause of variation that could be from incoming parts, manufacturing processes, testers, or operators.

Table 1 The financial information used by the management team of the RPP

	Description	January	February	March
1	Gross Sales	118,445	108,492	109,334
2	Within Company	-	-	-
3	Plastic Group	-	-	-
4	RPP Group - Domestic	-	-	-
5	RPP Group - Export	-	-	-
6	Other - Domestic	32,185	29,969	38,933
7	Other - Export	86,260	78,523	70,401
8	Discount	(1,850)	(295)	(1,309)
9	Return & Claim	(217)	(50)	(1,156)
10	Net Sales	116,377	108,147	106,869
11	Freight & Trans - Domestic	(430)	(369)	(383)
12	Freight & Trans - Export	(5,476)	(5,333)	(3,916)
13	Insurance & Clearance	(2,209)	(1,433)	(2,871)
14	Commission & Quota	(615)	(342)	(552)
15	Net Ex. Factory	107,647	100,672	99,146
16	Cost of Goods Sold	105,669	103,044	100,173
17	Gross profit (Loss)	1,979	(2,373)	(1,027)
18	% Gross Margin	1.8%	(2.4%)	(1.0%)
19	SG&A	(3,266)	(3,351)	(3,260)
20	Selling	(1,138)	(1,284)	(1,285)
21	Administrative	(546)	(546)	(546)
22	Accounting	(738)	(738)	(738)
23	Management Fee	(844)	(782)	(691)
24	Allocation Expenses	-	-	-
25	Provision for Bad Debt	-	-	-
26	Provision for Obsolete	1,947	3,726	727
27	EBIT	659	(1,997)	(3,560)
28	Interest Income	-	-	-
29	Interest Expense	-	-	-
30	EBT (GL)	659	(1,997)	(3,560)
31	Income Tax	-	-	-
32	Other Income	5,435	2,626	(5,731)
33	Allocation Income	-	-	-
34	Gain (Loss) from FX	3,443	1,709	-6295
35	Other Income (Expense)	1,991	916	564
36	Net Profit (GL)	6,093	629	(9,291)
37	MIS Adjustment	(6,556)	(4,726)	3,359

Table 1 (Continued)

Description	January	February	March
38 Net Profit (MIS)	(462)	(4,097)	(5,932)
39 Depreciation - Office	7	6	7
40 Depreciation - Plant	4,346	4,010	4,266
41 EBITDA	10,446	4,645	-5018
42 SG&A (GL)	(10,050)	(7,100)	(10,256)
43 Accounts Receivable	327,319	328,843	314,552
44 RPP Group - Domestic	2,345	1,495	1,320
45 RPP Group - Export	13	13	13
46 Other - Domestic	105,408	102,481	107,406
47 Other - Export	219,553	224,854	205,812
48 Inventory	225,587	217,677	242,228
49 Finished Goods	77,214	71,023	79,309
50 Work in Process	8,006	6,652	7,832
51 Raw Material	78,348	79,197	95,091
52 Others	62,019	60,805	59,996
53 Sales Quantity (Tons)	1,667.7	1,635.7	1,660.3
54 Plastic Group	-	-	-
55 RPP Group - Domestic	-	-	-
56 RPP Group - Export	-	-	-
57 Other - Domestic	520.3	478.3	619.6
58 Other - Export	1,147.4	1,157.5	1,040.7
59 Price (Baht/Kg)	64.5	61.5	59.7
60 Max. Capacity (Tons)	-	-	-
61 Prod. Quantity (Tons)	1,594.4	1,527.4	1,784.2
62 Prod. Yield	93.5%	95.0%	94.7%
63 Prod. Cost (Baht/Kg)	60.5	61.3	59.5
64 Raw Material	48.2	48.4	48.1
65 Overhead	12.3	13.0	11.4
66 MIS Adjustment	(6,556)	(4,726)	3,359
67 Management Fee	15	(47)	(138)
68 Interest on Capital	(3,128)	(2,970)	(2,798)
69 Cost of Sales	-	-	-
70 NRV	-	-	-
71 Foreign Exchange	(3,443)	(1,709)	6,295

Note : 35 Baht is approximately equivalent to 1USD.

The above Table is represent for accounting system that use in RPP, for the value that use for this thesis work is present in Appendix A

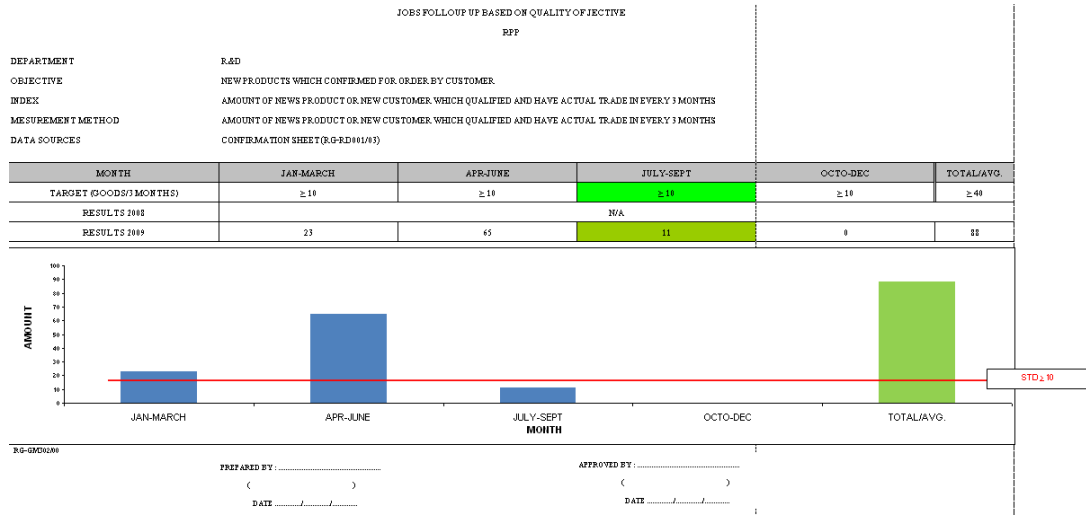


Figure 1 The R&D information used by the management team of RPP

OBJECTIVES

The purposes of this study are

1. To determine BSC parameters which effect on earning before incomes TAX.
2. To assess and evaluate the usefulness of the results of performance analysis in improving the quality of management's decision making.

Scopes

We assume the following conditions:

1. The study will be done in the Rigid Plastic Production Plant (RPP), where the name is reserved. The location of the plant is in Thailand
2. The study will assess the financial, R&D, and customer perspectives information of the RPP with respect to the balanced scorecard suggestion.
3. The finance information used in this study will be collected from January 2007 to December 2008. The R&D information used will be collected from January 2008 to December 2008.
4. The managers who will assess the usefulness of the results of performance analysis in this study are R&D manager of the firm.

LITERATURE REVIEW

The literature review consists of five parts: management decision making, management system model, performance measurement, balanced scorecard, and regression analysis.

1. Management decision making

Managing is decision making (Simon, 1977). Decision making is a process that reflects the scientific method and ends in an observable behavior of choosing. According to Forrester (1961), decision making is the process of converting information into action. It is, in turn, controlled by various explicit and implicit policies of behavior. Therefore, it depends primarily on what information is chosen and how the conversion is executed. This is illustrated in Figure1 (Forrester, 1961). The manager receives information from management tools to make decisions and generate actions from the decisions to affect the work flow, or operation, of his or her responsibility.

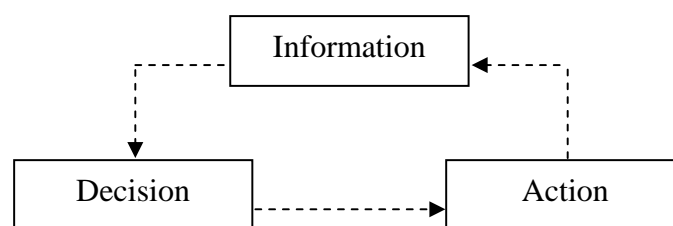


Figure 2 Forrester's figure shows a decision stream in the simplest framework of an Information- feedback system

According to Forrester (1961), a necessary, but not sufficient condition for good decision making is information. Another necessary condition is a good decision making process that acts on good information.

Kurstedt (1992) commented that information constitutes the interface between the manager and the decision tools. The manager may request information of and/or provide information to the decision tools. The decision tools provide information to the manager.

Kaye (1995) suggested that good information is essential to the success of an organization. If an organization is to survive and prosper, it must understand both its own internal workings and the nature of the environment to which it has to adapt and respond. Good information improves decision making, enhances efficiency and provides a competitive edge to the organization which has more information than the opposition. According to Kaye (1995), information is to be used by managers in all three groups of executive roles suggested by Mintzberg (1975); they are (1) interpersonal - which includes figurehead, leader, and liaison; (2) informational - which includes monitor, disseminator, and spokesperson; and (3) decisional - which includes entrepreneur, disturbance handler, resource allocator, and negotiator.

Liangrokapart et al. (2001) was determined and develop methodology on decision making under the customer satisfaction on logistics. Where supply chain managers can use to measure how effective closely-linked decision making units (DMUs) within the chain are using resources to satisfy customers, and to identify opportunities for improvements in efficiency.

2. Management system model

Kurstedt (1992) developed the Management System Model (MSM), describing the components and relationships in the management system. The model highlights the need for balance obtained by matching the interfaces between pairs of components. Figure 3 shows the three essential components of a management system with arrows showing how one component affects the others.

The determination of each component in the MSM is described as follows:

1. The “who manages” component, or the manager, is anyone who uses information to make decisions resulting in actions affecting what is managed.
2. The “what is managed component”, or the operation, includes the tangible things the manager is responsible for.
3. The “what is used to manage” component, or the management tools, comprises tools like organizational structures, plans, and information systems.
4. The arrows in Figure 3 show the interface between each pair of components. They show that (1) the manager makes decisions resulting in actions affecting the operation; (2) by measuring indicators in the operation we get data to feed into our management tools; and (3) the management tools portray information to be perceived by the manager to support decision making.

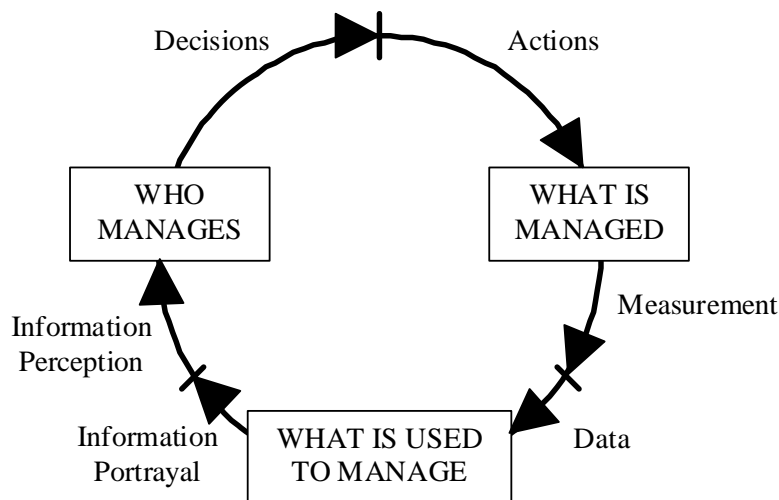


Figure 3 A management system

The arrows in Figure 3 show the need of matching between the requirements of each pair of components. The information portrayal from management tools needs to match with the manager’s preferred information perception. The manager’s characteristics for cognitive style affect how he or she like to see or hear information and are important in making the match. The manager also wants to match the

decisions he or she makes with the actions he or she takes affecting the operation. Likewise, the arrows show a needed match between measurement of the operation and the data that feed into the management tools.

The MSM illustrates many important management principles, including: (1) management is decision making (2) the decision maker converts information into decisions; (3) decisions are valueless unless they become actions; (4) actions cause the operation to change; (5) management must know what to measure before they can get useful data; (6) all management tools convert data into information; (7) when managers portray information, they must consider how the information will be perceived.

3. Performance measurement

Performance measurement (PM) is the process of quantifying past action (Neely, 1998). It was developed in an attempt to give management a more strategic, outward-looking focus, incorporating non-financial, competitor-centered and customer-focused information into the search for a sustainable competitive advantage in services provision. According to Parker (2000), the reasons why organizations measure performance are to:

1. identify success;
2. identify whether they are meeting customer requirements;
3. help them understand their process;
4. identify where problems bottlenecks, waste, etc., exist and where improvements are necessary;
5. ensure decisions are based on fact, not on supposition, emotion, faith, or intuition;
6. show if expected improvements actually happened.

The importance of PM in terms of ensuring that decisions are based on fact is emphasized in Malcom Baldrige National Quality Award (MBNQA) Models for

Business Excellence and Performance. The MBNQA Criteria (2006) booklet reiterates the concept of fact-based management as follows:

Organizations depend on the measurement and analysis of performance. Such measurements should derive from business needs and strategy, and they should provide critical data and information about key processes, outputs, and results.

Analysis refers to extracting larger meaning from data and information to support evaluation, decision making, and improvement. Analysis entails using data to determine trends, projections, and cause and effect that might not otherwise be evident.

According to Parker (2000), although performance measures are useful, they also attract much cynicism and skepticism over why, how and when they are used. There are issues of measuring the right things, of comparing like with like, and of comparing yesterday with today. Traditional business performance measures have been financial – measuring such ratios as rate of return, cash flow, profit margins, and so on. These financial data have the advantage of being precise and objective. However, there are many arguments against the traditional metrics. The major inadequacies of traditional metrics discussed in the literature are as follows:

- they are too historical and backward-looking (e.g. Ittner and Larcker, 1998);
- they lack the ability to explain future performance (e.g. Ittner and Larcker, 1998);
- they fail to include the less tangible factors such as product or service quality, customer satisfaction and employee morale (e.g. Parker, 200);
- they do not link the non-financial metrics to financial numbers (e.g. Kaplan and Norton, 1996);
- they are inadequate for strategic decision making (e.g. Kaplan and Norton, 1996); and
- they provide little information on root causes (e.g. Ittner and Larcker, 1998).

