CHAPTER 7

VERIFICATION AND VALIDATION OF KBCLMM MODEL

7.0 Introduction

This chapter describes the verification and validation process of the KBCLMM Model by using data from both real industrial and published case studies. To ensure that the model works as planned and has the capability in identifying and suggesting the areas that need improvement, the developer must ensure that the model has sufficient accuracy. To achieve this sufficient accuracy, the model shall be verified and validated which leads to improving model's credibility [Carson (2002)].

Verification of the KB model is the determination of whether or not the model is functioning as intended while validation determines how closely the KB model decision matches human expert in a particular domain [Hussain (1998)]. Verification involves the determination of input and output data, information and knowledge accuracy, and checking the explanation and justification [Wibisono (2003)]. On the other hand, validation involves the process of ensuring that the model incorporates and uses the knowledge to solve a problem, and behaves in a similar manner as the human experts [Kelton *et. al.* (2007)]. In simpler words, verification process is to build the model right while validation process is to build the right model [Awad (1996), Carson (2002), Kelton *et. al.* (2007)].

In this study, since there is no previous available system designed for CLMM development, the verification of the KBCLMM Model is not easy, and

according to Carson (2002), no model is ever 100% validated. Kelton *et. al.* (2007) support this argument by mentioning that verification process can be difficult and complete validation can be impossible for such system. Only the *Market Analysis* and *Financial Analysis* are the modules in the KBCLMM Model which can be validated completely, since basic information needed in this module are standardised and readily available from the organisation's annual report. Hence, the emphasis of this chapter is more on the verification and refinement of the KBCLMM Model.

In order to verify the KBCLMM Model through real industrial data, four automotive organisations in Malaysia have been approached and chosen. The organisations consist of two OEMs (Original Equipment Manufacturers) and two of their suppliers (Tier 1 and Tier 2). The verification processes are conducted from Level 0 down to Level 5 of the KBCLMM System structure. The verifications are also conducted across the organisations to identify the opportunity gap for collaborative improvement between them. In addition to these industrial cases, two published case studies are also presented to support the validation processes.

7.1 Industrial Cases Verification Environments

In this study, four automotive manufacturing organisations in Malaysia which are inter-related to each other were selected to participate in the verification process. The verification process was done in May 2008. These organisations were visited during this time and at least one person (the user) from each organisation was involved in the interview session. The interview session

took two hours in average to complete. Beside this, the KBCLMM Model was also demonstrated to the users and results of the System were explained.

A brief description of each company and the relationship between them are given in the following sub-sections. The verification process of the KBCLMM is based on interviews, questions and input/information. The input/information (answers to questions and input data) provided by each person in each company is their own data (based on their current and previous data, past experiences and judgement). The knowledge contained in the model is also tested and verified (through user feedback during the system testing).

7.1.1 Perusahaan Otomobil Nasional Sdn. Bhd (PROTON)

Established in 1983, Perusahaan Otomobil Nasional Sdn. Bhd (PROTON) is the first Malaysian national automobile company. The first Malaysian car, *Proton Saga* was produced in 1985. Since its establishment, PROTON has proved to be a successful project for the Malaysian Government where it once controlled more than 60% of the passenger car market in Malaysia [Ahmad (2003)]. Presently the market share is around 30%, with annual turnover of £722 million and number of employees of more than 6000 people.

In 2005, PROTON opened its second plant to support the projected increase in both domestic and export sales. The factory is located in Tanjung Malim at the Government purpose-built "Proton City". Mostly automated, with 180 robots, the 1280-acre plant is five times larger than Proton's existing facility in Shah Alam. The site houses five main complexes; the engine shop, stamping shop, body shop, paint shop, and trim and final shop and incorporates the latest manufacturing systems and technology designed for better efficiency,

productivity and quality. The current PROTON production capacity is around 400,000 vehicles per year. However, both plants are capable of producing 1.23 million vehicles per year once they achieve their maximum capacity.

The KBCLMM Model developed was verified by the Procurement Control Executive, Mr. Rosli Ripin who has 14 years working experience in various departments with PROTON. A former manager of PROTON was also interviewed in the verification process. Most of the modules were verified by them while *Financial Analysis* module was validated using PROTON Annual Report.

7.1.2 Perodua Manufacturing Sdn. Bhd. (PERODUA)

Perodua Manufacturing Sdn. Bhd. (PERODUA) was established in 1993 and started operations in 1994, producing passenger cars. PERODUA is a joint venture company between Malaysian and Japanese partners. The shareholders are UMW Corporation Sdn. Bhd. with 38% stake, Daihatsu Motor Co. Ltd. (20%), MBM Resources Bhd (20%), PNB Equity Resources Corporation Sdn Bhd (10%), Mitsui & Co. Ltd (7%) and Daihatsu (Malaysia) Sdn Bhd (5%). It has an annual turnover of approximately £1.22 billion. As of 2008, PERODUA has sold more than one million vehicles of various models.

The PERODUA plant is located on an 81 hectare site in Bukit Beruntung, which houses corporate building, R&D testing laboratories and styling studio, vehicle test track, manufacturing plant, engine plant, pre-delivery inspection area, vehicle distribution stockyard and parts warehouse. There are a total of over 10,000 staff and the plant currently has the capacity to produce 250,000 cars per annum. PERODUA vehicles are mainly marketed in Malaysia although a

small percentage is exported to countries such as UK, Singapore, Brunei, Fiji, Nepal and Sri Lanka.

The KBCLMM Model developed for the whole modules were verified by interviewing an engineer of Press Shop Department, Mr. Zamzakri Daud. He also provided a copy of technical notes on Total Productive Maintenance as a proof of Lean Manufacturing implementation at Perodua.

7.1.3 PHN Industry Sdn. Bhd. (PHN)

Established in 1990, PHN Industry Sdn. Bhd. (PHN) has expertise as a manufacturer and supplier of metal parts, metal components and automotive dies. With an annual turnover of around £20 million and more than 1000 employees, PHN is 35% owned by PROTON, the main customer of PHN. Other shareholders include Malaysian conglomerate, HICOM Holdings (53.5%) and two Japanese companies, Nagoya Oak Ind. (9.0%) and Mitsubishi Corp. (2.5%). Besides PROTON, other major customers include PERODUA, HONDA Malaysia Sdn. Bhd. (HONDA), and Toyota Boshoku UMW (M) Sdn. Bhd. (TOYOTA) for automotive parts.

There are four PHN plants across Malaysia, with the main plant and headquarters at Shah Alam which is very close to the PROTON plant. The second plant is located at Bukit Beruntung, which is in the same industrial area with PERODUA. To meet the demand from the HONDA plant in Melaka, the third PHN plant was built in Melaka. The fourth plant is in Subang Jaya, which is in the area of capital of Malaysia, and manufactures PROTON spare parts, including Hood Assembly, Front Fender Assembly and Head Lamp Support Assembly.

The KBCLMM Model developed for the whole modules were verified by interviewing a group of management and technical staff headed by one of the senior manager, Mr. Zulkifli Hassan. Among of the interviewees includes quality control engineer and production executive who involves in the improvement programs of the company.

7.1.4 Profen Sdn. Bhd. (PROFEN)

PROFEN Sdn. Bhd. (PROFEN), incorporated in 1989, initially manufactures and assembles parts and components for PROTON. PROFEN has gradually grown in strength and capability, and now supplies parts and components to other automobile manufacturers such as PERODUA, Toyota, Nissan and Volvo. It has an annual turnover of approximately £10 million and employees of 590 people.

Besides supplying directly to OEM companies, PROFEN also supply parts and components to 1st tier supplier to OEM. For example, in this study PHN is one of the major customers of PROFEN. The main suppliers of PROFEN are two Korean-based steel manufacturers: Pohang Iron and Steel Company (POSCO) and Posmmit Steel Centre Sdn. Bhd. (POSMMIT). There are two PROFEN plants in operations: one is located near to PROTON factory in Shah Alam and another one near to PERODUA factory in Bukit Beruntung.

The KBCLMM Model developed for the whole modules were verified by interviewing the Procurement and Vendor Development Manager, Mr. Jarisman Jalil. He has 10 years working experience in various departments of automotive manufacturing companies.

7.1.5 The Organisational Relationship and Profile

The relationship of the four organisations involved in the verification and validation process for KBCLMM is depicted in Figure 7.1. The company profiles of PROTON, PERODUA, PHN and PROFEN can be summarised as shown in Table 7.1.