New measurement systems should be able to facilitate the strategic management of companies and correctly state the core capabilities, strengths and weaknesses. Therefore, organizations today are searching for ways to incorporate intangibles – such as quality management, customer retention, research and development and innovation – into their regular performance measurement rather than the financial measure alone (Lingle and Schiemann, 1996 and Ernst & Young, 2001). More modern PM systems have recognized and addressed such limitations. However, in order to succeed in implementing PM systems in any organization, a complete analysis and feedback loop must be included. This ensures that performance measurement is analyzed and then translated into actions and behaviors which change the nature of activity and of performance (Parker, 2000).

Srisukpongsak J.(2003) was solved the problem in small manufacturing office and motivate to develop a set of performance metrics. Where the propose of performance metrics is for measurable in terms of quality and quantity. Process performance metrics methodologies (PPMM) are used to lay the foundation. Finally, internal process such quotation process, order processing under performance measurement criteria were carried out successfully with efficiency, effectiveness, quality, and productivity.

4. Balanced scorecard

The Balanced Scorecard Concept (BSC) is a widely used management framework for the measurement of organizational performance. It raised great interest both among practitioners and academics. The total number of companies using the BSC was estimated to be at least 40 percent of Fortune 1,000 companies in the year 2000 (Frigo and Krumwiede, 2000). BSC was introduced in 1992 to give managers a fast but comprehensive view of the business (Kaplan and Norton, 1996). It suggests that the state of process of an organization can be best assessed by taking a “balanced” view across a range of performance measures. Based on existing visions and strategies, it allows users to expand on this approach, to understand the essential

elements for management success in their cause-and-effect relations and, therefore, to promote even more efficient business administration (Kaplan and Norton, 1996).

According to Kaplan and Norton (1996), the BSC supplements traditional financial measures with criteria that measure performance from three additional perspectives – those of customers, internal business processes, and learning and growth (Figure 4)

Customer perspective: Since companies create value through customers, understanding how they view performance becomes a major aspect of performance measurement.

Internal business process perspective: According to Kaplan and Norton (1996) in the internal-business-process perspective, executives identify the critical internal processes in which the organization must excel to achieve its goals.

Learning and growth perspective: According to Kaplan and Norton (1996) this perspective of the BSC identifies the infrastructure that the organization must build to create long-term growth and improvement. Learning and growth come from three principal sources: people, systems, and organizational procedures.

Financial perspective: Within the BSC, financial measures remain an important dimension. Financial performance measures indicate whether a company's strategy, implementation, and execution are contributing to bottom-line improvement.

Kaplan and Norton (1996) suggested that, in order to achieve BSC implementation, the measurement metrics must be defined in a way that is aligned to the organization's strategies. The strategy map can help managers at each level of the organization specify scorecards that describe the strategy as a set of cause-and-effect relationships that can be tested and adjusted. It supports alignment of and focus on strategy by making everyone in the organization understand the hypotheses that define the strategy, coordinating action in accordance with the hypotheses, testing the hypotheses and adapting them.

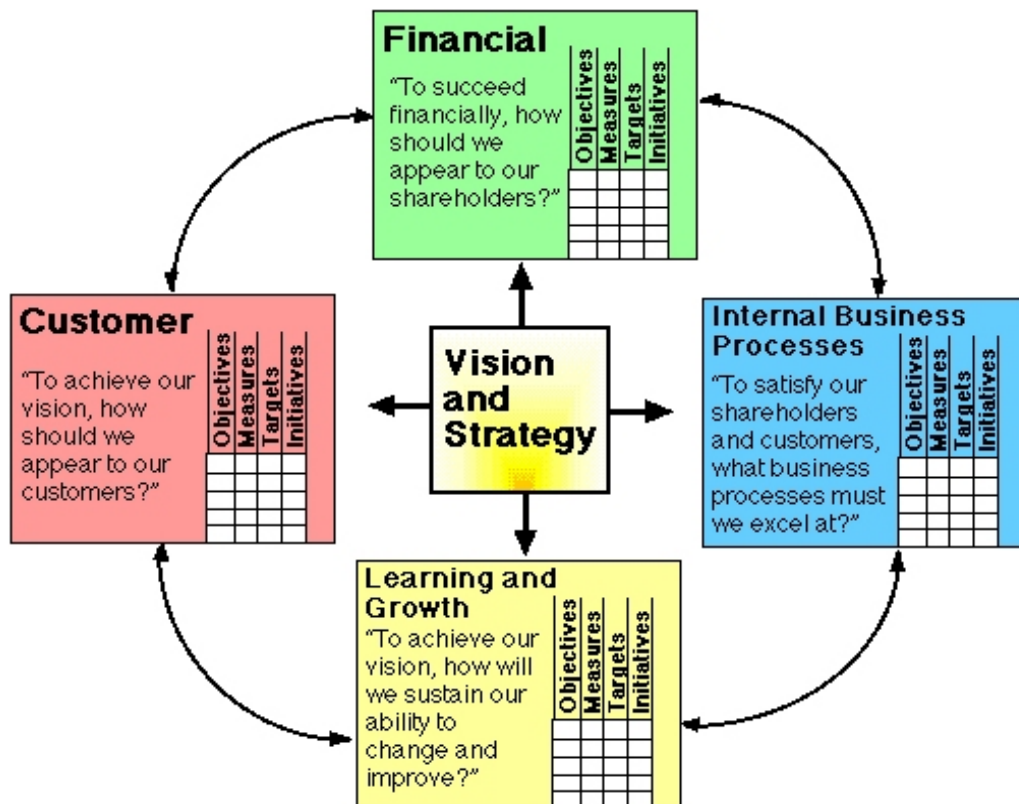


Figure 4 The BSC framework

Refer to BSC frame work above RPP parameters to study are presented in Table 2.

Table 2 BSC Parameter for RPP

Financial	Customer	Internal Processes	Innovation and Learning
F1 = Interest per man-day cost (Baht/Baht)	C1=New customer per total customers (%) (Based on 100 number of December 2007)	IP1 = On time sample delivery (%)	IL1 = R&D cost per new products order intake (Baht/Baht)
F2 = Revenue per trial order (Baht/Baht)	C2 = Claim per total claim of each year (%)	IP2 = Output per head (Tons/head)	IL2 = Bonus per salary (%)
F3 = EBIT per number of R&D staffs (Baht/head)	C3 = Number of customer complaint per month (Time/Month)	IP3 Product quantity (tons)	IL3 = Over time per salary
F4 = Revenues from new product per total revenue (%)	C4. Successful order (Approved Art Work) per total order (%)	IP4 = Labor cost (Baht/Kilogram)	IL4 = Welfare per salary (%)
F5 = Revenue per raw material cost (Baht/Baht)		IP5. Labor Cost per production output (Baht/Kilogram)	IL5. Marketing expense per customer (Baht/customer)
		IP6 = Yield (%)	IL6. Investment in new product per R&D staff (Baht/head)

Table 2 (Continued)

Financial	Customer	Internal Processes	Innovation and Learning
			IL7 = Employee training cost per number of employee (Baht/head)

5. Regression analysis

5.1 Simple and Multiple Regression

Regression analysis is a statistical tool for the investigation of relationships between variables. Usually, the investigator seeks to ascertain the causal effect of one variable upon another, for example, the effect of a price increase upon demand or the effect of changes in the money supply upon the inflation rate. To explore such issues, the investigator assembles data on the underlying variables of interest and employs regression to estimate the quantitative effect of the causal variables upon the variable that they influence. The investigator also typically assesses the “statistical significance” of the estimated relationships, that is, the degree of confidence that the true relationship is close to the estimated relationship.

There are two types of regressions as follows:

5.1.1 Simple Regression

The case of simple regression considers a single regressor or predictor, (x) and a single dependent, or response variable, (Y). If the true relationship between Y and x is a straight line and the observation Y at each level of x is a random variable, we call it a “simple linear regression”. In such case, we assume that each observation, Y , can be described by the model

$$Y = b_0 + b_1x_1 + \text{error} \quad (5-1)$$

where the intercept “ b_0 ” and the slope “ b_1 ” are unknown regression coefficients and “error” is the random error with mean zero and (unknown) variance σ^2 .

5.1.2 Multiple Regression

Many applications of regression analysis involve situations in which there are more than one regressor variables. Multiple Regression is a technique that allows additional factors to enter the analysis separately so that the effect of each can be estimated. It is valuable for quantifying the impact of various simultaneous

influences upon a single dependent variable. Further, because of omitted variables bias with simple regression, multiple regression is often essential even when the investigator is only interested in the effects of one of the independent variables. Benefits of Multiple Regression are: (1) explores the existence of relationship between a dependent variable and several independent variables; (2) screens multiple input variables and determine which variables have the greatest impact on the response variable; and (3) describes the nature of the relationship with an equation and use it which can be used for prediction.

If the model is linear with respect to coefficients, we call it a “multiple linear regression”. An example of a multiple linear regression model can be described as follow.

$$Y = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + \text{error} \quad (5-2)$$

where the intercept “ b_0 ” and the slope “ b_1 ”, “ b_2 ”, and “ b_3 ” are unknown regression coefficients and “error” is the random error with mean zero and (unknown) variance σ^2 .

5.2 Hypothesis tests in simple linear regression

An important part of assessing the adequacy of a linear regression model is testing statistical hypotheses about the model parameters. If we wish to test if a significant relationship exists between a regressor (x) and response variable (Y), the appropriate hypotheses are

$$H_0: b_1 = 0$$

$$H_1: b_1 \neq 0$$

These hypotheses relate to the significance of regression. Failure to reject H_0 means that there is not sufficient evidence of a linear relationship between x and Y . Alternatively, rejection of H_0 implies that x is of value in explaining the variability in Y . While this shows that the linear effect is significant, there may be higher order models that are more appropriate.

5.3 Hypothesis tests in multiple linear regression

In multiple linear regression problems, certain tests of hypotheses about the model parameters are useful in measuring model adequacy. The test for significance of regression is a test to determine whether a linear relationship exists between the response variable (Y) and a subset of the regressor variables x_1, x_2, \dots, x_k . The appropriate hypotheses are

$$H_0: b_1 = b_2 = \dots = b_k = 0$$

$$H_1: b_j \neq 0 \text{ for at least one } j$$

Rejection of H_0 implies that at least one of the regressor variables x_1, x_2, \dots, x_k contributes significantly to the model. Alternatively, failure to reject H_0 means that there is not sufficient evidence of a linear relationship between x_1, x_2, \dots, x_k and Y .

5.4 Adequacy of the regression model

Fitting a regression model requires several assumptions. The analyst should always consider the validity of these assumptions to be doubtful until conducting analyses to examine the adequacy of the model

5.4.1 Residual Analysis

The residuals from a regression model are $e_i = y_i - y_i\text{-estimated}$, $i = 1, 2, \dots, n$, where y_i is an actual observation and $y_i\text{-estimated}$ is the corresponding fitted value from the regression model. Analysis of the residuals is frequently helpful in checking the assumption that the errors are approximately normally distributed with constant variance, and in determining whether additional terms in the model would be useful.

As an approximate check of normality, the experimenter can construct a frequency histogram of the residuals or a normal probability plot of

residuals. It is frequently helpful to plot the residuals (1) in time sequence; (2) against the y_i -estimated (3) against the independent variable x . Coefficient of Determination (R^2)

The quantity

$$R^2 = SS_R / SS_T = 1 - SS_E / SS_T \quad (5-3)$$

Where SS_R is the regression sum of squares, SS_E is the error sum of squares, and SS_T is the total sum of squares of the response variable, y is called the coefficient of determination and is often used to judge the adequacy of a regression model. We often refer loosely to R^2 as the amount of variability in the data explained or accounted for by the regression model. However, R^2 does not measure the appropriateness of the model, since it can be artificially inflated by adding higher order polynomial terms in x to the model. Even though R^2 is large, this does not necessarily imply that the regression model will provide accurate predictions of future observations.

5.5 Multicollinearity

In multiple regression problems, we expect to find dependencies between the response variable Y and the regressor x_j . In most regression problems, however, we find that there are also dependencies among the regressor variables x_j . In situation where these dependencies are strong, we say that multicollinearity exists. Multicollinearity can have serious effects on the estimates of the regression coefficients and on the general applicability of the estimated model.

The effects of multicollinearity can be defined as the variance inflation factor for as

$$VIF(b_j) = 1/(1 - R_j^2) \quad j = 1, 2, \dots, k \quad (5-4)$$

Where R_j^2 is the coefficient of multiple determination resulting from regressing x_j on the other $k-1$ regressor variables. The stronger the linear dependency of x_j on the remaining regressor variables, and hence the stronger the multicollinearity, the larger the value of R_j^2 will be. We say that the variance of b_j -estimated is “inflated” by the quantity $(1 - R_j^2)$.

The presence of multicollinearity can be detected in several ways. One of the more easily understood of these is the variance inflation factors, as defined above in equation (4-4). They are very useful measures of multicollinearity. The larger the variance inflation factor, the more severe the multicollinearity. Some authors have suggested that if any variance inflation factor exceeds 10, multicollinearity is a problem. Others authors consider this value too liberal and suggest that the variance inflation factors should not exceed 4 or 5. Minitab, which is a computer program developed for statistical analysis, can calculate the variance inflation factors.

In this study, Minitab version 13 is used as a tool for establishing multiple regression models to screen multiple input variables and establishing simple regression models to check the significance of the relationship between each pair of response variables and screened regressor variable.

MATERIALS AND METHODS

1. Materials and Equipments

1.1 Hardware :

1.1.1 Laptop Personnel Computer, Toshiba, model M100s

1.1.2 Desktop Computer, OS name is Microsoft Window XP Professional Version 2002 Service Pack 2.

2.2 Special software: Minitab version 13 is used for regression analysis.

2.3 Microsoft Office 2007 Student/Home Edition.

2.4 Literatures:

2.4.1 The literatures will be copied from the website of the main library of Kasetsart University.

2.4.2 Textbooks will come from the International Graduate Program (Industrial Engineering).

2.5 Data: The data will be collected at RPP of a trading company for the periods January 2007 – December 2008 for accounting and periods January 2008 – December 2008 for R&D which have been presented for some parameters.

2. Methodology

The steps that will be taken for research completion are as follows:

2.1 Study the relevant theories.

2.2 Identify the information to be tested.

2.3 Collect information from the RPP.

2.4 Examine and establish the possible relationships between the financial, R&D, and the customer perspectives information.