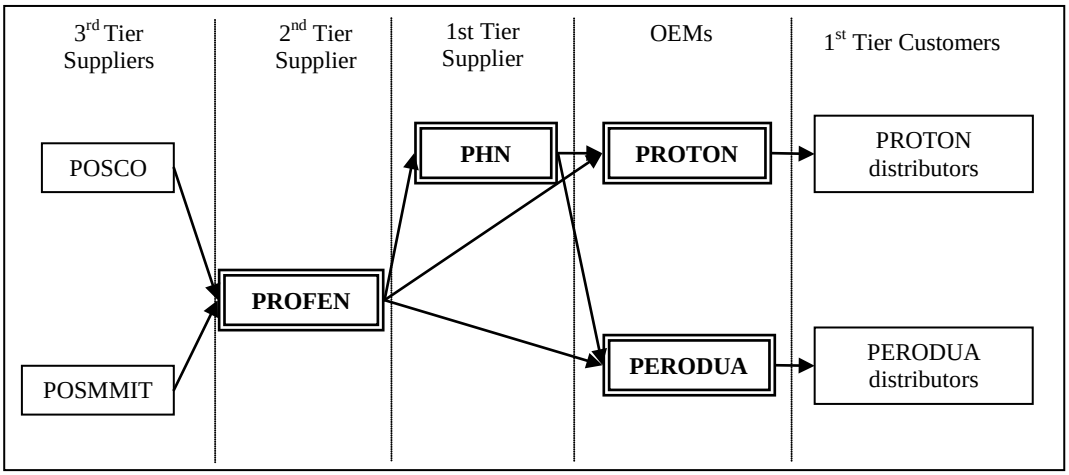

Figure 7.1: Relationship of the Organisations in the Automotive Supply Chain

Table 7.1: Summary of Organisation Profile Used in KBCLMM Model Verification and validation

	PROTON	**PERODUA**	**PHN**	**PROFEN**
Position in Supply Chain	OEM	OEM	1st-Tier Supplier	1st and 2nd Tier Supplier
Established	1983	1993	1990	1989
Number of employees	> 6000	> 10,000	> 1000	590
Annual Turnover (approx.)	£722 million	£1, 220 million	£20 million	£10 million
Number of Plants and Locations	2: Shah Alam and Tanjung Malim	1: Bukit Beruntung	4: Shah Alam, Bukit Beruntung, Melaka and USJ	2: Shah Alam and Bukit Beruntung
Products	Passenger Cars	Passenger Cars	Body panels, metal parts, and stamping components	Automotive metal components, tube racks, and engine parts
Markets	Local and Global	Local and Global	Local and Global	Local

7.2 Verification and validation of KBCLMM Model - Industrial Case Data

The KBCLMM System consists of six perspectives: one pre-requisite perspective (Level 0 – *Organisation Environment* Perspective) and five main perspectives (Level 1 to Level 5) as shown in Figure 4.8 (page 83), each of which is validated by using the input from industrial users. The detailed inputs, outputs and analysis of PROTON are used in this chapter to demonstrate the modules and procedures verification and validations, and hence the KBCLMM ability. For the other three organisations, the results are presented as summaries in this chapter while the detailed inputs and outputs are shown in Appendix E. The KBCLMM modules are linked to each other and the information is transferred through the import/export functions of the *AM for Windows* system. It should be pointed out that there is confidentiality of the financial data input to the KBCLMM System, since out of the four case organisations, three were reluctant to disclose the information due to their organisational status of being private limited companies.

7.2.1 Level 0 - Organisation Environment Perspective

This module is used to gather information related to general information and background of the organisation, as shown in Figure 7.2.

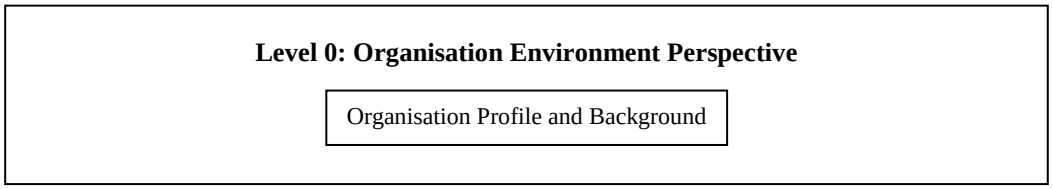

Figure 7.2: *Organisation Environment* Perspective

The inputs from user response for this module are shown in Table 7.2. Based on the inputs shown in Table 7.2, the KBCLMM has produced the output as shown in Table 7.3.

Table 7.2: Inputs of *Organisation Environment Perspective* Module for PROTON

Variables Description	**Data**		
Name of user (the interviewee)	Rosli Mohd Ripin		
Post	Executive		
Department	Procurement Control		
Organisation	Perusahaan Otomobil Nasional Sdn. Bhd.		
Address of Organisation	HICOM Industrial Estate, Batu 3, P.O. Box 7100, 40918 Shah Alam, Selangor Darul Ehsan.		
Annual Sales	> RM25 million		
Number of Employees	> 150		
Position in Automotive Industry	OEM		
Products	Passenger Cars		
Age of Organisation	25 years (1983)		
	Age of Relationship		
	< 5 years	**5 – 10 years**	**> 10 years**
Number of Suppliers	0	0	> 200
Number of Customers	> 60 abroad	0	3
	Last Year	**2 Years Ago**	**3 Years Ago**
CLMM Investment Activities:			
Just-In-Time (JIT)	Yes	Yes	Yes
Manufacturing Resources Planning (MRP II)	Yes	Yes	Yes
Total Quality Management (TQM)	Yes	Yes	Yes

Table 7.3: Output of *Organisation Environment Perspective* Module for PROTON

Category	**Description**
Size of Organisation	Large
Stage in Business Cycle	Harvest stage
Relationship with Suppliers	Good and Stable
Relationship with Customers	Good and Stable
Strategic improvement	Yes
CLMM activities	Implemented for all activities

From the figures of annual sales and number of employees, KBCLMM categorised PROTON as a large organisation, according to the scale produced by Small and Medium Enterprise Development Corporation of Malaysia [SMIDEC (2007)], which has stated that an organisation with annual sales of over RM 25

million (approximately £ 3.68 million) and number of employees of over 150 people is considered as a large-scale company. By referring to the age of the organisation, KBCLMM considered PROTON as an organisation in harvest stage of business cycle.

In terms of supply chain, since all of the suppliers have relationship of more than 10 years with PROTON, the KBCLMM classified PROTON as having a good and stable relationship with suppliers. On the other hand, the KBCLMM identified that there are three loyal customers (in this case, distributor is the 1st-tier customer) for the past ten years. The System has also found that PROTON has taken strategic steps by appointing more than 60 distributors worldwide. Apart from these, the System also found that investment and implementation of CLMM activities such as JIT, MRPII, and TQM have been in place since more than three years ago. All information in this module is stored in the information base, and can be retrieved in the other modules by utilising the import/export facility in the *AM for Windows* software.

In summary, for Level 0, the KBCLMM gathers the basic information and general profile of the organisation. The System also gives some general idea about the organisation in terms of size, stage in business cycle, relationships with customers and suppliers, and investment of CLMM activities.

7.2.2 Level 1 - Collaborative Business Perspective

The *Collaborative Business* Perspective consists of two modules, which are *Market Analysis* and *Financial Analysis* as shown in Figure 7.3.

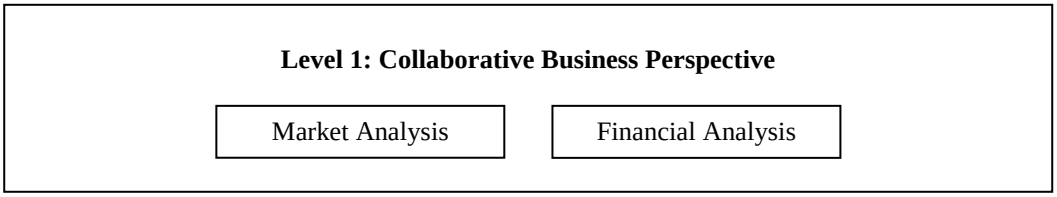

Figure 7.3: *Collaborative Business* Perspective

Market Analysis module gathers information that relates to the organisation's market competition and share in local, regional and global markets. In the case of PROTON, the market analysis is conducted for PROTON Marketing Sdn. Bhd., a wholly owned subsidiary of PROTON Holdings Bhd involved in marketing PROTON cars.

PROTON captured 29.7% of the local market share in 2007, which is a decline from 39.1% (2006) and 40.0% (2005). However, there is no exact percentage of regional and global market shares captured by PROTON, even though based on 2007 Annual Report [PROTON (2007)], export markets representing 20,528 units sold compared to the previous financial years' figures of 12,527 units (2006) and 17,234 units (2005). The inputs of performance for market competition and market share of PROTON is listed in Table 7.4.

Table 7.4: Inputs of *Market Analysis* for PROTON

Main Product: **Passenger Cars**			
Market Competition	**2007**	**2006**	**2005**
Local	5-20 companies	5-20 companies	5-20 companies
Regional	5-20 companies	5-20 companies	5-20 companies
Global	> 20 companies	> 20 companies	> 20 companies
Market Share	**2007**	**2006**	**2005**
Local	20-30%	30-40%	40-50%
Regional	No information	No information	No information
Global	No information	No information	No information
Additional information:	Local market: 88,635 units (2007) – 29.7%: 166,656 units (2006) – 39.1% Export market: 20,528 units (2007), 12,527 units (2006) *Financial year ended 31st March every year		

Based on the inputs given, Table 7.5 shows the output processed by the KBCLMM System.

Table 7.5: Output of *Market Analysis* for PROTON

		Trend	Remarks
Market Competition	Local	Steady for 3 years	
	Regional	Steady for 3 years	
	Global	Steady for 3 years	
Market Share	Local	Dropped	Need attention
	Regional	No information	Need to measure
	Global	No information	Need to measure

The KBCLMM concluded that PROTON has steady market competition for the last three years, either locally, regionally or globally. However, the KBCLMM spotted that the local market share for 2007 dropped from the previous years and no exact percentage figures for regional and global market shares. The reason is because the figures are relatively very small compared to the world total industry volume (TIV) of approximately 53 million cars a year [OICA (2007)]. In essence, the output from the KBCLMM indicates that PROTON has only focused to gain and maintain the local market share. Hence, the KB System suggests that the PROTON management to measure the regional and global market share, and expand the capability to compete regionally and globally.