2.5 Analyze the appropriateness of the information based on the examining results together with R&D section manager.

2.6 If the information is inappropriate; establish a new set of performance metrics to be measured based on the BSC.

2.7 Interview the management team at RPP to assess the usefulness of the analysis results and the new set of performance metrics in terms of the attempt to improve the management's decision making process.

2.8 Report the results in written literature.

2.9 Release methods of analysis to RPP to use in further as a requirement of ISO9001 version 2000 requirement 8.

RESULTS AND DISCUSSION

Refer to methodologies of regression, the financial data, customer issues, internal process, innovation and learning were selected to plot in single and multiple model. The table 3 was rearranged to plot for the mathematic model as represent in Table 3 for simple regression model and polynomial regression model, and Table 4. for multiple regression model. To study time lag effect the statistics and mathematics is required. Thus, the agreed conditions for an equation's development are identified and finalised together with the RPP management team. A selected equation is based on p-value < 0.3 , Adj-R² $> 70\%$ and VIF < 5.0 (for a multiple regression model). The variance inflation factor (VIF) is used to detect whether one predictor has a strong linear association with the remaining predictors (the presence of multicollinearity among the predictors). VIF measures how much the variance of an estimated regression coefficient increases if predictors are correlated (multicollinear).

Table 3 Simple regression model and polynomial regression model parameters matching

Model No.	Model Pattern	Note
1	$F_{(i)} = AF_{(j)}$	$i=1-5 ; i < j < 6$
2	$F_{(i)} = AC_{(j)}$	$i=1-5 ; j=1-4$
3	$F_{(i)} = AIP_{(j)}$	$i=1-5 ; j=1-6$
4	$F_{(i)} = AIL_{(j)}$	$i=1-5 ; j=1-7$
5	$C_{(i)} = AC_{(j)}$	$i=1-4 ; i < j < 5$
6	$C_{(i)} = AIP_{(j)}$	$i=1-4 ; j=1-6$
7	$C_{(i)} = AIL_{(j)}$	$i=1-4 ; j=1-7$
8	$IP_{(i)} = AIP_{(j)}$	$i=1-6 ; i < j < 7$
9	$IP_{(i)} = AIL_{(j)}$	$i=1-6 ; j=1-7$

Table 3 (Continue)

Model No.	Model Pattern	Note
10	$IL_{(i)} = AIL_{(j)}$	$i=1-7 ; i < j < 8$

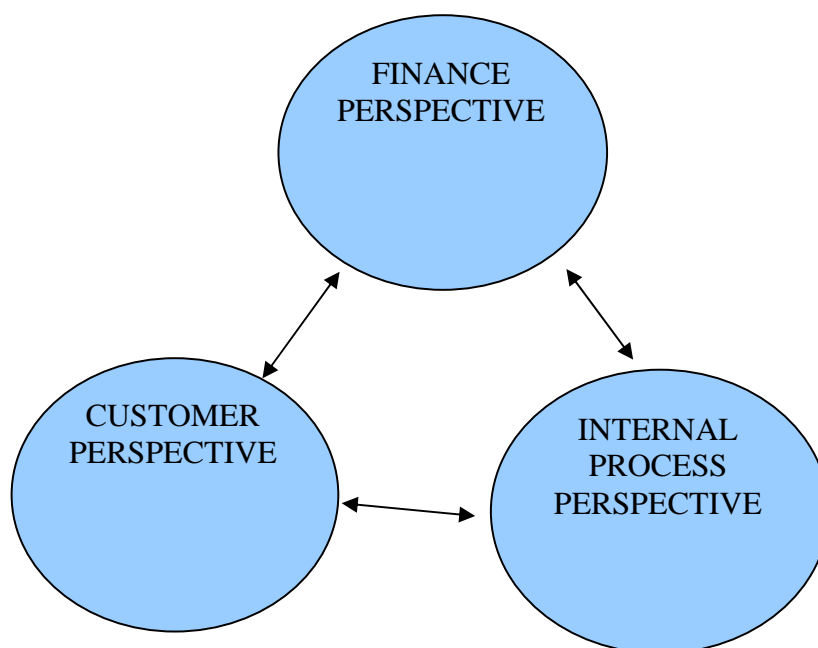
Table 4 Multiple regression model parameters matching

Model No.	Model Pattern	Note
1	$F_{(i)} = AF_{(j)} + BF_{(k)}$	$i=1-5 ; i < j < 6 ; i < j < k < 6$
2	$F_{(i)} = AF_{(j)} + BC_{(k)}$	$i=1-5 ; i < j < 6 ; k=1-4$
3	$F_{(i)} = AF_{(j)} + BIP_{(k)}$	$i=1-5 ; i < j < 6 ; k=1-6$
4	$F_{(i)} = AF_{(j)} + BIL_{(k)}$	$i=1-5 ; i < j < 6 ; k=1-7$
5	$F_{(i)} = AC_{(j)} + BC_{(k)}$	$i=1-5 ; j=1-4 ; j < k < 5$
6	$F_{(i)} = AC_{(j)} + BIP_{(k)}$	$i=1-5 ; j=1-4 ; k=1-6$
7	$F_{(i)} = AC_{(j)} + BIL_{(k)}$	$i=1-5 ; j=1-4 ; k=1-7$
8	$F_{(i)} = AIP_{(j)} + BIP_{(k)}$	$i=1-5 ; j=1-6 ; j < k < 7$
9	$F_{(i)} = AIP_{(j)} + BIL_{(k)}$	$i=1-5 ; j=1-6 ; k=1-7$
10	$F_{(i)} = AIL_{(j)} + BIL_{(k)}$	$i=1-5 ; j=1-7 ; j < k < 8$
11	$C_{(i)} = AC_{(j)} + BC_{(k)}$	$i=1-4 ; i < j < 5 ; j < k < 5$
12	$C_{(i)} = AC_{(j)} + BIP_{(k)}$	$i=1-4 ; i < j < 5 ; k=1-6$
13	$C_{(i)} = AC_{(j)} + BIL_{(k)}$	$i=1-4 ; i < j < 5 ; k=1-7$
14	$C_{(i)} = AIP_{(j)} + BIP_{(k)}$	$i=1-4 ; j=1-6 ; j < k < 7$
15	$C_{(i)} = AIP_{(j)} + BIL_{(k)}$	$i=1-4 ; j=1-6 ; k=1-7$
16	$C_{(i)} = AIL_{(j)} + BIL_{(k)}$	$i=1-4 ; j=1-7 ; j < k < 8$
17	$IP_{(i)} = AIP_{(j)} + BIP_{(k)}$	$i=1-6 ; i < j < 7 ; i < j < k < 7$
18	$IP_{(i)} = AIP_{(j)} + BIL_{(k)}$	$i=1-6 ; i < j < 7 ; k=1-7$

Table 4 (Continued)

Model No.	Model Pattern	Note
19	$IP(i)=AIL(j)+BIL(k)$	$i=1-6 ; j=1-7 ; j < k < 8$
20	$IL_{(i)}=AIL_{(j)}+BIL_{(k)}$	$i=1-7 ; i < j < 8 ; i < j < k < 8$

Mini-tab a statistical software version 13 is used to determine time lack effect, and internal relationship. Before the study the parameter that used for determine characteristics of the business or key performance measurement of the business is only financial figures, customer claim, and internal processes ; where it can plot in Figure 5 RPP original key performance measurement parameters based on Appendix table B2, B3, B4 and B5. Since the results were carried out with new suggestion based on balance scorecard methods, it was found that the data from Table 2 BSC Parameter for RPP able to re-arrange for the internal relationship as represent in Figure 6 New proposed internal relationship.

**Figure 5** RPP original key performance measurement parameters

Refer to Figure 5 it has no concern for innovation and learning for the past performance measurement. In general point of view it is mean the management did not focus on to internal innovation and learning as a major factor. However, during thesis work the recommendation to management of RPP to monitoring the innovation and learning were carried out. New recommendation parameters are relevant to BSC technique represents in Figure 6.

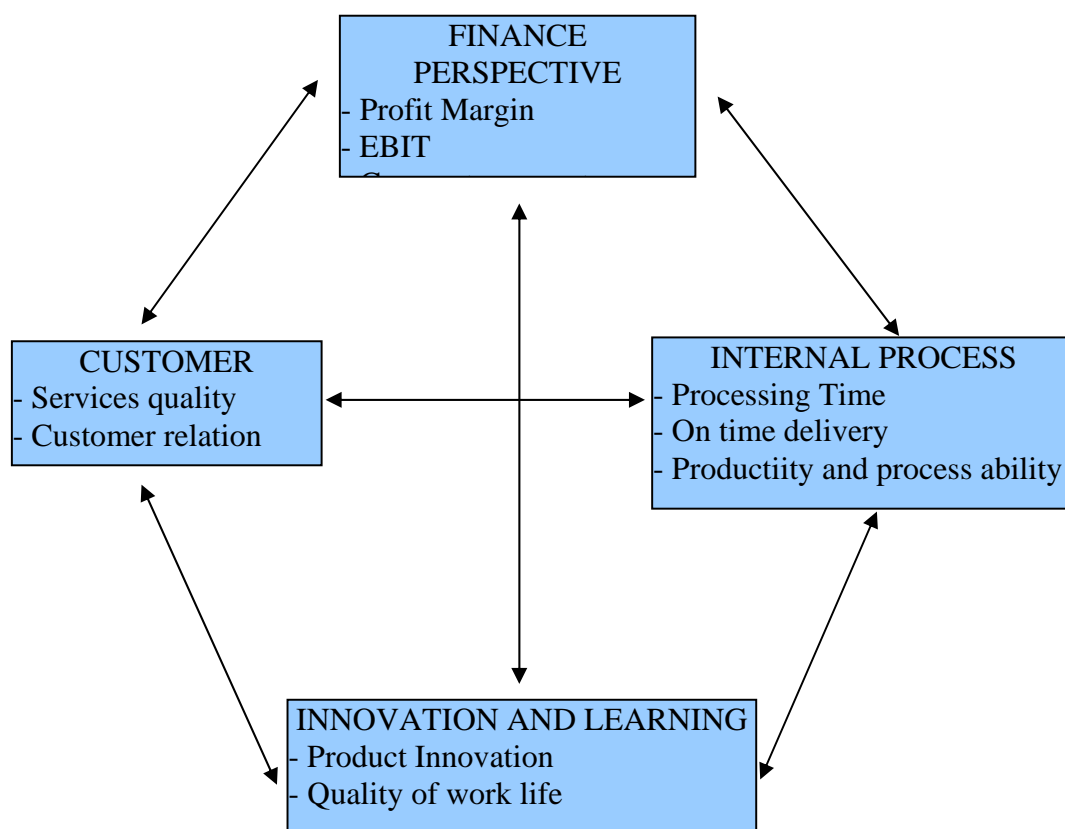


Figure 6 New RPP key performance measurement parameters

As a results, refer to Table 3 and Table 4 with regression analysis; It was found that only Internal process has significant relation with financial terms under simple regression assumption. Refer to Table 5 The results from the simple regression model; the increasing of IP4 (Labor cost (Baht)/Kilogram) of product) made F1 (Interest per man-day cost (Baht/Baht)) decreasing. This is meant the lower IP4, the better to company finance and cost. RPP states for interest as cost of investment, where it is normally be expense. F2 (Revenue per trial order (Baht/Baht) has affected

by IP1 (On time sample delivery (%)), this meant whenever, the factory or R&D and Production Section did fast response on trial order the revenue will come faster. Where the trail order is a new product that requested by customer which never produce in the production line before. New products that practically lunched from the factory are induced the end customer to decide for “buy it now” instead of “buy it later”. The customer needs the trial order products to ensure the finished goods able to fulfill the end user for its features, price level, and properties. On the other factor, IP5 (Labor Cost per production output (Baht/Kilogram)) has direct affected to F3 (EBIT per number of R&D staffs (Baht/head)). Most of the company in Thailand have concern for benefit or lost, where it is represented by term of Earnings before Income Interest and TAX or known as EBIT. The successful operating company the EBIT must be negative sign in contrast with poor operating company the EBIT should be at negative sign. In depth of financial analysis the poor operating company was getting worsen by major factor such operation cost, raw material cost, product selling price, and others outside effects. The increasing for labor cost caused EBIT goes low as a fact.

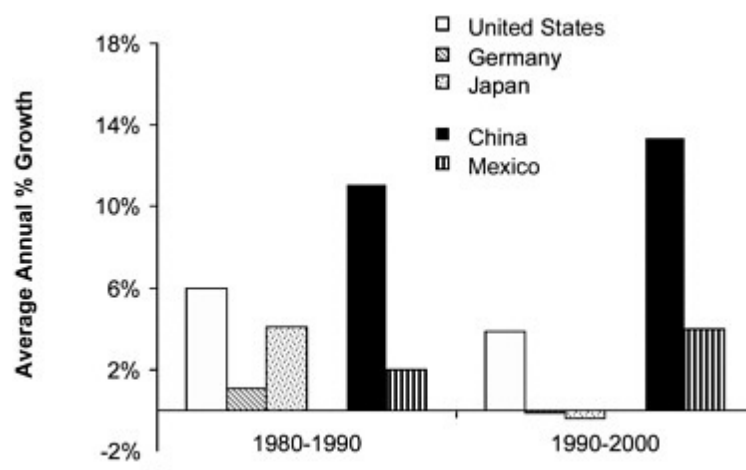


Figure 7 Average annual percentage growth in manufacturing for five countries in the periods 1980 to 1990 and 1990 to 2000. SOURCE: The World Bank 2002 World Development Indicators. Available at <http://www.worldbank.org/data/>.

Refer to Figure 7, it is representative for average annual percentage growth manufacturing where Mexico and China were the most of the growth country during 1990-2000. This data is support to the question “Why the world class manufacturing move to China or Mexico?” However, the RPP was founded by Thai businesses partnership. So the management has no policy to move to China or the other area that have lower in wage. Furthermore, IP5 is also affected to F5 (Revenue per raw material cost (Baht/Baht)). IP5 has lower degree affect to F5 while compare to IP5 affected to F3. F5 equation has a high constant at 2016 to absorb the variation of IP5. Refer to the F5 equation, the RPP management is normally prefer to see this value at as high as possible. The F5 is also meaning the benefit that the RPP will earn for each period of products sales and quality of production material output.