In the *Financial Analysis* module, *Income Statement*, *Balance Sheet* and *Cash Flow Statement* are three financial reports used as inputs to calculate various financial ratios. These three reports are shown in Tables 7.6, 7.7 and 7.8 respectively.

Table 7.6: Income Statement of PROTON (Based on exchange rate of £1.00 = RM6.80)

INCOME STATEMENT	**2007 (in '000 £)**	**2006 (in '000 £)**	**2005 (in '000 £)**
Net Sales	722,330	1,146,608	1,247,543
Cost of goods sold	-668,755	-1,013,984	-1,044,484
Other expenses	-88,091	-77,474	-43,512
Depreciation	-51,897	-50,293	-45,945
Net Interest	-4,488	-2,212	1,088
Tax	4,205	4,178	4,430

Table 7.7: Balance Sheet of PROTON

BALANCE SHEET	**2007 (in '000 £)**	**2006 (in '000 £)**	**2005 (in '000 £)**
Current Assets			
Cash & short term securities	92,129	233,233	360,988
Receivables	149,405	175,372	204,408
Inventories	187,296	204,265	142,218
Other current assets	36,691	38,744	31,576
Long term assets			
Land, plant & equipment	467,565	487,198	487,258
Other long term assets	88,498	83,655	67,967
Current liabilities			
Short term debt	24,180	118,348	33,518
Payables	153,873	183,431	251,232
Other current liabilities	47,504	42,495	42,344
Long term liabilities			
Long term debt & capital leases	26,711	14,743	109,621
Other long term liabilities	111	118	158
Common shareholders' equity	769,204	863,331	857,540

Table 7.8: Cash Flow Statement of PROTON

CASH FLOW STATEMENT	**2007 (in '000 £)**	**2006 (in '000 £)**	**2005 (in '000 £)**
Net Cash Flow provided by operating activities	-14,205	-53,236	108,359
Net Cash used in investing activities	-40,146	-61,875	-201,114
Net Cash Flow provided by financing activities	20,789	-15,596	-35,416
Exchange rate effects	954	746	75
Cash and cash equivalent at beginning of year	101,940	231,901	359,996
Cash and cash equivalent at end of year	**69,632**	**101,940**	**231,900**

From the above three tables, the KBCLMM Model implements brief types of input for *Income Statement*, *Balance Sheet* and *Cash Flow Statement*

that most companies use practically, but is still able to accommodate a company's requirements for financial performance reports. Based on these data of *Income Statement*, *Balance Sheet*, and *Cash Flow Statement*, the KBCLMM uses its internal KB rules to produce the output shown in Table 7.9.

Table 7.9: Output of *Financial Analysis* for PROTON

FINANCIAL PERFORMANCE RESULTS	**2007**		**2006**		**2005**		**Trend**
	Ratio	Category	Ratio	Category	Ratio	Category	
Leverage Ratio							
Debt Ratio	0.03	Good	0.02	Good	0.11	Good	Fluctuated
Liquidity Ratio							
Current Ratio	2.06	Good	1.89	Good	2.26	Good	Fluctuated
Quick Ratio	1.07	Good	1.19	Good	1.73	Good	Decreased continuously
Profitability Ratio							
Net Profit Margin (%)	-12.00	Poor	0.60	Poor	9.55	Good	Decreased continuously
Sales to Total Assets	0.71	Fair	0.94	Good	0.96	Good	Decreased continuously
Inventory Turnover	1.71	Poor	2.93	Fair	4.03	Good	Decreased continuously
Return on Total Assets (%)	-8.49	Poor	0.56	Poor	9.20	Good	Decreased continuously
Return on Equity (%)	-11.27	Poor	0.79	Poor	13.89	Good	Decreased continuously
Cash Flow	£69.6 million		£101.9 million		£231.9 million		Decreased continuously
Profit Values							
Gross Profit	£53.6 million		£132.6 million		£203.1 million		Decreased continuously
Net Profit	- £86.7million		£6.8 million		£119.1 million		Decreased continuously

The KBCLMM has shown (Table 7.9) that PROTON has a fluctuated *Debt Ratio* in the last three years, but still maintain in *Good* category. In terms of *Current Ratio*, the performance has fluctuated but has tended to decrease in the last year relative to two years ago. For *Quick Ratio*, the performance decreased continuously from the previous years. The System has also indicated that the cash flow of PROTON in 2007 has dropped significantly from the previous years, which portrayed the financial problem of PROTON.

Table 7.9 present examples of various financial ratios calculated by the KBCLMM in terms of leverage, liquidity, and profitability. All the financial ratios are then to be classified into three categories: *Good, Fair,* or *Poor*. The System also presents the trend for the financial ratios for the last three years, to show whether they have improved or deteriorated.

Since PROTON did not make profit in 2007, it can be expected that the KBCLMM will not show good values for the profitability ratios. The System has shown that *Net Profit Margin* has decreased from 9.55% in 2005 to 0.6% in 2006 to -12% (loss) in 2007. *Sales to Total Assets Ratio* has decreased from 0.96 (2005) to 0.94 (2006) to 0.71 (2007). The same trends also happened to *Inventory Turnover*, *Return on Total Assets,* and *Return of Equity* ratios as depicted in Table 7.9. For all of these variables, the KBCLMM System provides indications of the trend in the last three years: in this case fluctuating or decreasing continuously, and from *Good* to *Poor* performance. In brief, the KBCLMM has concluded that PROTON's financial performance has worsened continuously over the period of last three years, with the worst scenario of £86.7 million net loss in 2007.

In summary, for the Level 1 of the KBCLMM, the System has found that market and financial performances of PROTON have dropped, which is the correct analysis, existing at PROTON. Thus, the KBCLMM concluded that PROTON needs to take actions to improve these two performances. These actions, in a way, are captured in Level 2 to Level 5.

7.2.3 Level 2 - Lean Manufacturing Perspective

The *Lean Manufacturing* Perspective module consists of three modules, which are *Product Design for Manufacture*, *Internal Lean Chain*, and *External Lean Chain* as shown in Figure 7.4.

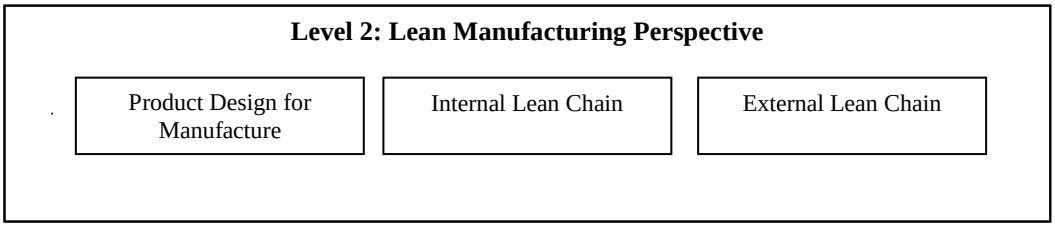

Figure 7.4: *Lean Manufacturing* Perspective

Table 7.10 shows the summarised GAP Analysis Results of *Lean Manufacturing Perspective*. It contains the total number of 165 questions that have been asked, the number of *Good Points* (GP) and the number of *Bad Points* (BP), along with their problem categories. In the GAP Analysis, only BP are categorised into Problem Categories, with the aim of identifying the missing pre-requisites that are needed in order to implement CLMM successfully.

Table 7.10: Summarised GAP Analysis Results of *Lean Manufacturing* Perspective for PROTON

Level 2: Lean Manufacturing Perspective	**No of Questions**	**GAP Analysis**						
		GP	BP	Problem Category				
				1	2	3	4	5
Product Design for Manufacture (PDfM)								
Conceptual Design	49	42	7	0	0	0	7	0
Design Tools for Analysis	19	19	0	0	0	0	0	0
Product Development	16	14	2	2	0	0	0	0
Total	**84**	**75**	**9**	**2**	**0**	**0**	**7**	**0**
Internal Lean Chain (ILC)								
Internal Continuous Improvement	31	28	3	1	0	0	2	0
Internal Process Control	18	13	5	5	0	0	0	0
Total	**49**	**41**	**8**	**6**	**0**	**0**	**2**	**0**
External Lean Chain (ELC)								
Integration with Suppliers	24	18	6	4	1	1	0	0
Integration with Customers	8	6	2	1	0	0	0	1
Total	**32**	**24**	**8**	**5**	**1**	**1**	**0**	**1**
Grand Total	**165**	**140**	**25**	**13**	**1**	**1**	**9**	**1**

In the *Product Design for Manufacture* (*PDfM*) module, the KBCLMM has identified many problems at *Conceptual Design* with seven from nine *Bad Points* being exactly there. However, all the problems are not serious problems since all of them are under PC4 whereas for *Product Development*, there are two PC1. In the *Internal Lean Chain* (*ILC*) module, the System has found five PC1 at *Internal Process Control*, which indicates the area needs immediate improvement. In the *External Lean Chain* (*ELC*) module, the KBCLMM has discovered that the major problem area is at *Integration with Suppliers* with six *Problem Categories* (four PC1, one PC2, and one PC3) out of eight *Bad Points*.

Based on the results of the GAP analysis, the KBCLMM System then processes the results using the AHP approach to determine which aspect should be in priority of improvement and how the weight of priority between *PDfM*, *ILC* and *ELC* should be determined. Tables 7.11 to 7.13 depict the priority vector values for each of the elements in each of the sub-modules, and Table 7.14 shows the priority vector values for *PDfM*, *ILC* and *ELC* based on the results of the GAP analysis.

Table 7.11: AHP Analysis with priority vector for *PDfM* module for PROTON

Aspect	Conceptual Design	Design Tools for Analysis	Product Development	Priority Vector
Conceptual Design	1	1	½	0.2680
Design Tools for Analysis	1	1	½	0.1946
Product Development	2	2	1	**0.5374**

Table 7.11 shows that the priority vector for *Conceptual Design* is 0.2680, *Design Tools for Analysis* is 0.1946, and *Product Development* is 0.5374. It means that based on the GAP analysis and AHP process embedded in the

system, for *PDfM*, PROTON should place its improvement priority firstly on the *Product Development*.

Table 7.12: AHP Analysis with priority vector for *ILC* module for PROTON

Aspect	Internal Continuous Improvement	Internal Process Control	Priority Vector
Internal Continuous Improvement	1	1/3	0.2500
Internal Process Control	3	1	**0.7500**

Table 7.12 shows that the priority vector for *Internal Continuous Improvement* is 0.25 and for *Internal Process Control* is 0.75. This means PROTON should place its improvement priority firstly on the *Internal Process Control* compared to *Internal Continuous Improvement* aspect.

Table 7.13: AHP Analysis with priority vector for *ELC* module for PROTON

Aspect	Integration with Suppliers	Integration with Customers	Priority Vector
Integration with Suppliers	1	2	**0.6667**
Integration with Customers	½	1	0.3333

Table 7.13 shows that the priority vector for *Integration with Suppliers* is 0.6667 and for *Integration with Customers* is 0.3333. This means PROTON should place its improvement priority firstly on *Integration with Suppliers* compared to *Integration with Customers*.

The same AHP process is then carried out at a higher level for *PDfM*, *ILC* and *ELC*. Table 7.14 shows that the priority vector for *PDfM* is 0.1638, for *ILC* is 0.2973, and for *ELC* is 0.5390. Based on the GAP analysis and AHP process embedded in the system, PROTON should place its improvement priority firstly on *ELC*, then *ILC* and lastly *PDfM*. Similar procedures of performance assessment are conducted for the other levels and will be discussed in the

following sections. The assessment results for the other organisations are shown in Appendix E.

Table 7.14: AHP Analysis with priority vector for Level 2: *Lean Manufacturing Perspective* for PROTON

Aspect	Product Design for Manufacture (PDfM)	Internal Lean Chain (ILC)	External Lean Chain (ELC)	Priority Vector
Product Design for Manufacture (PDfM)	1	½	1/3	0.1638
Internal Lean Chain (ILC)	2	1	½	0.2973
External Lean Chain (ELC)	3	2	1	**0.5390**

Based on the results from Tables 7.11 to 7.14, Table 7.15 provides the summary of the AHP Priority Vectors for each of the modules and sub-modules for Level 2. From Table 7.15, it can be seen that the KBCLMM System suggests that PROTON should focus firstly to improve the *External Lean Chain (ELC)* activity because of the highest Priority Vector of 0.5390. In the *ELC* itself, PROTON should place its improvement priority on the *Integration with Suppliers* elements (with Priority Vector of 0.6667).

Table 7.15: Summary of AHP Results for Level 2: *Lean Manufacturing* Perspective for PROTON

Level 2: Lean Manufacturing Perspective			
Module	**Priority Vector**	**Sub-module**	**Priority Vector**
Product Design for Manufacture (PDfM)	0.1638	Conceptual Design	0.2680
		Design Tools for Analysis	0.1946
		Product Development	**0.5374**
Internal Lean Chain (ILC)	0.2973	Internal Continuous Improvement	0.2500
		Internal Process Control	**0.7500**
External Lean Chain (ELC)	**0.5390**	Integration with Suppliers	**0.6667**
		Integration with Customers	0.3333

It can also be seen in Table 7.15 that the following suggestions by the KBCLMM System. PROTON then should focus to improve *Internal Lean*

Chain (ILC) activity (with Priority Vector of 0.2973) before committing the improvement program for *Product Design for Manufacture (PDfM)* activity (with Priority Vector of 0.1638). In the *ILC* activity, PROTON needs to focus more on *Internal Process Control* aspect (with Priority Vector of 0.75) compared to *Internal Continuous Improvement* aspect (with Priority Vector of 0.25). Lastly, in the *PDfM* activity, PROTON need to focus more on *Product Development* aspect (with Priority Vector of 0.5374) compared to both *Conceptual Design* (with Priority Vector of 0.2680) and *Design Tools for Analysis* aspects (with Priority Vectors of 0.1946).

In summary, for the Level 2 of the KBCLMM, the System has found the performance gap of 25 *Bad Points* from 165 questions asked. Thus, the KBCLMM concluded that PROTON needs to take actions to improve the lean manufacturing chain, especially the *Integration with Suppliers* element in *External Lean Chain* and collaboration in achieving CLMM. Thus the KBCLMM assists the decision-makers, in a prioritised way, to focus on the improvement needed to achieve a best practice standard for this module.

7.2.4 Level 3 - Organisation CLMM Capability - Competitive Priorities Perspective

The *Organisation CLMM Capability - Competitive Priorities* Perspective consists of five modules, which are *Quality*, *Time*, *Flexibility*, *Value* and *Supply Chain* as shown in Figure 7.5.

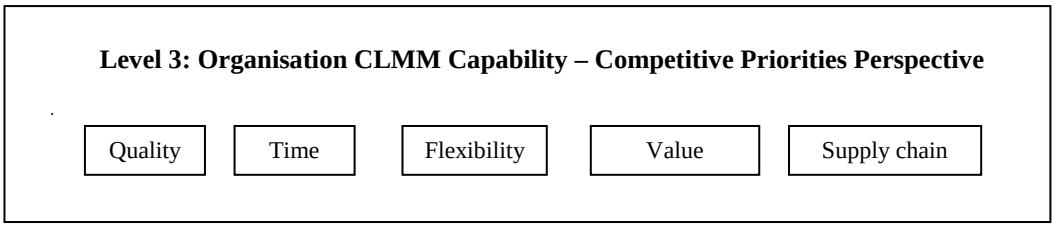

Figure 7.5: *Organisation CLMM Capability – Competitive Priorities* Perspective

Table 7.16 shows the summarised GAP Analysis Results of *Competitive Priorities* Perspective for PROTON. A total number of 154 questions have been asked in this module.

Table 7.16: Summarised GAP Analysis Results of *Competitive Priorities* Perspective for PROTON

Level 3: Organisation CLMM Capability - Competitive Priorities Perspective	**No of Questions**	**GAP Analysis**						
		GP	BP	Problem Category				
				1	2	3	4	5
Quality								
Quality in Supply	16	14	2	0	1	0	0	1
Quality in Production	20	14	6	3	1	1	0	1
Quality in Delivery	16	14	2	0	1	0	0	1
Total	**52**	**42**	**10**	**3**	**3**	**1**	**0**	**3**
Time								
Time in Supply	11	5	6	0	0	3	0	3
Time in Production	11	8	3	0	0	0	0	3
Time in Delivery	11	4	7	4	0	3	0	0
Total	**33**	**17**	**16**	**4**	**0**	**6**	**0**	**6**
Flexibility								
Flexibility in Supply	7	7	0	0	0	0	0	0
Flexibility in Production	15	12	3	3	0	0	0	0
Flexibility in Delivery	7	7	0	0	0	0	0	0
Total	**29**	**26**	**3**	**3**	**0**	**0**	**0**	**0**
Value								
Material cost	5	4	1	1	0	0	0	0
Production cost	10	8	2	2	0	0	0	0
Resources cost	10	5	5	2	0	3	0	0
Total	**25**	**17**	**8**	**5**	**0**	**3**	**0**	**0**
Supply Chain								
Location	7	7	0	0	0	0	0	0
Logistics	8	8	0	0	0	0	0	0
Total	**15**	**15**	**0**	**0**	**0**	**0**	**0**	**0**
Grand Total	**154**	**117**	**37**	**15**	**3**	**10**	**0**	**9**

In the *Quality* module, the KBCLMM has identified major problem area at *Quality in Production* with all three BP being PC1. In the *Time* module, *Time in Delivery* was found as the main problem area with seven BP (four PC1 and three PC3) out of 11 questions asked. The similar assessment by the System has also ascertained that *Flexibility in Production* (three PC1) is the most problematic area in *Flexibility* module and *Resources Cost* (five BP, with two PC1 and three PC3) in *Value* module. It should be pointed out that the KBCLMM found that in the *Supply Chain* module, all questions were satisfactorily answered. This indicates that the system concludes that PROTON has successfully adopted the best practice for supply chain activities.

The KBCLMM System then processes the GAP Analysis results using the AHP approach to determine which aspect should be in priority of improvement and how the weight of priority between *Quality*, *Time*, *Flexibility*, *Value* and *Supply Chain* should be determined. Tables 7.17 to 7.21 depict the priority vector values for each of elements (sub-modules) in each of the modules, and Table 7.22 shows the priority vector values for these modules.

Table 7.17: AHP Analysis with priority vector for *Quality* module for PROTON

Aspect	Quality in Supply	Quality in Production	Quality in Delivery	Priority Vector
Quality in Supply	1	2	½	0.2000
Quality in Production	3	1	3	**0.6000**
Quality in Delivery	1	1/3	1	0.2000

Table 7.17 shows that the priority vectors for *Quality in Supply* and *Quality in Delivery* are both 0.2 and for *Quality in Production* is 0.6. This means that based on the GAP Analysis and AHP embedded in the System, PROTON

should place its improvement priority firstly on *Quality in Production*. This need is triple as compared to each aspect of *Quality in Supply* and *Quality in Delivery*.