Table 5 The results from the simple regression model

	Relationship	p-value	Adj-R2 (%)
F1	487 - 20.1 IP4	0.000	79.7%
F2	2119 - 20.02 IP1	0.000	70.0%
F3	252.5 - 39.70 IP5	0.000	70.5%
F5	2016 - 47.38 IP5	0.000	71.4%

As a results from Table 5, the RPP R&D management need to see in case of this study is the finance perspective F4 (Revenues from new product per total revenue (%)) and IL1 (R&D cost per new products order intake (Baht/Baht)). This preferred relationship will answer the top management of RPP for the return of investment on R&D cost for new products. However, it did not found any relationship between these expected two parameters.

Table 6 The results from polynomial regression model

	Relationship	p-value	Adj-R ² (%)
F1	$677.5 - 47.32 IP4 + 0.954 IP4^2$	0.000	79.5%
F1*	$397.5 - 29.15 IP5^* + 0.8765 IP5^{*2}$	0.001	74.4%
F2*	$8823 - 194.7 IP1^* + 1.090 IP1^{*2}$	0.000	81.8%
F3*	$- 224.4 + 44.06 IP5^* - 3.275 IP5^{*2}$	0.000	71.4%
IP1*	$91.36 + 378.8 IL3^* - 4586 IL3^{*2}$	0.000	94.6%

Note : * Meant the data is account only in fiscal year 2008 for none * mean the data from fiscal year 2007 and 2008 was accounted in regression.

Refer to Table 6 the results from polynomial regression; it was found that IP4 has effect on F1 at significance level. IP4 has the average points during 11-14 Baht/Kg. As per discussion with the management of RPP, the F1 that the RPP need is the lower the better to operate this kind of business where the IP4 has to concerns at the optimum point. For this case it hard to point out which is the optimal point for F1 and IP4 on operation. The higher IP4 the lower F1, where IP4 can not go at thigh value due to it will effect on products base price.

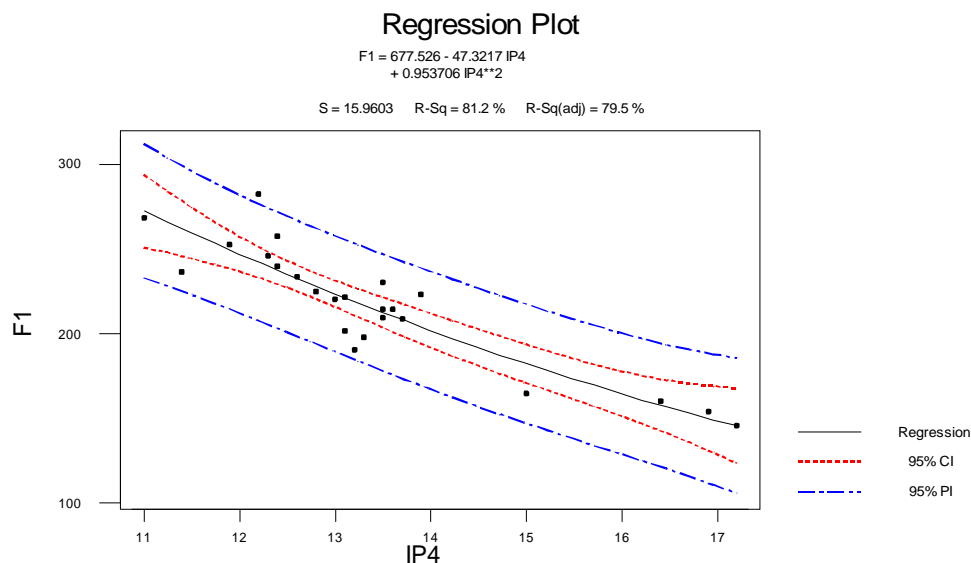


Figure 8 Regression plot IP1 and F1 for polynomial model

So for this case, the management did agreement to do so the operation point must control during 11-14 for IP4, while accepted F1 is ranging from 200-300 Baht/Baht. According to polynomial regression model between IP5 and F1, it was found the bottom of polynomial plot for IP5 value at 17 Baht/Kg and F1 at 155.26 Baht/Baht. This bottom point is mean if the IP5 value going high than 17 Baht/Kg, the production yield is going worse due to production output less production manager expectation, design value is ranging from 11-17 Baht. For financial perspective F1, the interest rate for capital investment, the management needs to minimize this value as much as possible. However, it related direct to labor cost and production cost for RAW material, the accounting system of RPP is account all cost for production to be terms of loan. So the interest rate has involved in every unit that able to count for money. Refer to Figure 9, the F1 touch down at the bottom line at 155.26 which can not reduce any more in term of cost-saving for interest rate.

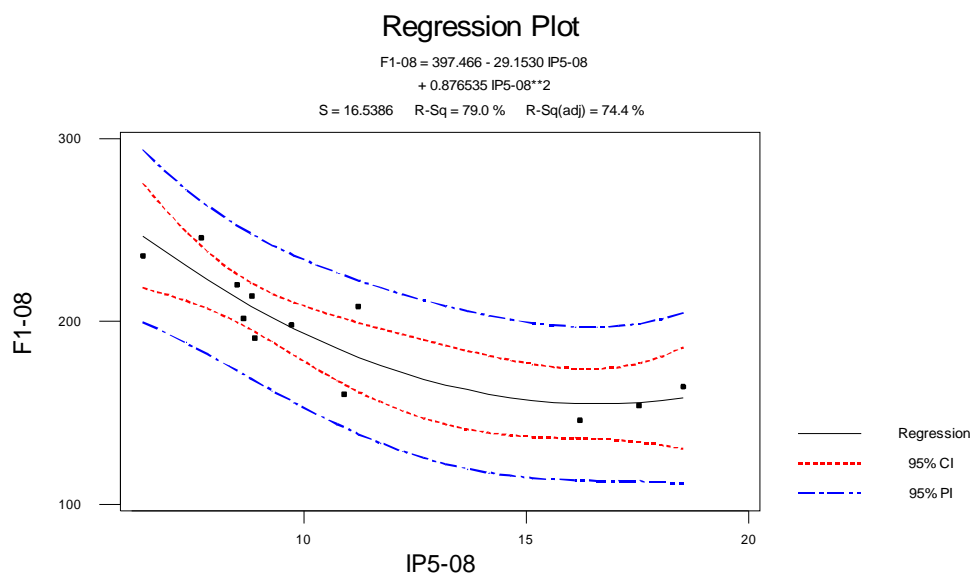


Figure 9 Regression plot IP5-08 and F1-08 for polynomial model

Refer to Table 6, it was found the relationship between IP1 (On time sample delivery (%)) has influent on F2 (Revenue per trial order (Baht/Baht)). The polynomial model for IP1 and F2 is representing for the bottom line of operation figure. The relationship between IP1 and F2 is also representing for the success of R&D to effort the company income. The RPP top management is prefer to see the value of F2 as much as possible. F2 will reflect to revenue of the factory each of period during new released products from R&D sector. Refer to Figure 10, it was found that fast response does not mean higher in revenue but it is mean fast in customer response for secured order.

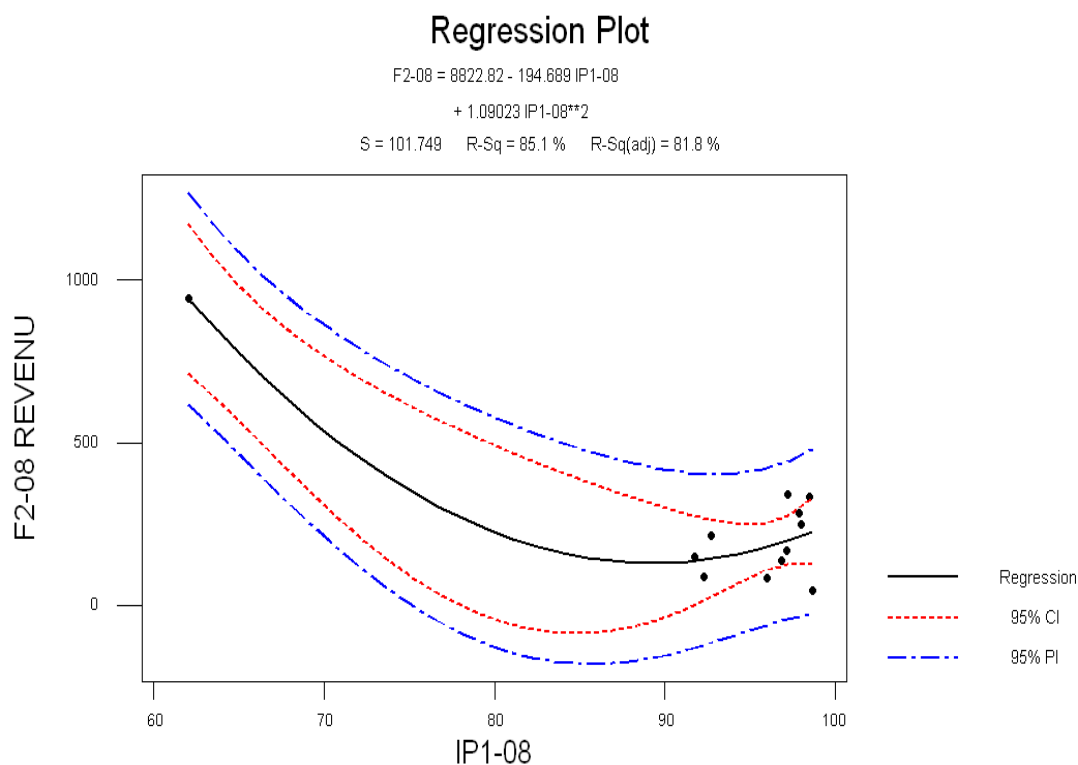


Figure 10 Regression plot IP1-08 and F2-08 for polynomial model

On the other hand the higher revenue F2 in Figure 10 was derived from a complicated formulation product which has large quantity of order from end customers. The response time for the complicated product leads R&D sample preparation officer did slow in sample preparation. A new sample request from end customer need to re-formulation and test for physical properties based on end customer requirement. Several trial orders have to given up due to the complicate of the formula and the specifications are not meet the requirement. Fast response is one of the quality policies at RPP by top management, as a result of IP1 and F2, fast response never get zero or lost in revenue.

Refer to financial perspective; the EBIT is the most important for business operation. According to polynomial plot model between F3 (EBIT per number of R&D staffs (Baht/head)) and IP5 (Labor Cost per production output (Baht/Kilogram)) for the plot, it was fitted based on division criteria only for the data which done during fiscal year 2008. During fiscal year 2008, world economic was under crisis which

derived from the United State of America sub-prime problem. The sub-prime problem was effected directly to Thai economic with out any abstain. The recession of Thai economic is presented in Table 7 Thailand industrial products during year 2007-2008. The RPP company is under the chemical production sector. Table 7 is shown that chemical product was highly affected under Thai economic recession.

Table 7 Thailand industrial product yearly comparison fiscal year 2007/2008

INDUSTRY	WEIGHT	2006	2007	2008		
				1 ST HALF	2 ND HALF	ALL 2008
Woven	12.23	2.2	-2.5	-2.4	-1.9	-2.1
Electronic	10.31	23.8	25.3	28.9	4.2	14.9
Petroleum	9.48	2.4	1.2	7.1	-1.6	2.7
Automotive	6.85	4.8	4.0	24.8	6.0	14.8
Food	6.82	7.6	4.5	5.4	0.3	3.2
Beverage	5.11	14.1	3.3	3.8	2.1	3.0
Electric Appliance	5.05	-8.1	6.0	16.0	-6.0	4.9
Leather	2.79	-26.9	22.7	-75.7	-52.9	-68.9
Chemical*	2.36	0.4	7.6	5.9	-16.4	-5.9
Steel	2.21	-3.4	-2.3	5.3	-25.2	-9.7
Hardware	1.84	5.6	-3.6	-4.8	-12.4	-8.6
Other	10.62	0.3	1.8	-3.1	-6.6	-4.9
Total	75.68	7.3	8.2	11.4	-0.4	5.3

Note : This table derived from Bank of Thailand Annual report for finance and economy for fiscal year 2008 section 2.2.1

*The RPP is located in Chemical Group

For the period fiscal year 2008, RPP EBIT is a bit higher or less than zero which mean the company getting worse from the economic situation. IP5-08 in any value cannot fulfill the company profit F3-08. However, refer to Figure 11 the best way to maintain the business profit to minimize lost in EBIT; the production section has to produce more goods at maximum capacity, where the IP5-08 region is around 7-10 Baht/Kg. It is possible to monitor and control IP5 to let F3 on positive value. Figure 12 is representative for successful IP5 control to let F3 getting positive value.