Table 7.18: AHP Analysis with priority vector for *Time* module for PROTON

Aspect	Time in Supply	Time in Production	Time in Delivery	Priority Vector
Time in Supply	1	2	¼	0.2014
Time in Production	½	1	1/5	0.1179
Time in Delivery	4	5	1	**0.6806**

Table 7.18 shows that the priority vector for *Time in Supply* is 0.2014, *Time in Production* is 0.1179, and *Time in Delivery* is 0.6806, suggesting that PROTON should place its improvement priority firstly on the *Time in Delivery*.

Table 7.19: AHP Analysis with priority vector for *Flexibility* module for PROTON

Aspect	Flexibility in Supply	Flexibility in Production	Flexibility in Delivery	Priority Vector
Flexibility in Supply	1	1/3	1	0.2000
Flexibility in Production	3	1	3	**0.6000**
Flexibility in Delivery	1	1/3	1	0.2000

Table 7.19 shows that the priority vectors for *Flexibility in Supply* and *Flexibility in Delivery* are both 0.2 and for *Flexibility in Production* is 0.6. The System concludes that PROTON should place its improvement priority firstly on *Flexibility in Production*. This need is three times as compared to each aspect of *Flexibility in Supply* and *Flexibility in Delivery*.

Table 7.20: AHP Analysis with priority vector for *Value* module for PROTON

Aspect	Material Cost	Production Cost	Resource Cost	Priority Vector
Material Cost	1	1	½	0.2500
Production Cost	1	1	½	0.2500
Resources Cost	2	2	1	**0.5000**

Table 7.20 shows that the priority vectors for *Material Cost* and *Production Cost* are both 0.25 and for *Resources Cost* is 0.5. The System concludes that PROTON should place its improvement priority firstly on *Resources Cost*.

Table 7.21: AHP Analysis with priority vector for *Supply Chain* module for PROTON

Aspect	Location	Logistics	Priority Vector
Location	1	1	0.5000
Logistics	1	1	0.5000

Table 7.21 shows that the priority vectors for both *Location* and *Logistics* are both 0.5, suggesting that PROTON should place its improvement as a similar priority for both aspects.

Finally, Table 7.22 shows that the priority vector for each of the modules: *Quality* (0.1246), *Time* (0.2519), *Flexibility* (0.1773), *Value* (0.3591), and *Supply Chain* (0.0870), concluding that PROTON should place its improvement priority firstly in this sequential order: *Value*, *Time*, *Flexibility*, *Quality*, and lastly *Supply Chain*. Similar procedures of performance assessment are conducted for the other organisations as shown in Appendix E.

Table 7.22: AHP Analysis with priority vector for *Competitive Priorities Perspective* for PROTON

Aspect	Quality	Time	Flexibility	Value	Supply Chain	Priority Vector
Quality	1	½	½	1/3	2	0.1246
Time	2	1	2	½	3	0.2519
Flexibility	2	½	1	½	2	0.1773
Value	3	2	2	1	3	**0.3591**
Supply Chain	½	1/3	1/2	1/3	1	0.0870

Based on the results from Tables 7.17 to 7.22, Table 7.23 provides the summary of the AHP Priority Vectors for each of the modules and sub-modules. The KBCLMM System suggests that PROTON should focus firstly to improve

the *Value* activity because of the highest Priority Vector of 0.3591. In the *Value* module itself, PROTON should place its improvement priority on the *Resources Cost* element (with Priority Vector of 0.5).

Table 7.23: Summary of AHP Results for Level 3: *Competitive Priorities* Perspective for PROTON

Level 3: Organisation CLMM Capability - Competitive Priorities Perspective			
Module	**Priority Vector**	**Sub-module**	**Priority Vector**
Quality	0.1246	Quality in Supply	0.2000
		Quality in Production	**0.6000**
		Quality in Delivery	0.2000
Time	0.2519	Time in Supply	0.2014
		Time in Production	0.1179
		Time in Delivery	**0.6806**
Flexibility	0.1773	Flexibility in Supply	0.2000
		Flexibility in Production	**0.6000**
		Flexibility in Delivery	0.2000
Value	**0.3591**	Material Cost	0.2500
		Production Cost	0.2500
		Resources Cost	**0.5000**
Supply Chain	0.0870	Location	0.5000
		Logistics	0.5000

Based on Table 7.23, the KBCLMM also gives the following suggestions. PROTON then should focus to improve *Time* activity (with Priority Vector of 0.2519) before committing the improvement program for *Flexibility, Quality, and Supply Chain.* In the *Time* activity, PROTON needs to focus more on *Time in Delivery* aspect (with Priority Vector of 0.6806). In the *Flexibility* activity, PROTON needs to focus more on *Flexibility in Production* aspect (with Priority Vector of 0.6). Also, in the *Quality* activity, PROTON needs to focus more on *Quality in Production* aspect (with Priority Vector of 0.6). Lastly, in the *Supply Chain* activity, PROTON needs to focus with same weigh for both *Location* and *Logistics* aspects (both with Priority Vectors of 0.5).

In summary, for the Level 3 of the KBCLMM, the System has found the performance gap of 37 *Bad Points* from 154 questions asked. Thus, the KBCLMM concluded that PROTON needs to take actions to improve the competitive priorities especially the *Resources Cost* element in *Value* module in achieving CLMM.

7.2.5 Level 4 - Organisation CLMM Capability - Resources Perspective

The *Organisation CLMM Capability – Resources* Perspective consists of three modules, which are *Human Resource*, *Technology Resource*, and *Financial Resource* as shown Figure 7.6.

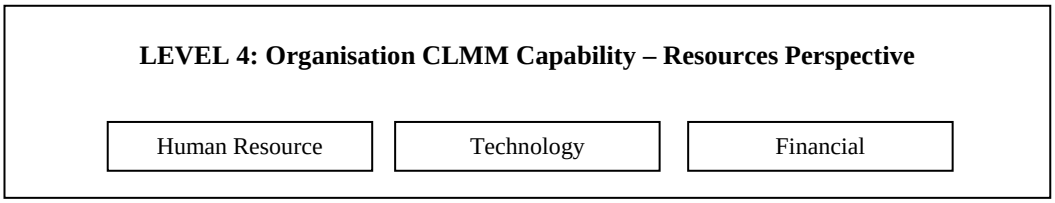

Figure 7.6: *Organisation CLMM Capability – Resources* Perspective

Table 7.24 shows the summarised GAP Analysis Results of *Resources* Perspective for PROTON. A total number of 106 questions have been asked in this module.

In the *Human Resource* module, the KBCLMM has identified major problem area at *Development* with all three *Bad Points* being there. In the *Technology Resource* module, *Information Technology* was found as the main problem area with six BP (five PC1 and one PC2) out of eight questions asked. The similar assessment by the System has also ascertained that *Financial for Human* (four BP) is the most problematic area in *Financial Resource* module.

Table 7.24: Summarised GAP Analysis Results of *Resources* Perspective for PROTON

Level 4: Organisation CLMM Capability - Resources Perspective	**No of Questions**	**GAP Analysis**						
		GP	BP	Problem Category				
				1	2	3	4	5
Human Resource								
Development	26	23	3	0	2	1	0	0
Support	14	14	0	0	0	0	0	0
Values	11	11	0	0	0	0	0	0
Sub-total	**51**	**48**	**3**	**0**	**2**	**1**	**0**	**0**
Technology Resource								
Technology Management	11	11	0	0	0	0	0	0
Process Technology	15	15	0	0	0	0	0	0
Information Technology	8	2	6	5	1	0	0	0
Sub-total	**34**	**28**	**6**	**5**	**1**	**0**	**0**	**0**
Financial Resource								
Financial for Human	9	5	4	0	0	0	4	0
Financial for Technology	9	7	2	0	0	0	2	0
Financial for Implementation	3	2	1	0	0	0	1	0
Sub-total	**21**	**14**	**7**	**0**	**0**	**0**	**7**	**0**
Grand Total	**106**	**90**	**16**	**5**	**3**	**1**	**7**	**0**

From the GAP analysis results, the AHP results are generated, to determine which aspect should be in priority of improvement and how the weight of priority between *Human Resource*, *Technology Resource*, and *Financial Resource* should be determined. Similar procedures of performance assessment which were described in the previous section are conducted for the AHP Analysis and only the summary is shown in Table 7.25.

Table 7.25: Summary of AHP Results for Level 4: *Resources Perspective* for PROTON

Level 4: Organisation CLMM Capability - Resources Perspective			
Module	**Priority Vector**	**Sub-module**	**Priority Vector**
Human Resource	0.1593	Development	**0.5000**
		Support	0.2500
		Values	0.2500
Technology Resource	**0.5889**	Technology Management	0.1111
		Process Technology	0.1111
		Information Technology	**0.7778**
Financial Resource	0.2519	Financial for Human	**0.4905**
		Financial for Technology	0.1976
		Financial for Implementation	0.3119

The KBCLMM System suggests that PROTON should focus firstly to improve the *Technology Resource* activity because of the highest Priority Vector of 0.5889. In the *Technology Resource* itself, PROTON should place its improvement priority on the *Information Technology* element (with Priority Vector of 0.7778). The System also gives the following suggestions: PROTON should then focus to improve *Financial Resource* activity (with Priority Vector of 0.2519) before committing the improvement program for *Human Resource.* In the *Financial Resource* activity, PROTON needs to focus more on *Financial for Human* aspect (with Priority Vector of 0.4905) while in the *Human Resource* activity, PROTON needs to focus more on the *Development* aspect (with Priority Vectors of 0.5).

In summary, for the Level 4 of the KBCLMM, the System has found the performance gap of 16 *Bad Points* from 106 questions asked. Thus, the KBCLMM concluded that PROTON needs to take actions to improve the resources especially the *Information Technology* element in *Technology Resource* sub-module in achieving CLMM.

7.2.6 Level 5 - Organisation CLMM Alignment – Process Perspective

The *Organisation CLMM Alignment - Process* Perspective consists of three modules, which are *Employee Involvement*, *Waste Elimination*, and *Continuous Improvement* as shown Figure 7.7.

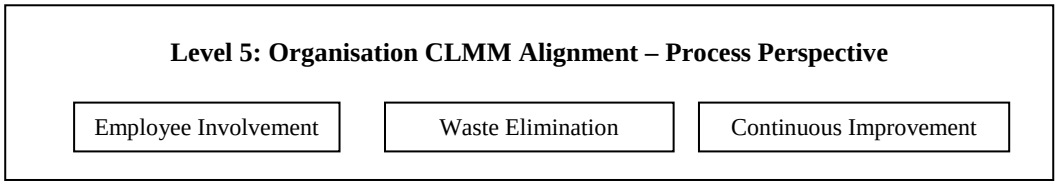

Figure 7.7: *Organisation CLMM Alignment - Process* Perspective

Table 7.26 shows the summarised GAP Analysis Results of *Organisation CLMM Alignment - Process* Perspective for PROTON. A total number of 47 questions have been asked in this module.

Table 7.26: Summarised GAP Analysis Results of *Organisation CLMM Alignment - Process* Perspective for PROTON

Level 5: Organisation CLMM Alignment - Process Perspective	**No of Questions**	**GAP Analysis**						
		GP	BP	Problem Category				
				1	2	3	4	5
Employee Involvement								
Measurement & benchmark	12	9	3	0	0	3	0	0
Evaluation, diagnosis & action	9	9	0	0	0	0	0	0
Sub-total	**21**	**18**	**3**	**0**	**0**	**3**	**0**	**0**
Waste Elimination								
Measurement & benchmark	7	6	1	0	1	0	0	0
Evaluation, diagnosis & action	4	3	1	0	1	0	0	0
Sub-total	**11**	**9**	**2**	**0**	**2**	**0**	**0**	**0**
Continuous Improvement								
Measurement & benchmark	12	12	0	0	0	0	0	0
Evaluation, diagnosis & action	3	2	1	0	1	0	0	0
Sub-total	**15**	**14**	**1**	**0**	**1**	**0**	**0**	**0**
Grand Total	**47**	**41**	**6**	**0**	**3**	**3**	**0**	**0**

In the *Employee Involvement* module, the KBCLMM has identified major problem activity at *Measurement & Benchmark* with all three *Bad Points* being there. Although in the *Waste Elimination* module, there is one PC2 each for *Measurement & Benchmark* and *Evaluation, Diagnosis & Action*, the latter is considered as the more problematic activity due to the percentage of BP out of the number of questions asked (one PC2 out of four questions asked). The similar assessment by the System has also ascertained that *Evaluation, Diagnosis & Action* (one PC2) is the problematic element in *Continuous Improvement* module.

The KBCLMM System then processes the GAP Analysis results using the AHP approach to determine which aspect should be in priority of

improvement and how the weight of priority between *Employee Involvement*, *Waste Elimination*, and *Continuous Improvement* should be determined. Table 7.27 provides the summary of the AHP Priority Vectors for each of the modules and sub-modules.

Table 7.27: Summary of AHP Results for Level 5: *Process Perspective* for PROTON

Level 5: Organisation CLMM Alignment - Process Perspective			
Module	**Priority Vector**	**Sub-module**	**Priority Vector**
Employee Involvement	0.1976	Measurement & Benchmark	**0.6667**
		Evaluation, Diagnosis & Action	0.3333
Waste Elimination	**0.4905**	Measurement & Benchmark	0.3333
		Evaluation, Diagnosis & Action	**0.6667**
Continuous Improvement	0.3119	Measurement & Benchmark	0.3333
		Evaluation, Diagnosis & Action	**0.6667**

The KBCLMM System suggests that PROTON should focus firstly to improve the *Waste Elimination* activity because of the highest Priority Vector of 0.4905. In the *Waste Elimination* itself, PROTON should place its improvement priority on the *Evaluation, Diagnosis & Action* element (with Priority Vector of 0.6667). The System also gives the following suggestions: PROTON should then focus to improve *Continuous Improvement* activity (with Priority Vector of 0.3333) before committing the improvement program for *Employee Involvement.* In the *Continuous Improvement* activity, PROTON needs to focus more on *Evaluation, Diagnosis & Action* aspect (with Priority Vector of 0.6667) while in the *Human Resource* activity, PROTON needs to focus more on the *Measurement & Benchmark* aspect (with Priority Vectors of 0.5).

In summary, in the Level 5 of the KBCLMM, the System has found the performance gaps of 6 *Bad Points* from 47 questions asked. Thus, the KBCLMM concluded that PROTON needs to take actions to improve the

process alignment especially the *Evaluation, Diagnosis & Action* element in *Waste Elimination* module in achieving CLMM.

7.3 Summary of Industrial Cases Validation

The previous discussion has focused on a detailed validation of the KBCLMM within PROTON. The following sections summarise the results analysis for PROTON as well as the other three industrial companies.

7.3.1 Summarised Analysis for PROTON

Table 7.28 shows the summary results of KBCLMM Model Verification and validation in terms of GAP Analysis for PROTON. Out of a total of 472 KB rules that were responded, 388 were *Good Points* and 84 were *Bad Points* (representing 18.6%). The number of *Bad Points* indicates the present performance gap of the organisation relative to the best practice standard contained in the model.

Table 7.28: Summarised GAP Analysis Results for PROTON

Perspective	**Module**	**No of Questions**	**GAP Analysis**						
			GP	BP	Problem Category				
					1	2	3	4	5
Level 2: Lean Manufacturing	Product Design for Manufacture	84	75	9	2	0	0	7	0
	Internal Lean Chain	49	41	8	6	0	0	2	0
	External Lean Chain	32	24	8	5	1	1	0	1
	Total	**165**	**140**	**25**	**13**	**1**	**1**	**9**	**1**
Level 3: Competitive Priorities	Quality	52	42	10	3	3	1	0	3
	Time	33	17	16	4	0	6	0	6
	Flexibility	29	26	3	3	0	0	0	0
	Value	25	17	8	5	0	3	0	0
	Supply Chain	15	15	0	0	0	0	0	0
	Total	**154**	**117**	**37**	**15**	**3**	**10**	**0**	**9**
Level 4: Resources	Human	51	48	3	0	2	1	0	0
	Technology	34	28	6	5	1	0	0	0
	Financial	21	14	7	0	0	0	7	0
	Total	**106**	**90**	**16**	**5**	**3**	**1**	**7**	**0**
Level 5: Process	Employee Involvement	21	18	3	0	0	3	0	0
	Waste Elimination	11	9	2	0	2	0	0	0
	Continuous Improvement	15	14	1	0	1	0	0	0
	Total	**47**	**41**	**6**	**0**	**3**	**3**	**0**	**0**
	Grand Total	**472**	**388**	**84**	**33**	**10**	**15**	**16**	**10**

Based on the detailed discussion in Section 7.2 and from Table 7.28, it can be seen that in the Level 2: *Lean Manufacturing* Perspective, 15.2% (25 out of 165) of the responses was *Bad Points*. In the other levels, the percentages of *Bad Points* are: 24.0% (37 out of 154) in the Level 3: *Competitive Priorities* Perspective, 15.1% (16 out of 106) in the Level 4: *Resources* Perspective, and 12.8% (6 out of 47) in the Level 5: *Process* Perspective.

Table 7.29 shows the summary results for the AHP Analysis in terms of *Priority Vector* values. From the results, KBCLMM acts as a decision support system to the organisation by showing the actions needed to be tackled in a prioritised order. It needs to be reiterated that if GAP Analysis provides the performance gaps of the organisations relative to the best practice for each activities within a module and a sub-module, then AHP provides the improvement initiative priorities across the modules and sub-modules. The bold figures show the priorities for each perspective. For example in the Level 2: *Lean Manufacturing* Perspective, PROTON needs to focus first on improving the *External Lean Chain* activities, and within this module it needs to focus on *Integration with Suppliers* sub-module. Furthermore, the GAP Analysis discussed earlier for this *Integration with Suppliers* sub-module has identified the key aspects which need to be overcome to achieve the duly best practice.