Figure 12 is point for the region that monitored IP5 to support F3 to get positive

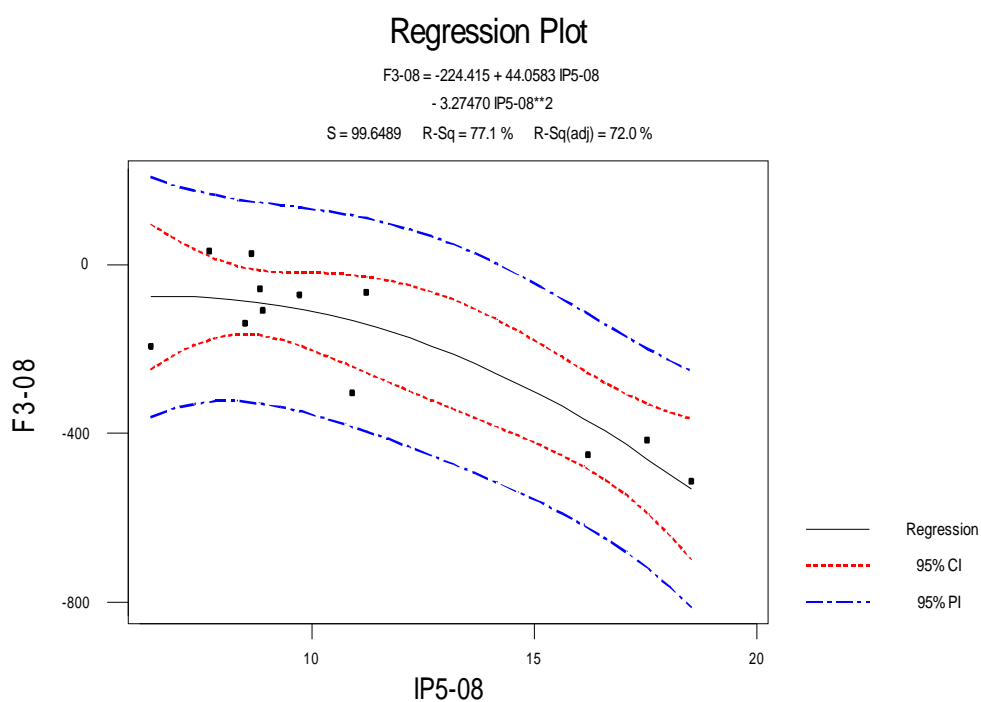


Figure 11 Regression plot IP5-08 and F3-08 for polynomial model during year 2008

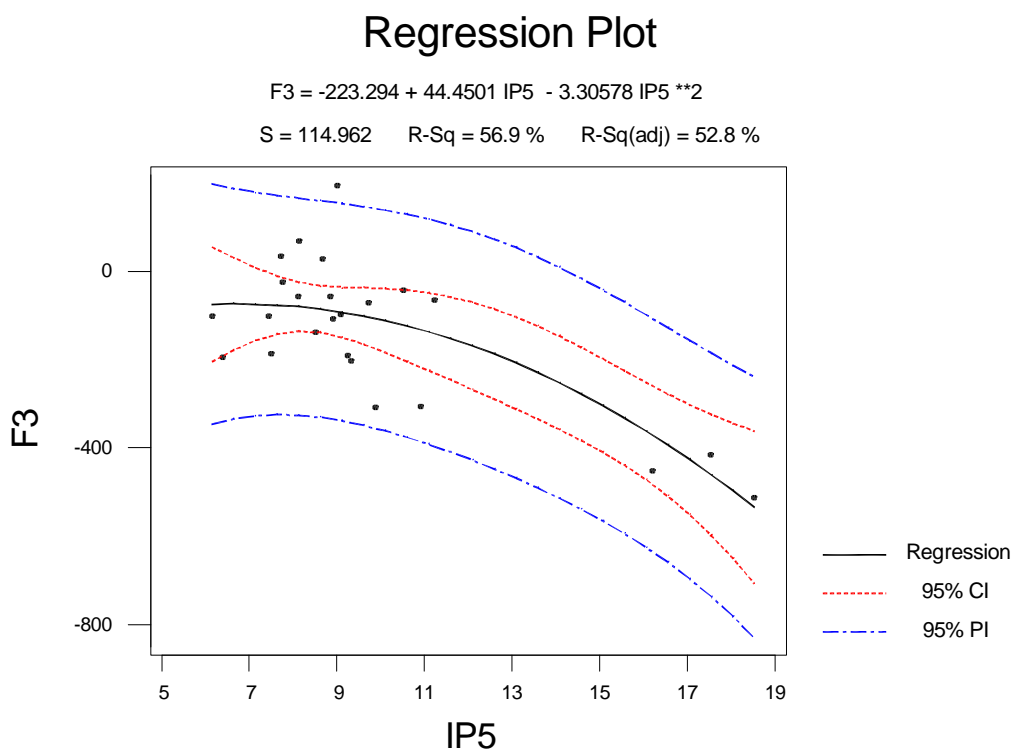


Figure 12 Regression plot between IP5 and F3 for polynomial model during year 2007-2008

The optimal values are ranging from 7-9 for IP5 to let F3 to be in positive value. However, Figure 12 is un-qualified equation based on equation selective criterion. So the Figure 12 is use only for monitoring only.

Refer to Table 6 it was also found the relationship between IL3 (Over time per salary (%)) and IP1 (On time sample delivery (%)). Working overtime is not preferred too much from the top management of RPP except the order that has large quantity and quality guarantee products are committed to customers.

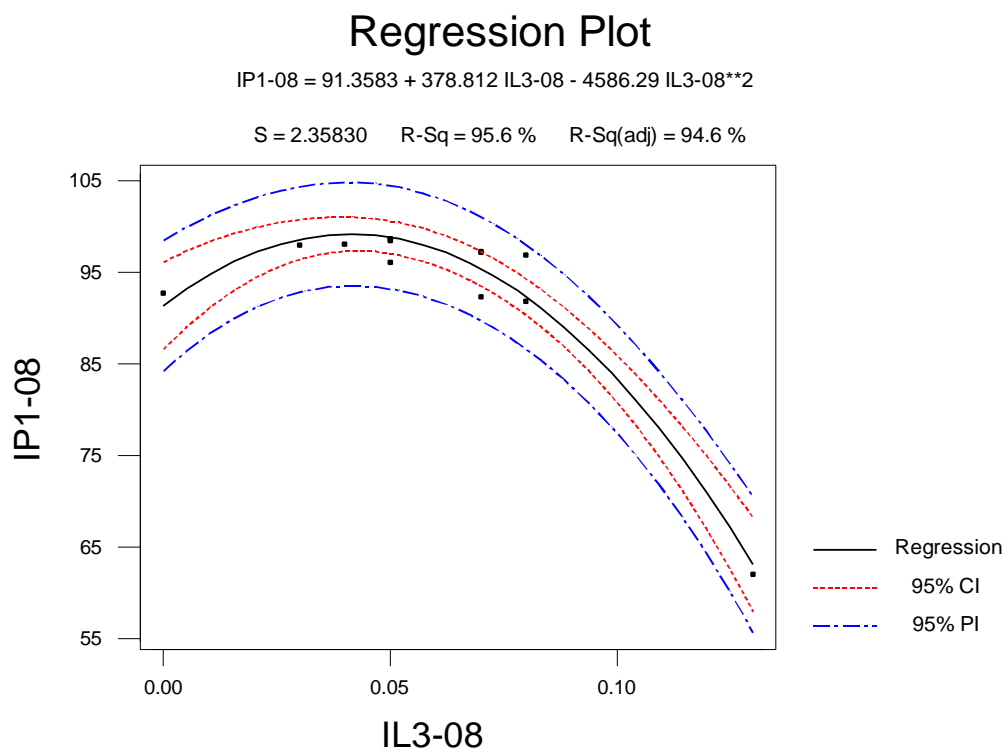


Figure 13 Regression plot between IL3-08 and IP1-08 for polynomial model during year 2008

According to polynomial model plot between IL3 and IP1 for fiscal year 2008, it was carried out for maximum IP1-08 at 99.20% where IL3-08 is at 0.04. As a result, the over time is no need to apply for the response of customer on time delivery. Even though the operator work only standard working hour (12 hours/shift), IP1 at 91.35% is still accepted by the management of RPP. This result is support to a real working life. At RPP, the employee for production line is work for 8 hours standard with special additional 4 hours for extra wages. So that max capability of workers was completely included for productivity. The data from IL3-08 is included for office employee overtime wage. The normal office hour for office worker (white collar) is standard 8 hours which starting from 8:00 to 17:00 in the evening. Refer to Figure 3, the optimal over time for white collar worker is no more than 4% of 8 hours or half an hour/day on average for all employee (265 Man).

On the other point of view with multiple regression model results in Table 8. It was found that many parameters which represented in balanced scorecard with combination are reflected to finance perspective. As a result, the combination of IP4 (Labor cost (Baht/Kilogram)) and C2 (Claim per total claim of each year (%)) is play the important role for F1 (Interest per man-day cost (Baht/Baht)). The model $F1 = 486 + 0.016C2 - 20.1IP4$, means the increasing of IP4 where C2 is constant. It makes F1 decreasing significantly. While IP4 is constant, the increasing of C2 is not much effect on F1. In actual the increasing of C2 will effect to customer trust or the quality of goods. This result agrees with simple regression between IP4 and F1, where the increasing of IP4 is converse to F1 value.

The combination between IP1 and IP4 is also effect on F1 value, model $F1=507 - 0.270IP1 - 19.8IP4$. Where the increasing of IP4 and IP1 lead to decreasing in F1, while IP4 has more important effect than increasing of IP1 in value. To consider the combination between IP3 (Product quantity (tons)) and IP4, the increasing of IP3 leads to increasing of F1 in contrast with the increasing of IP4. In fact the more products output mean the more capital cost that RPP has invest in raw material, so the production output is accounted in terms of interest rate expense together. See IP4 (Labor cost (Baht/Kilogram)) and IP5 (Labor Cost per production output (Baht/Kilogram)) combination, the increasing of IP4 and IP5 lead F1 to deduct in value. IP4 is normally fixes for all operation year but the IP5 is varied by the production output tons/month. It is representing to the management of RPP for 'to control the interest rate effect the output has to maintain at a high level as much as possible'. High production output is induce IP5 lowering in value and leads the F1 lower based on the relation accordingly. Similar IP4 (Labor cost (Baht/Kilogram)) and IP6 (Yield (%)) combination is effect on F1 at the same trend.

Table 8 The results from the multiple regression model for F1 group

	Relationship	p-value	Adj-R2 (%)	
F1	$486 + 0.016C2 - 20.1IP4$	0.000	78.7%	
	Predictor	Coeff	p-value	VIF
	Constant	486	0.000	
	C2	0.016	0.975	1.010
	IP4	-20.1	0.000	1.010
F1	$507 - 0.270IP1 - 19.8IP4$	0.000	79%	
	Predictor	Coeff	p-value	VIF
	Constant	507	0.000	
	IP1	0.27	0.592	1.089
	IP4	-19.8	0.000	1.089
F1	$455 + 0.0106IP3 - 18.9IP4$	0.000	79%	
	Predictor	Coeff	p-value	VIF
	Constant	455	0.000	
	IP3	0.0106	0.646	2.477
	IP4	-18.9	0.000	2.477
F1	$468 - 17.7IP4 - 1.37IP5$	0.000	79.2%	
	Predictor	Coeff	p-value	VIF
	Constant	468	0.000	
	IP4	-17.7	0.000	3.856
	IP5	-1.3	0.511	3.856
F1	$1006 - 20.6IP4 - 5.51IP6$	0.000	79.2%	
	Predictor	Coeff	p-value	VIF
	Constant	1006	0.000	
	IP4	-20.6	0.000	1.013
	IP6	-5.51	0.043	1.013

Table 8 (Continued)

	Relationship	p-value	Adj-R2 (%)	
F1*	431 - 1.15C1* - 16.1IP4*	0.000	85.2%	
	Predictor	Coeff	p-value	VIF
	Constant	431	0.000	
	C1*	-1.15	0.528	1.029
	IP4*	-16.1	0.000	1.029
F1*	299 - 3.85C1* - 6.80IP5*	0.000	85.2%	
	Predictor	Coeff	p-value	VIF
	Constant	299	0.001	
	C1	-3.85	0.144	1.001
	IP5	-6.8	0.001	1.001
F1*	237 + 1.98C2* - 0.750C4*	0.000	71.4%	
	Predictor	Coeff	p-value	VIF
	Constant	237	0.001	
	C1	1.98	0.015	1.002
	IP5	-0.75	0.001	1.002
F1*	408 + 0.612C2* - 15.5IP4*	0.000	86.9%	
	Predictor	Coeff	p-value	VIF
	Constant	408	0.000	
	C2	0.612	0.232	1.134
	IP4	-15.5	0.000	1.134
F1	329 - 3.93C3* - 9.60IP5*	0.000	84.5%	
	Predictor	Coeff	p-value	VIF
	Constant	329	0.000	
	C3	-3.93	0.047	2.130
	IP5	-9.60	0.000	2.130

Table 8 (Continued)

	Relationship	p-value	Adj-R2 (%)	
F1*	407 - 0.237C4* - 13.8IP4*	0.000	84.5%	
	Predictor	Coeff	p-value	VIF
	Constant	407	0.000	
	C4	-0.237	0.103	1.653
	IP4	-13.8	0.000	1.653
F1*	280 - 0.381C4* - 5.00IP5*	0.001	75.1%	
	Predictor	Coeff	p-value	VIF
	Constant	280	0.000	
	C4	-0.381	0.066	1.468
	IP4	-5.00	0.008	1.468
F1*	371 + 4.96IP2* - 14.3IP4*	0.001	86%	
	Predictor	Coeff	p-value	VIF
	Constant	371	0.000	
	IP2	4.96	0.350	2.122
	IP4	-14.3	0.001	2.122
F1*	438 - 17.1IP4* - 13.4IL1*	0.000	85.7%	
	Predictor	Coeff	p-value	VIF
	Constant	438	0.000	
	IP4	-17.1	0.000	1.147
	IP1	-13.4	0.399	1.147
F1*	420 - 16.0IP4* + 16.8IL2*	0.000	87.3%	
	Predictor	Coeff	p-value	VIF
	Constant	420	0.000	
	IP4	-16.0	0.000	1.023
	IL2	16.8	0.192	1.023

Table 8 (Continued)

	Relationship	p-value	Adj-R2 (%)	
F1*	416 - 15.9IP4* + 56IL3*	0.000	87.3%	
	Predictor	Coeff	p-value	VIF
	Constant	416	0.000	
	IP4	-15.9	0.000	1.335
	IL2	56	0.698	1.335
F1*	423 - 15.8IP4* - 0.660IL4*	0.000	86.8%	
	Predictor	Coeff	p-value	VIF
	Constant	423	0.000	
	IP4	-15.8	0.000	1.054
	IL4	-0.66	0.239	1.054
F1*	422 - 16.0IP4* - 0.0145IL5*	0.000	84.8%	
	Predictor	Coeff	p-value	VIF
	Constant	422	0.000	
	IP4	-16.0	0.000	1.237
	IL5	-0.0145	0.693	1.237
F1*	457 - 17.9 IP4* - 0.000436IL6*	0.000	91.2%	
	Predictor	Coeff	p-value	VIF
	Constant	457	0.000	
	IP4	-16.0	0.000	1.140
	IL6	-0.000436	0.028	1.140
F1*	428 - 16.6IP4*+ 0.046IL7*	0.000	84.7%	
	Predictor	Coeff	p-value	VIF
	Constant	428.21	0.000	
	IP4	-16.6	0.000	1.1
	IL7	-0.046	0.737	1.101

Note : * Meant the data is account only in fiscal year 2008 for none * mean the data from fiscal year 2007 and 2008 was accounted in regression.