Table 7.29: Summary of AHP Priority Vector Values for PROTON

Perspective	Module	Priority Vector	Sub-Module (with Priority Vector)		
Level 2: Lean Manufacturing	Product Design for Manufacture	0.1638	Conceptual Design 0.2680	Design Tools for Analysis 0.1946	Product Development **0.5374**
	Internal Lean Chain	0.2973	Internal Continuous Improvement 0.2500		Internal Process Control **0.7500**
	External Lean Chain	**0.5390**	**Integration with Suppliers 0.6667**		Integration with Customers 0.3333
Level 3: Competitive Priorities	Quality	0.1246	Quality in Supply 0.2000	Quality in Production **0.6000**	Quality in Delivery 0.2000
	Time	0.2519	Time in Supply 0.2014	Time in Production 0.1179	Time in Delivery **0.6806**
	Flexibility	0.1773	Flexibility in Supply 0.2000	Flexibility in Production **0.6000**	Flexibility in Delivery 0.2000
	Value	**0.3591**	Material Cost 0.2500	Production Cost 0.2500	**Resource Cost 0.5000**
	Supply Chain	0.0870	Location 0.5000		Logistics 0.5000
Level 4: Resources	Human	0.1593	Development **0.5000**	Support 0.2500	Values 0.2500
	Technology	**0.5889**	Technology Management 0.1111	Process Technology 0.1111	**Information Technology 0.7778**
	Financial	0.2519	Financial for Human **0.4905**	Financial for Technology 0.1976	Financial for Implementation 0.3119
Level 5: Process	Employee Involvement	0.1976	Measurement & Benchmark **0.6667**		Evaluation, Diagnosis & Action 0.3333
	Waste Elimination	**0.4905**	Measurement & Benchmark 0.3333		**Evaluation, Diagnosis & Action 0.6667**
	Continuous Improvement	0.3119	Measurement & Benchmark 0.3333		Evaluation, Diagnosis & Action **0.6667**

Based on both AHP and GAP Analysis results provided by the KBCLMM, Figure 7.8 shows the summary of identified areas or activities that need priority improvement for PROTON. In Level 2, *External Lean Chain* is the module needs to be in the first priority for immediate improvement mainly *Integration with Suppliers* activity. For Level 3, PROTON needs to prioritise first on *Value* especially on *Resources Cost*.

In Level 4, PROTON needs to focus first on *Technology Resource* with special attention to *Information Technology*. Finally in Level 5, *Waste Elimination* module needs attention with priority on *Evaluation, Diagnosis & Action Plan* activity. Thus all the high level, mid level and low level modules can be analysed in a step-by-step, prioritised manner to improve the CLMM.

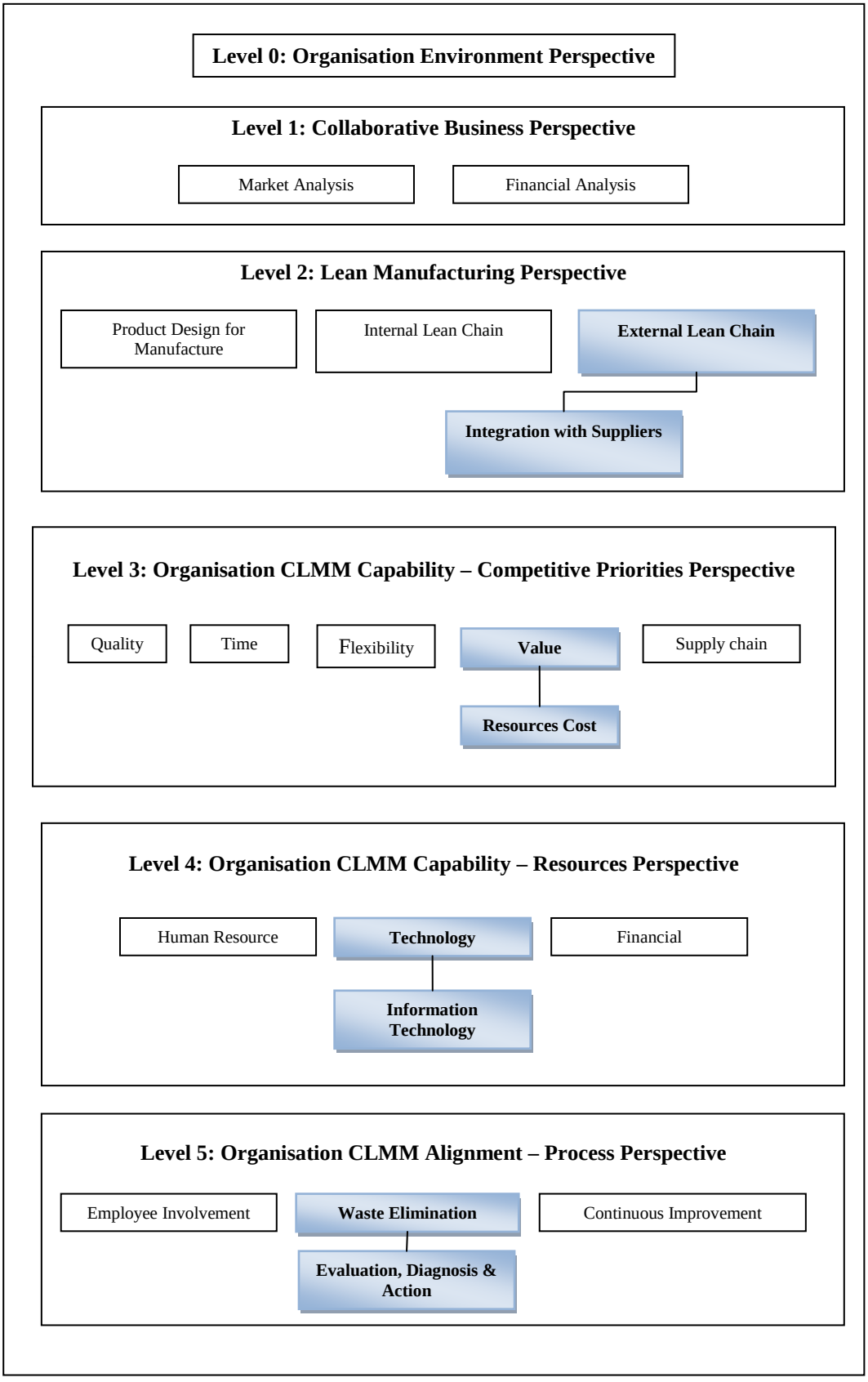

Figure 7.8: The Immediate Improvement Areas or Activities for PROTON Based on AHP/GAP Analysis Embedded in KBCLMM

7.3.2 Summarised Analysis for PERODUA

Based on the detailed inputs and outputs of GAP and AHP results for PERODUA as shown in Appendix E, the summary results of KBCLMM Model Verification and validation in terms of GAP Analysis are depicted in Table 7.30. There were 412 *Good Points* and 60 *Bad Points* (representing 12.7%) out of 472 KB rules that were responded. The number of *Bad Points* indicates the present performance gap of the organisation relative to the best practice standard contained in the model.

Table 7.30: Summarised GAP Analysis Results for PERODUA

Perspective	**Module**	**No of Questions**	**GAP Analysis**						
			GP	BP	Problem Category				
					1	2	3	4	5
Level 2: Lean Manufacturing	Product Design for Manufacture	84	66	18	0	2	7	9	0
	Internal Lean Chain	49	46	3	1	0	0	2	0
	External Lean Chain	32	29	3	1	1	1	0	0
	Total	**165**	**141**	**24**	**2**	**3**	**8**	**11**	**0**
Level 3: Competitive Priorities	Quality	52	50	2	0	0	0	2	0
	Time	33	17	16	1	0	4	5	6
	Flexibility	29	29	0	0	0	0	0	0
	Value	25	22	3	1	0	2	0	0
	Supply Chain	15	15	0	0	0	0	0	0
	Total	**154**	**133**	**21**	**2**	**0**	**6**	**7**	**6**
Level 4: Resources	Human	51	49	2	0	1	1	0	0
	Technology	34	28	6	6	0	0	0	0
	Financial	21	19	2	0	0	0	2	0
	Total	**106**	**96**	**10**	**6**	**1**	**1**	**2**	**0**
Level 5: Process	Employee Involvement	21	18	3	0	0	1	2	0
	Waste Elimination	11	10	1	0	1	0	0	0
	Continuous Improvement	15	14	1	0	1	0	0	0
	Total	**47**	**42**	**5**	**0**	**2**	**1**	**2**	**0**
	Grand Total	**472**	**412**	**60**	**10**	**6**	**16**	**22**	**6**

From Table 7.30, it can be seen that in the Level 2: *Lean Manufacturing* Perspective, 14.5% (24 out of 165) of the responses were *Bad Points*, but most of them are not categorised as serious problems (8 PC3 and 11 PC4). In the Level 3: *Competitive Priorities* Perspective, 13.6% (21 out of 154) of the responses were *Bad Points*, with 16 of them were from *Time* Module. The *Flexibility* and *Supply Chain* Modules were found to be fully in line with the best practice standard as there were no *Bad Points* responses in these modules.

It can also be seen in Table 7.30 that 10 out of 106 (representing 9.4%) responses in Level 4: *Resources* Perspective were *Bad Points*, with all 6 PC1 contained in *Technology* Module. Lastly in Level 5: *Process* Perspective, 10.6% (5 out of 47) of the responses were *Bad Points*, most of them contained in *Employee Involvement* Module. However, the problems were not as serious as problems found in the other two modules, *Waste Elimination* and *Continuous Improvement* Modules.