The increasing of IP4 and IP6 leads F1 to reducing in its value. Where increasing of IP4 has higher effect than increasing of IP6 about 4 times/unit. Refer to simple regression model and polynomial regression model, IP6 is not present for any internal relation to the financial perspective, but for the multiple regression model products yield has relative important to financial interest. Higher yield mean higher in good product output from processing unit, it is make production line do optimum cost based on financial designed (labor cost/kg), the loss in energy, labor, time, and material are minimized. Thus the interest cost (F1) by accounting calculation for loss in capital cost has minimized at the same time.

Innovation and learning perspective has effect to F1 as it represent in Table 8. where the combination of IP4 is involved. As a results, IL1 (R&D cost per new products order intake (Baht/Baht)), IL4 (Welfare per salary (%)), IL5 (Marketing expense per customer (Baht/customer)) and IL6 (Marketing expense per customer (Baht/customer)) lead the result in reducing of F1 in value, when it is increasing in value. However, the number of IL5 and IL6 can be negligible due to the multiplier is small in number. In contrast with the combination between IP4 and IL2 (Bonus per salary (%)), IL3 (Over time per salary (%)), and IL7 (Employee training cost per number of employee (Baht/head)) effect on F1, it given the positive results to F1. The most effect that given the F1 in positive value are IL2 and IL3. As usual on accounting system IL2 and IL3 have accounted for expense. So some interest rate has applied to IL2 and IL3. In this moment, the new data that keep during fiscal year 2008 has play some effect to financial perspective. Therefore, to monitor and control for F1 innovation and learning perspective able to adjust F1 in some degree. Where the RPP management has to use those new parameters from innovation and learning to adjust the financial perspective (F1) in proper conditions and proper time. The above results for F1, is only guide line for monitoring and control of business direction. In actual it must use together with the management experience to do double check with achieved data and results.

Table 9 The results from the multiple regression model for F2 group

	Relationship	p-value	Adj-R2 (%)	
F2*	$1727 - 22.3IP1^* + 43.2IP4^*$	0.000	79.5%	
	Predictor	Coeff	p-value	VIF
	Constant	1727	0.000	
	IP1	-22.3	0.000	1.093
	IP4	43.2	0.042	1.093
F2*	$7921 - 22.9IP1^* - 59.2IP6^*$	0.000	72.6%	
	Predictor	Coeff	p-value	VIF
	Constant	7921	0.000	
	IP1	-22.9	0.000	1.314
	IP6	-59.2	0.196	1.314
F2*	$2030 - 18.4IP1^* - 283 IL1^*$	0.000	77.9%	
	Predictor	Coeff	p-value	VIF
	Constant	2030	0.000	
	IP1	-18.4	0.000	1.054
	IL1	-283	0.061	1.054
F2*	$1983 - 17.4IP1^* - 0.00470IL6^*$	0.000	77.9%	
	Predictor	Coeff	p-value	VIF
	Constant	1983	0.000	
	IP1	-17.4	0.000	1.098
	IL6	-0.00470	0.023	1.098

Note : * Meant the data is account only in fiscal year 2008 for none * mean the data from fiscal year 2007 and 2008 was accounted in regression.

According to Table 9 it was found the relationship between internal process perspective combination and innovation and learning perspective. The combination

which effect to F2 (Revenue per trial order (Baht/Baht)). F2 is the most RPP management need to see for the advantage of new material design from R&D department under cooperative with production department. The equations in Table 9 are based founded with IP1 which it has similar trend. The increasing of IP1 (On time sample delivery (%)) make F2 a little deduction in value. IP1 value in decimal increment for all F2 equation has play a little role for F2 value. However, in fact if the value of IP1 is less than 50% or 0.5 in equation, it is possible to make RPP faced on problem for customer trust. The other internal process effect on F2, it is IP6 (Yield (%)), the increasing of yield deduct the value of F2 maximum at 59.2.

This relationship is not mean the lower yield the better in F2. Production manager are normally concern of percentage of yield (Output good products/Input Raw Material). Higher yield means higher in production out put for good products. Refer to Table 9 it was only found two parameters from innovation and learning, which effect on F2. It is IL1 (R&D cost per new products order intake (Baht/Baht)) and IL2 (Bonus per salary (%)). IL1 is the most effective factor to rise up or rise down the F2 value. In real life if R&D cost going high, it is absolutely effect on revenues. Where, the trial order cost which is dividend of revenue from total products will going high. Thus the F2 is going small in this case. Effect of IL6 on F2 is completely infinitesimal amount to overall F2 with IP4 combination. IL6 is a representative for new products investment, which means the company concern in innovation point of view.

In the innovation company such software computer, computer hardware, and short life cycle products company; the value of IL6 is crucial important on company revenue. Event the IL6 is trivial factor on F1; the RPP managements are still concern for long term of employee development. Refer to the act of Ministry of Labor and Social Welfare, the training course able to deduct for TAX at 200%. If the accounting system by RPP has changed for employee training expense to employee training income, the IL6 will change F1 on positive site.

Table 10 The results from the multiple regression model for F3 group

	Relationship	p-value	Adj-R2 (%)	
F3*	$126 + 16.5C1^* - 39.4 IP5^*$	0.001	71.7%	
	Predictor	Coeff	p-value	VIF
	Constant	126	0.383	
	C1	16.5	0.262	1.001
	IP5	-39.4	0.000	1.001
F3*	$123 + 6.94C2^* - 33.4IP5^*$	0.001	75.4%	
	Predictor	Coeff	p-value	VIF
	Constant	123	0.293	
	C2	6.94	0.116	1.276
	IP5	-33.4	0.002	1.276
F3*	$811 - 70.8IP4^* + 273IL2^*$	0.001	71.9%	
	Predictor	Coeff	p-value	VIF
	Constant	811	0.007	
	IP4	-70.8	0.002	1.023
	IL2	273	0.025	1.023
F3*	$850 - 66.8IP4^* - 12.4IL4^*$	0.001	74.3%	
	Predictor	Coeff	p-value	VIF
	Constant	850	0.004	
	IP4	-66.8	0.002	1.054
	IL4	-12.4	0.017	1.054

Table 10 (Continued)

	Relationship	p-value	Adj-R2 (%)	
F3*	3530 - 42.8IP5* - 34.7IP6*	0.002	70.9%	
	Predictor	Coeff	p-value	VIF
	Constant	3530	0.277	
	IP5	-42.8	0.000	1.150
	IP6	-34.7	0.310	1.150
F3*	359 - 43.7IP5* - 1030IL3*	0.002	70.0%	
	<i>Predictor</i>	<i>Coeff</i>	<i>p-value</i>	<i>VIF</i>
	Constant	359	0.037	
	IP5	-43.7	0.001	1.325
	IL3	-1030	0.382	1.325

Note : * Meant the data is account only in fiscal year 2008 for none * mean the data from fiscal year 2007 and 2008 was accounted in regression.

According to Table 10, it is representative for interrelationship between BSC parameters on F3 (EBIT per number of R&D staffs (Baht/head)). the combination between C1 New (customer per total customers (%)) and IP5 (Labor Cost per production output (Baht/Kilogram)), C1 is given the positive site on F3, while IP3 is given negative site on F3. C1 is clearly shown that new customer able to enhance RPP revenue significantly. In general, to increase the numbers of new customer products and marketing cost (IL5) have to strongly invest. However, the increasing value of marketing cost will lead interest cost increasing unavoidably. When the RPP managements were consider between C1 and IL5, the decision to make profit to RPP is increasing number of C1 instead of IL5 concerning.

Refer to Table 10 the combination of C2 (Claim per total claim of each year (%)) and IP5 (Labor Cost per production output (Baht/Kilogram)), it is also effect to

F3 value. C2 tend to increase the F3 value, intact it is contra with management feeling, but the equation state only in percentage level. C2 is claim in percentage of each month compare to total claim of each year. R&D and production department is not need to re-claim process occurred. Due to, most of customer of RPP locate outside Thailand, if the loss due to re-claim products means the lost of those goods which included labor cost, raw material cost, logistics. To take the goods back to recycle from over sea can not meet the economic cost. Claim from customers can divided in to two major reasons, first reason is technical claim, second reason is commercial claim. In dept of claim analysis, the RPP managements have summarized in Table 11 for claim problem.

Table 11 Claim summary from RPP, collection from fiscal year 2008

Technical Claim		Commercial Claim	
Problem	Time	Problem	Time
Thickness	4	Key with wrong price	20
Stick Mark	-	Special Price	-
Black Spot	1	Customer Cancel Tax Invoice	-
Oil Mark	2	Issue Over P/O	-
Color	8	Weight	-
Scratch	-	Communication (Sales & Customer)	7
Snow	1	Delay of Shipment	1
Wrinkle	-	Damaged During Transportation	5
Wavy Edge	3	Loss (Transportation)	1
Fish Can	-	Accident (Transportation)	-
Size	-	Tax Invoice	5
Embossing Shrinkage	-	Other	2
Loss Roll	-		
Vacuum	1		
Heat Shrinkage	2		

Table 11 (Continued)

Technical Claim		Commercial Claim	
Problem	Time	Problem	Time
Weight	-		
Squareness	-		
Take-Off Mark	3		
Wrong Packing	1		
Static	-		
Lamination	4		
Printing	1		
Other	-		
Total	31	Total	41

Top three of claims are key in wrong price (commercial), miss match color (technical), and communication break down (commercial). Those claim, if it is accounted for value. It is about 20,000,000 Thai Baht. From this study, claim value can reduce under increase training, working more concentrate on each order, and also the managements have to supervise for the important order. On the other hand, IP5 provide the negative site to F3, when its increasing in value. The more products out put in kilogram, the lower IP5 value, then F3 (EBIT) is increase later.

The result from the combination between IP4 (Labor cost (Baht/Kilogram)) and IL2 (Bonus per salary (%)) on F3 is shown that IP4 deduct the value of F3 while IL2 enhance the value of F3. If the labor cost in creasing, absolutely it defect on EBIT due to cost of production or cost of goods sold caused higher in price. Bonus over salary in percentage is able to enhance the value of F3 where that maximum value is 25% or 3 months bonus. It is true that, when the end of each year, the employee normally waiting for bonus which announced by the RPP management. In psychology point of view bonus is motivation tool to enhance the employee morality to make them eager to work, to eager to put the force in their own function, and to put a strong intension of own task. Finally, IL2 is a benefit to RPP in all rounds.

Result for the combination of IP4 and IL4 (Welfare per salary (%)) effect on F3, the result shown that IL4 given the negative value to F3 when its increasing. In RPP accounting system, welfare is the expense or cost of management. So it was effect in negative site for EBIT (F3). For the IP4, it has a similar result to another combination of BSC parameters that discuss in above.

The result for IP5 (Labor Cost per production output (Baht/Kilogram)) and IP6 (Yield (%)) combination on F3, both IP5 and IP6 given a negative site for F4 when it increasing in number. IP6, increasing only in percentage level which ranging above 90%. Yield (IP6). So to maintain F3 on track, the only IP5 will take in charge for monitoring and control. To control value for IP5, the RPP managements have to minimize IP5 by increasing production output as much as possible.

To analyses the F3 under the effect of IP5 (Labor Cost per production output (Baht/Kilogram)) and IL3 (Over time per salary), it is given the negative trend for increasing both IL3 an IP5 in number. Labor cost which design by RPP management for entire of business year is direct effect to EBIT. Over time is a special labor cost is also effect to EBIT. In this case of combination, the management can do monitoring and control only for control the employee over time to maximize F3 value.

Table 12 The results from the multiple regression model for F5 group

F5*	2219 - 13.4C3* - 57.1IP5*	0.001	71.6%	
	Predictor	Coeff	p-value	VIF
	Constant	2219	0.000	
	C3	-13.4	0.326	2.130
	IP5	-57.1	0.002	2.130
F5*	1142 - 2.98C4* + 0.425IP3*	0.002	70.2%	
	Predictor	Coeff	p-value	VIF
	Constant	1142	0.003	
	C4	-2.98	0.054	1.433
	IP3	0.425	0.021	1.433
F5*	2085 - 2.53C4* - 35.9IP5*	0.000	79.7%	
	Predictor	Coeff	p-value	VIF
	Constant	2085	0.000	
	C4	-2.53	0.051	1.468
	IP5	-35.9	0.003	1.468
F5*	2297 - 3.28IP1* - 45.2IP5*	0.002	70.8%	
	Predictor	Coeff	p-value	VIF
	Constant	2297	0.000	
	IP1	-3.28	0.401	1.078
	IP5	-45.2	0.001	1.078
F5*	2267 - 25.5IP4* - 37.7IP5*	0.002	70.0%	
	Predictor	Coeff	p-value	VIF
	Constant	2267	0.000	
	IP4	-25.5	0.484	3.122
	IP5	-37.71	0.044	1.078

Table 12 (Continued)

F5*	$2693 - 85.3IP4^* + 326IL2^*$	0.001	74.2%	
	Predictor	Coeff	p-value	VIF
	Constant	2693	0.000	
	IP4	-85.3	0.001	1.023
	IL2	326	0.020	1.023
F5	$2735 - 79.6IP4^* - 15.8IL4^*$	0.000	80.4%	
	Predictor	Coeff	p-value	VIF
	Constant	2735	0.000	
	IP4	-79.6	0.001	1.054
	IL4	-15.8	0.005	1.054
F5	$1846 - 41.0IP5^* + 1644IL3^*$	0.001	73.3%	
	Predictor	Coeff	p-value	VIF
	Constant	1846	0.000	
	IP5	-41.0	0.002	1.325
	IL3	1644	0.222	1.325
F5	$1991 - 41.0IP5^* - 5.99IL4^*$	0.002	70.9%	
	Predictor	Coeff	p-value	VIF
	Constant	1991	0.000	
	IP5	-41.0	0.006	1.619
	IL4	-5.99	0.387	1.619

Note : * Meant the data is account only in fiscal year 2008 for none * mean the data from fiscal year 2007 and 2008 was accounted in regression.

Refer to Table 12, the combination of C3 (Number of customer complaint per month (Time/Month)) and IP5 (Labor Cost per production output (Baht/Kilogram)) given the negative sign on F5 (Revenue per raw material cost (Baht/Baht)). High

volume in customer complaint mean lower in income, while the RPP lost in opportunity to make profit from raw material via conversion. Because of during complaint the customer normally suspended the further order.

To consider C4 (Successful order (Approved Art Work) per total order (%)) and IP3 (Product quantity (tons)) combination effect on F5, C4 was given positive sign to F5 in contrast with the increasing of IP3. Similar result when combine C4 and IP5 (Marketing expense per customer (Baht/customer)) , C4 was given negative result. However, IP5 is given enormous negative sign for F5. This relationship let RPP acknowledgement that, the cost which invest on marketing issue will proportional deduct the revenue from raw material (F5).

The effect of combination between IP1(On time sample delivery (%)) and IP5 (Labor Cost per production output (Baht/Kilogram)) on F5 have provide negative side, when both IP1 and IP5 increasing its own value. The most effect on F5 is IP5. This case, it is normal analysis cause and effect for finished goods production and selling. The combination model of regression between IP1 and IP5 has similar result as the combination of IP4 and IP5. It given the negative site to F5, IP4 is main cause for IP5. IP5 is the parameter which, divided by output of products (kg). So the result is similar to IP4, but depend on the products output of each month that RPP can produce.

Refer to the multiple regression model $F5 = 2693 - 85.3 IP4^* + 326IL2^*$, IP4 given the negative side to F5, in contrast with IL2 (Bonus per salary (%)) provide the positive side to F5 when both increasing in its own value. This is mean, the revenue from raw material able to to increase by gain up of IL2. However, the IL2 will effect to interest rate of RPP. So the IL2, control schematic has to consider with interest expense together.

When the combination between IP4 and IL4 (Welfare per salary (%)) took place IL2, IL4 was given the negative side to F5 at some degree. However, the increasing of IL4 has given maximum positive to F5 at 15.8 Unit. Welfare able to

improve quality of employee working life, its made morality of employee come better. IP4 and IL4 regression model on F5, has similar trend as the combination of IP5 and IL4. IP5 is derivative of IL4, where production output was accounted for.

See the IP5 and IL3 (Over time per salary (%)) combination multiple regression model, when the value of IP5 and IL3 increasing, IP5 deduct on F5 value while IL3 enhancing F5 value. So that, the over time able to increasing, revenue from raw material as usual. However, overtime working has limitation at maximum IL3 value at 1 (100%). This result is going as the similar way as polynomial model plot between IP1 and IL3, where IL3 is complete at maximum consideration 100%. Overtime is a major policy that RPP management command to production employee to do. So this relationship, the only IP5, can do only parameter to control to get the maximum revenue from raw material.

CONCLUSION AND RECOMMENDATION

Conclusion

Refer to results and discussion, this thesis work able to support for the two major problems. First, the R&D and production department able to effort the RPP on new revenue from new customer; effect of C1 (New customer per total customers (%)) on F3 (EBIT per number of R&D staffs (Baht/head)) which clearly founded under multiple regression method. Where (IP5 Labor Cost per production output (Baht/Kilogram)) is supportive parameter. Equation 7-1, is the relationship between C1 and F3, which C1 is mainly reflect to new customer, which intake from satisfaction of new product from R&D.

$$F3^*=126 + 16.51C1^* - 39.4IP5^* \quad (7-1)$$

New products from R&D derived to customer under C4 value (Successful order (Approved Art Work) per total order (%)). As results, C4 given revenue from raw material decrease at some degree. Due to a free sample to new customer or new order, it is absolutely deduct to F5 value (Revenue per raw material cost (Baht/Baht)).

$$F5^*=1142 - 2.98C4^* + 0.425IP3^* \quad (7-2)$$

$$F5^*=2085 - 2.53C4^* - 35.9IP5^* \quad (7-3)$$

Equation 7-2 and 7-3, repents for relationship of new product to new customer by R&D (C4) on revenue per raw material cost (F5). Thus R&D can strongly effort RPP to get more new customer and enhance EBIT of RPP. Where F5 (revenue) is sub-unit of F3 (EBIT).

Second, the data which correct during fiscal year 2008 related to ISO 9000 version 2000 item 18, especially for innovation and learning focus let the RPP managements to concern on it. Innovation and learning perspective of RPP has shown

that, it able to provide positive value to RPP firm. From polynomial regression model, it was found that innovation and learning parameter, which focus on over time working on work quality. During fiscal year 2008, 5% overtime can only provide on time delivery at maximum 99.2%. As a result, the over time is no need to apply for the employee.

This thesis work is carry out for the suitability monitoring and control parameter of information currently collected and capable to used in an organization based on balance scorecards frame work. Previously, the management focus only on one dimensional performance measurement, that is accounting system. Accounting system can only determine company profit or lost, but it does not inform the management level about internal process performance, customer relationship performance, and quality of work life performance. As a results from productivity and performance study, it was found that internal process perspective parameter (IP), customer perspective parameters (C), and innovation and learning (IL) perspective parameters able to enhance the RPP management on financial control (F). Furthermore the study of, it is also use as a general tool to motoring and control total plant operation, total quality policy, customer relationship management, and employee development. The out come of this work, states clearly for which parameters that managements of RPP are able to use to solve the company in further situation. Most of BSC parameters able to effort the performance of financial point of view especially for F1 (Interest per man-day cost (Baht/Baht)), F2 (Revenue per trial order (Baht/Baht)), F3 (EBIT per number of R&D staffs (Baht/head)) and F5 (Revenue per raw material cost (Baht/Baht)). Unfortunately, this thesis work is not find any relationship between IP, C, and IL on F4 (Revenues from new product per total revenue (%)).

Further information, the only study on simple regression from BSC parameter, the results from simple regression model does not provide sufficient data to the management of RPP. Additional study especially for polynomial regression given the RPP management able to view unseen result from polynomial model, as present in Figure 13, it is the relation ship between working overtime and results of on-time

work. The result was answered the RPP management for the optimality of working. It was found that over time which no more than one hour is the maximum of RPP employee can release maximum productivity output.

From multiple regressions, it was found the combination of each balance scorecards parameters effect on financial perspective. The combination of each parameters have dramatically shown side effect to financial perspective. The results from multiple regression model effort the RPP managements to firmly analyse the business situation based on mathematically analytic together with the management experience.

Finally, the firm foundation most wanted is income which is reflecting directly from EBIT. From this thesis work, it was found major relationship as summarized in Table 13.

To increase EBIT or make more profit, the RPP management have to increase positive activity from Table 13. It is C1, C2, and IL2 to improve in EBIT. At the same time negative activity such IP4, IP5, IP6, IL3, and IL4 have to minimize. In some case the IP6 have to maintain based on production department to get maximum yield as much as possible. To keep the employee morality, event the RPP has negative activity such IL4, the management has to compensate at the optimum level to maintain and improve quality of working life of employee on track, and welfare is a face of company that represent to global.

Table 13 Summarized of BSC parameter which effect on EBIT (F3)

DIRECT EFFECT OF BSC PARAMETER			
EBIT	BSC PARAMETER	INCREASING IN VALUE	NOTE
F3	C1 (%)	Increasing in number of new customers lead EBIT on positive value	The value of C1 is in percentage level.
F3	C2 (%)	Increasing in percentage of claim per total claim of each year lead EBIT on positive value. More claims mean more products out to end customers.	The value of C2 is in percentage level.
F3	IP4	Increasing of labor cost of production leads EBIT getting worse in value.	Plant manager have to control labor cost at the optimum value around 12-14 Baht/Kg. To maintain competitive in product price level.
F3	IP5	Labor cost getting high relative to production out put leads EBIT getting worse in value.	Plant manager has to operate on max through put to gain F3 in positive side.
F3	IL2 (%)	Bonus planning has effect direct to EBIT. This value to is enhance employee morality from indirect measurement.	Higher bonus means the company operation out come is excellence.
F3	IL3 (%)	Made F3 in negative side.	Production manager have to control over time of production staffs. It is recommend to do over time at no more than 40 minutes.
F3	IL4 (%)	Increasing in social welfare cost is lowering EBIT value.	Welfare expense has to plan at the optimum but it can not set as zero for expense. IL4 It is represent for quality of working life of employee.

Recommendation

This recommendation generates a strong evidence for compliance with Requirement 8 of ISO 9001:2000 (dealing with performance measurement, analysis and improvement) and Category 4 of the TQA (addressing the issues of performance measurement, analysis and knowledge management).

The data especially for additional on fiscal year 2008, it is recommend to RPP to do continual collection to keep in data base for further knowledge management. The additional parameter for further study are ROI form R&D new products, Revenue per energy cost, satisfied customer index, customer repurchasing rate.

Limitation of this thesis work, due to the time limitation some parameter such F4 (Revenues from new product per total revenue (%)) is not carried for interrelation between BSC parameter. If the data form RPP is more specific for only F4 and new products revenue it could found some relationship that how is a big effect from new product launching for new plastic application/products. The accounting system for RPP include R&D department in production department, so the core cost of R&D activities can not recognitions for this thesis work.

To predict the results from regression equation, maximum of 3 units forwarding is recommended.

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APPENDICES

Appendix A
Raw Data from RPP

Appendix Table A1 Financial data which use for time lag effects analysis

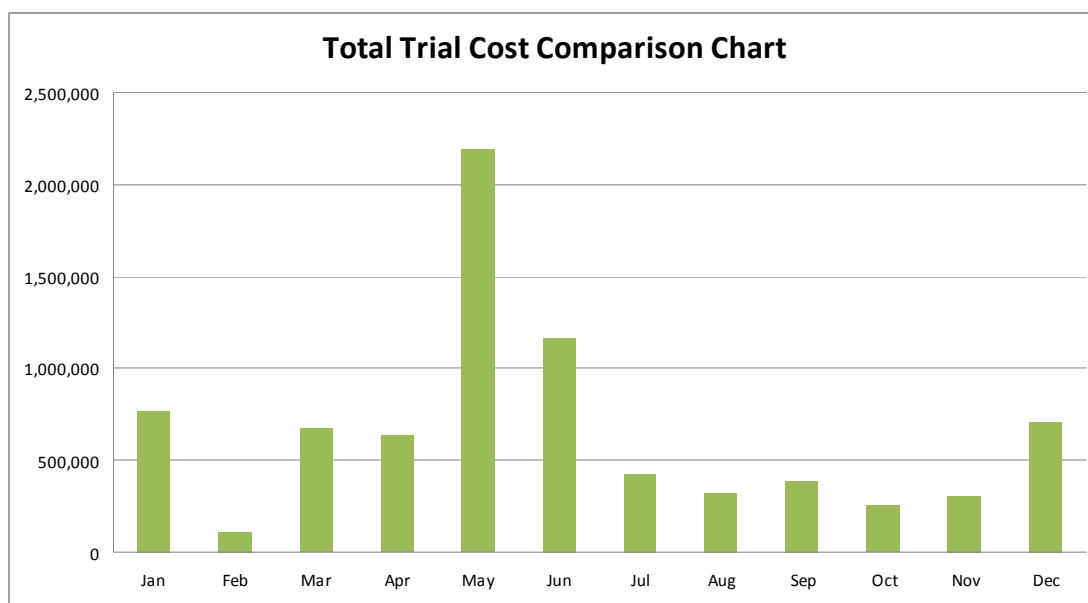
Period	Interest expense (KBaht)	Production cost /kg	Revenue ex- factory sale plus other rev (KBaht)	Trial order cost (KBaht)
Jan-2007	2906	13.1	85777	NO DATA
Feb-2007	3194	12.4	82737	NO DATA
Mar-2007	2955	11	93784	NO DATA
Apr-2007	2976	12.4	96645	NO DATA
May-2007	3443	12.2	92956	NO DATA
Jun-2007	3114	13.5	91137	NO DATA
Jul-2007	2826	13.5	105223	NO DATA
Aug-2007	2912	13.6	77157	NO DATA
Sep-2007	3005	11.9	91916	NO DATA
Oct-2007	2879	12.8	100594	NO DATA
Nov-2007	3101	13.9	83672	NO DATA
Dec-2007	2942	12.6	105701	NO DATA
Jan-2008	3023	12.3	113082	773
Feb-2008	2865	13	103297	110
Mar-2008	2693	11.4	93416	677
Apr-2008	2633	13.3	105719	633
May-2008	2520	13.2	95615	2193
Jun-2008	2644	13.1	99824	1167
Jul-2008	2858	13.7	91624	430
Aug-2008	2891	13.5	109837	322
Sep-2008	2630	16.4	95785	389
Oct-2008	2508	17.2	84883	256
Nov-2008	2609	16.9	86567	305
Dec-2008	2468	15	59011	714

Appendix Table A1 (Continued)

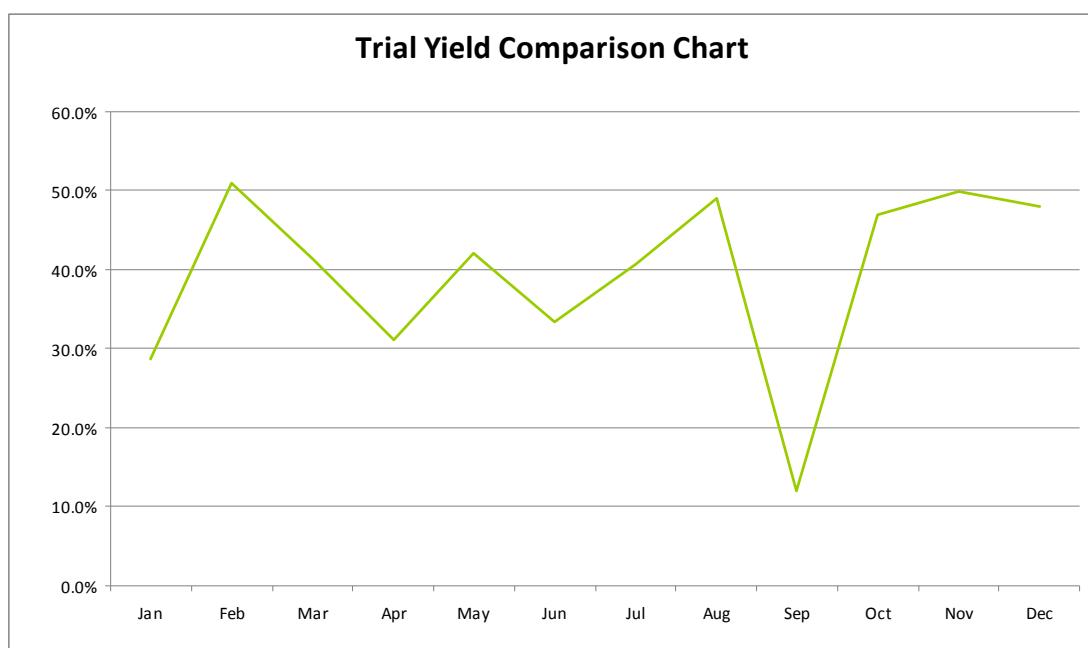
Period	Profit (EBIT), KBaht	Number of employee r&d (Head)	Revenue from new products (estimate margin at 15%)	Product cost (baht/kg)
Jan-2007	5805	30		59.8
Feb-2007	-2917	30		57.3
Mar-2007	-3063	30		54.5
Apr-2007	-764	30		56.2
May-2007	-3048	30		59.1
Jun-2007	-9267	30		60.9
Jul-2007	-6060	30		60.1
Aug-2007	-5736	30		61.2
Sep-2007	-5605	30		59.8
Oct-2007	2062	30		58.8
Nov-2007	-1299	30		62.2
Dec-2007	-1727	30		61.3
Jan-2008	990	30	1474.99	60.5
Feb-2008	-4144	30	4503.07961	61.3
Mar-2008	-5827	30	2667.4802	59.5
Apr-2008	-2138	30	5430.90973	63.1
May-2008	-3248	30	2816.79666	62.8
Jun-2008	819	30	8141.43282	62.8
Jul-2008	-1955	30	4966.020045	65.1
Aug-2008	-1745	30	17173.75017	67.8
Sep-2008	-9152	30	2954.50042	71.9
Oct-2008	-13556	30	5874.7221	70.2
Nov-2008	-12450	30	2999.97464	66.8
Dec-2008	-15350	30	3490.55935	53.5

Appendix Table A2 Quality objective of RPP from product and develop department
during fiscal year 2008

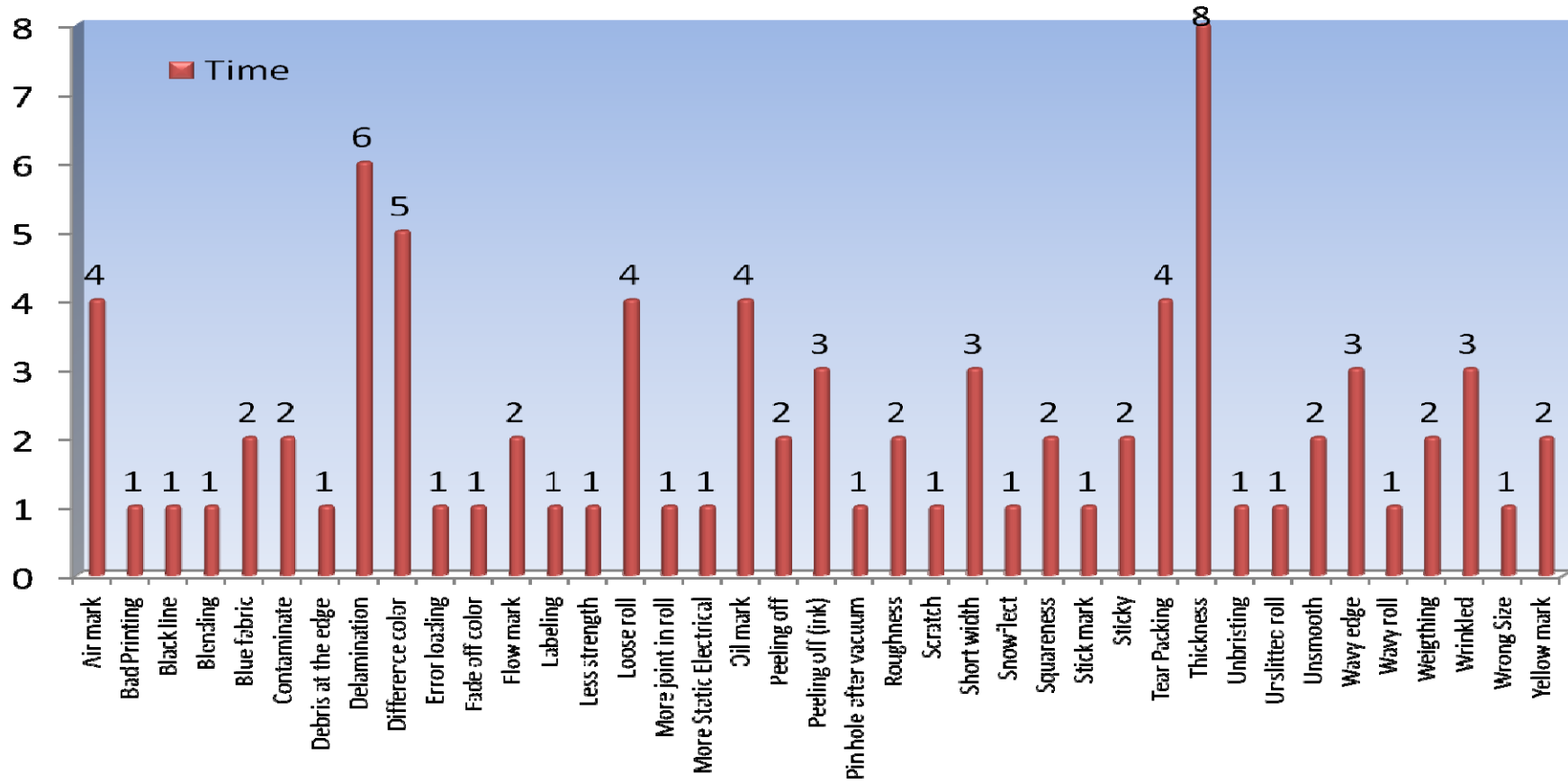
NO	OBJECTIVE	TARGET	1	2	3	4	5	6	7	8	9	10	11	12
1	NEW PRODUCTS WITH CONFIRM ORDER	>10	23	23	23	65	65	65	69	69	69	38	38	38
2	APPROVED SPECIFICATION BEFORE ORDER	> TARGET OF EACH MONTH	N/A	12	25	47	65	85	100	100	100	100	100	100
3	ON TIME DELIVERY	>90%	N/A	62	96.2	97.2	97.4	92.3	92.7	97.2	98.0	98.5	97.9	96.0
4	ON TIME FORMULATION	99%	N/A	100	99.5	100	100	100	100	100	98.5	100	99.2	97.6



Appendix Figure A1 Trial order cost during fiscal year 2008



Appendix Figure A2 Trial order Yield during fiscal year 2008



Appendix Figure A3 Detailed claim problem during fiscal year 2008

Appendix B

Definition of BSC Parameter and Results

Appendix Table B1 The common KPIs data collection based on Balanced Scorecard

Financial	Customer	Internal Processes	Innovation and Learning
F1 = Interest per man-day cost (Baht/Baht)	C1=New customer per total customers (%) (Based on 100 number of December 2007)	IP1 = On time sample delivery (%)	IL1 = R&D cost per new products order intake (Baht/Baht)
F2 = Revenue per trial order (Baht/Baht)	C2 = Claim per total claim of each year (%)	IP2 = Output per head (Tons/head)	IL2 = Bonus per salary (%)
F3 = EBIT per number of R&D staffs (Baht/head)	C3 = Number of customer complaint per month (Time/Month)	IP3 Product quantity (tons)	IL3 = Over time per salary (%)
F4 = Revenues from new product per total revenue (%)	C4. Successful order (Approved Art Work) per total order (%)	IP4 = Labor cost (Baht/Kilogram)	IL4 = Welfare per salary (%)

Appendix Table B1 (Continued)

Financial	Customer	Internal Processes	Innovation and Learning
F5 = Revenue per raw material cost (Baht/Baht)		IP5. Labor Cost per production output (Baht/Kilogram)	IL5. Marketing expense per customer (Baht/customer)
		IP6 = Yield (%)	IL6. Investment in new product per R&D staff (Baht/head)
			IL7 = Employee training cost per number of employee (Baht/head)

Note : 35 Baht is approximately equivalent to 1USD.

Appendix Table B2 The information from RPP for financial perspective

Period	Financial perspective				
	F1	F2	F3	F4	F5
January 2007	221.83	N/A	194	N/A	1434
February 2007	257.58	N/A	-97	N/A	1444
March 2007	268.64	N/A	-102	N/A	1721
April 2007	240.00	N/A	-25	N/A	1720
May 2007	282.21	N/A	-102	N/A	1573
June 2007	230.67	N/A	-309	N/A	1497
July 2007	209.33	N/A	-202	N/A	1751
August 2007	214.12	N/A	-191	N/A	1261
September 2007	252.52	N/A	-187	N/A	1537
October 2007	224.92	N/A	69	N/A	1711
November 2008	223.09	N/A	-43	N/A	1345
December 2008	233.49	N/A	-58	N/A	1724
January 2008	245.77	146.36	33	1%	1869
February 2008	220.41	942.97	-138	4%	1685
March 2008	236.24	137.92	-194	3%	1570
April 2008	197.99	167.03	-71	5%	1675
May 2008	190.89	43.59	-108	3%	1523
June 2008	201.86	85.51	27	8%	1590
July 2008	208.64	213.04	-65	5%	1407
August 2008	214.16	341.10	-58	16%	1620
September 2008	160.36	246.23	-305	3%	1332
October 2008	145.81	331.57	-452	7%	1209
November 2008	154.40	283.82	-415	3%	1296
December 2008	164.53	82.64	-512	6%	1103

Note : N/A is no data available during this period.

Appendix Table B3 The information from RPP for customer perspective

Period	Customer perspective			
	C1	C2	C3	C4
January 2007	N/A	5%	2	N/A
February 2007	N/A	4%	0	N/A
March 2007	N/A	8%	1	N/A
April 2007	N/A	0%	0	N/A
May 2007	N/A	5%	15	N/A
June 2007	N/A	21%	14	N/A
July 2007	N/A	15%	10	N/A
August 2007	N/A	15%	15	N/A
September 2007	N/A	2%	3	N/A
October 2007	N/A	8%	12	N/A
November 2008	N/A	7%	9	N/A
December 2008	N/A	10%	2	N/A
January 2008	5%	13%	10	12
February 2008	8%	4%	7	25
March 2008	4%	7%	10	47
April 2008	8%	7%	7	65
May 2008	10%	6%	9	85
June 2008	10%	11%	13	100
July 2008	7%	28%	5	100
August 2008	10%	13%	5	100
September 2008	6%	13%	11	100
October 2008	10%	0%	8	100
November 2008	7%	0%	0	100
December 2008	5%	0%	0	100

Note : N/A is no data available during this period.

Appendix Table B4 The information from RPP for internal processes perspective

Period	Customer perspective					
	IP1	IP2	IP3	IP4	IP5	IP6
January 2007	91.8	5%	2	N/A	N/A	N/A
February 2007	91.8	4%	0	N/A	N/A	N/A
March 2007	91.8	8%	1	N/A	N/A	N/A
April 2007	91.8	0%	0	N/A	N/A	N/A
May 2007	91.8	5%	15	N/A	N/A	N/A
June 2007	91.8	21%	14	N/A	N/A	N/A
July 2007	91.8	15%	10	N/A	N/A	N/A
August 2007	91.8	15%	15	N/A	N/A	N/A
September 2007	91.8	2%	3	N/A	N/A	N/A
October 2007	91.8	8%	12	N/A	N/A	N/A
November 2008	91.8	7%	9	N/A	N/A	N/A
December 2008	91.8	10%	2	N/A	N/A	N/A
January 2008	91.8	13%	10	12	12	12
February 2008	62.0	4%	7	25	25	25
March 2008	96.9	7%	10	47	47	47
April 2008	97.2	7%	7	65	65	65
May 2008	98.71	6%	9	85	85	85
June 2008	92.31	11%	13	100	100	100
July 2008	92.75	28%	5	100	100	100
August 2008	97.26	13%	5	100	100	100
September 2008	98.08	13%	11	100	100	100
October 2008	98.51	0%	8	100	100	100
November 2008	97.96	0%	0	100	100	100
December 2008	96.07	0%	0	100	100	100

Note : N/A is no data available during this period.

Appendix Table B5 The information from RPP for innovation and learning perspective

Period	Innovation and learning						
	IL1	IL2	IL3	IL4	IL5	IL6	IL7
January 2007	N/A	N/A	N/A	N/A	N/A	N/A	N/A
February 2007	N/A	N/A	N/A	N/A	N/A	N/A	N/A
March 2007	N/A	N/A	N/A	N/A	N/A	N/A	N/A
April 2007	N/A	N/A	N/A	N/A	N/A	N/A	N/A
May 2007	N/A	N/A	N/A	N/A	N/A	N/A	N/A
June 2007	N/A	N/A	N/A	N/A	N/A	N/A	N/A
July 2007	N/A	N/A	N/A	N/A	N/A	N/A	N/A
August 2007	N/A	N/A	N/A	N/A	N/A	N/A	N/A
September 2007	N/A	N/A	N/A	N/A	N/A	N/A	N/A
October 2007	N/A	N/A	N/A	N/A	N/A	N/A	N/A
November 2008	N/A	N/A	N/A	N/A	N/A	N/A	N/A
December 2008	N/A	N/A	N/A	N/A	N/A	N/A	N/A
January 2008	60%	8%	8%	6%	0	25753.30	0.00
February 2008	3%	8%	13%	3%	229	3651.46	3.76
March 2008	29%	8%	8%	8%	32	22575.76	48.87
April 2008	13%	8%	7%	2%	92	21096.87	0.00
May 2008	90%	8%	5%	7%	43	73114.86	0.00
June 2008	16%	8%	7%	5%	269	38910.86	7.52
July 2008	10%	8%	0%	8%	51	14335.53	0.00
August 2008	2%	8%	7%	4%	48	10740.56	0.00
September 2008	15%	8%	4%	8%	17	12998.13	15.04
October 2008	5%	9%	5%	5%	392	8551.27	3.76
November 2008	12%	8%	3%	9%	168	10177.53	101.50
December 2008	24%	-95%	5%	29%	114	23801.85	0.00

Note : N/A is no data available during this period.

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