Table 7.31: Summary of AHP Priority Vector Values for PERODUA

Perspective	Module	Priority Vector	Sub-Module (with Priority Vector)		
Level 2: Lean Manufacturing	Product Design for Manufacture	0.3119	Conceptual Design 0.3119	Design Tools for Analysis 0.1976	Product Development **0.4905**
	Internal Lean Chain	0.1976	Internal Continuous Improvement 0.3333		Internal Process Control **0.6667**
	External Lean Chain	**0.4905**	**Integration with Suppliers 0.6667**		Integration with Customers 0.3333
Level 3: Competitive Priorities	Quality	0.1889	Quality in Supply **0.4000**	Quality in Production 0.2000	Quality in Delivery 0.4000
	Time	**0.3222**	Time in Supply 0.2973	Time in Production 0.1638	**Time in Delivery 0.5390**
	Flexibility	0.1222	Flexibility in Supply 0.3333	Flexibility in Production 0.3333	Flexibility in Delivery 0.3333
	Value	0.2444	Material Cost 0.1976	Production Cost **0.4905**	Resource Cost 0.3119
	Supply Chain	0.1222	Location 0.5000		Logistics 0.5000
Level 4: Resources	Human	0.2519	Development **0.5000**	Support 0.2500	Values 0.2500
	Technology	**0.5889**	Technology Management 0.1429	**Process Technology 0.7143**	Information Technology 0.1429
	Financial	0.1593	Financial for Human 0.2500	Financial for Technology **0.5000**	Financial for Implementation 0.2500
Level 5: Process	Employee Involvement	0.1976	Measurement & Benchmark **0.6667**		Evaluation, Diagnosis & Action 0.3333
	Waste Elimination	**0.4905**	Measurement & Benchmark 0.3333		**Evaluation, Diagnosis & Action 0.6667**
	Continuous Improvement	0.3119	Measurement & Benchmark 0.3333		Evaluation, Diagnosis & Action **0.6667**

Table 7.31 shows the summary results for the AHP Analysis in terms of *Priority Vector* values. The bold figures show the priorities for each perspective. In the Level 2: *Lean Manufacturing* Perspective, *External Lean Chain* is the module with highest *Priority Vector* value (0.4905), and within this module

Integration with Suppliers is the activity that PERODUA needs to focus (with highest *Priority Vector* value of 0.6667). PERODUA then should focus to improve *Product Design for Manufacture (PDfM)* activity (with Priority Vector of 0.3119) before committing the improvement program for *Internal Lean Chain (ILC)* activity (with Priority Vector of 0.1976). In the *PDfM* activity, PERODUA need to focus more on *Product Development* aspect (with Priority Vector of 0.4905) compared to both *Conceptual Design* (with Priority Vector of 0.3119) and *Design Tools for Analysis* aspects (with Priority Vectors of 0.1976). Lastly in the *ILC* activity, PERODUA needs to focus more on *Internal Process Control* aspect (with Priority Vector of 0.6667) compared to *Internal Continuous Improvement* aspect (with Priority Vector of 0.3333).

Similar to the discussion for Level 2, key results for the other levels with first priority module and sub-module are: Level 3: *Time* Module (0.3222) with *Time in Delivery* sub-module (0.5390), Level 4: *Technology Resource* Module (0.5889) with *Process Technology* sub-module (0.7143), and Level 5: *Waste Elimination* Module (0.4905) with *Evaluation, Diagnosis & Action* sub-module (0.6667).

Based on both AHP and GAP Analysis results provided by the KBCLMM, Figure 7.9 shows the summary of identified areas or activities that need priority improvement for PERODUA. In Level 2, *External Lean Chain* is the module needs to be in the first priority for immediate improvement mainly *Integration with Suppliers* activity. For Level 3, PERODUA needs to prioritise first on *Time* especially on *Time in Delivery*. In Level 4, PERODUA needs to focus first on *Technology Resource* with special attention to *Process Technology*.

Finally in Level 5, *Waste Elimination* module needs attention with priority on *Evaluation, Diagnosis & Action Plan* activity. Same as the analysis for PROTON in the previous section, all the high level, mid level and low level modules for PERODUA can be analysed in a step-by-step, prioritised manner to improve the CLMM.

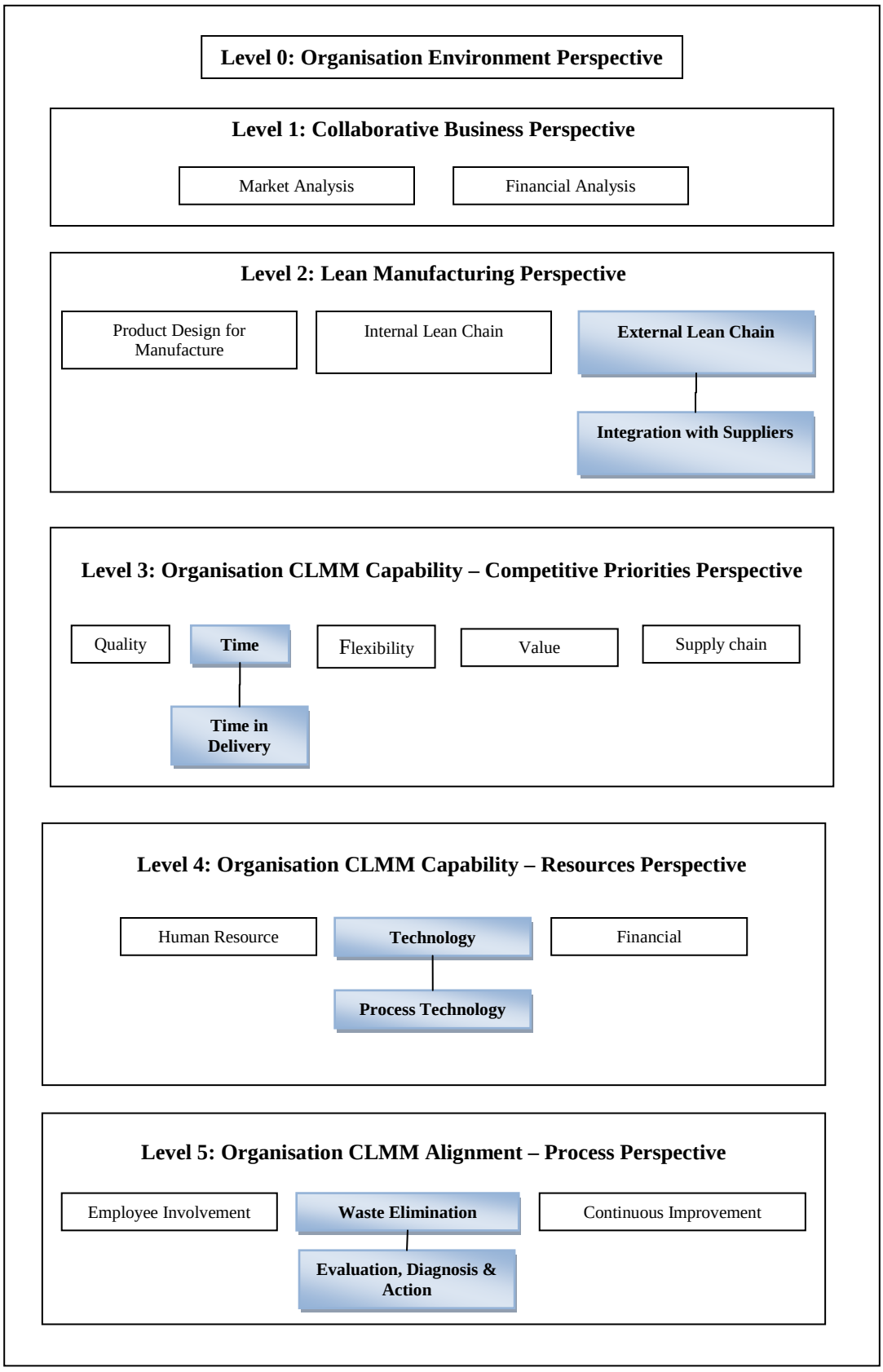

Figure 7.9: The Immediate Improvement Areas or Activities for PERODUA Based on AHP/GAP Analysis Embedded in KBCLMM

7.3.3 Summarised Analysis for PHN

Table 7.32 shows the summary results of KBCLMM Model Verification and validation in terms of GAP Analysis for PHN (The detail results are depicted in Appendix E). There were 368 *Good Points* and 96 *Bad Points* (representing 20.7%) out of 464 KB rules that were responded. The number of *Bad Points* indicates the present performance gap of the organisation relative to the best practice standard contained in the model.

Table 7.32: Summarised GAP Analysis Results for PHN

Perspective	**Module**	**No of Questions**	**GAP Analysis**						
			GP	BP	Problem Category				
					1	2	3	4	5
Level 2: Lean Manufacturing	Product Design for Manufacture	76	68	8	2	0	0	6	0
	Internal Lean Chain	49	40	9	7	0	0	2	0
	External Lean Chain	32	24	8	4	4	0	0	0
	Total	**157**	**132**	**25**	**13**	**4**	**0**	**8**	**0**
Level 3: Competitive Priorities	Quality	52	42	10	4	3	1	0	2
	Time	33	17	16	1	0	3	3	9
	Flexibility	29	22	7	5	0	2	0	0
	Value	25	21	4	1	0	3	0	0
	Supply Chain	15	15	0	0	0	0	0	0
	Total	**154**	**117**	**37**	**11**	**3**	**9**	**3**	**11**
Level 4: Resources	Human	51	43	8	1	5	2	0	0
	Technology	34	28	6	5	1	0	0	0
	Financial	21	9	12	0	0	8	4	0
	Total	**106**	**80**	**26**	**6**	**6**	**10**	**4**	**0**
Level 5: Process	Employee Involvement	21	17	4	0	0	4	0	0
	Waste Elimination	11	8	3	0	2	1	0	0
	Continuous Improvement	15	14	1	0	1	0	0	0
	Total	47	**39**	**8**	**0**	**3**	**5**	**0**	**0**
	Grand Total	**464**	**368**	**96**	**30**	**16**	**24**	**15**	**11**

Based on the results in the above table, for the Level 2: *Lean Manufacturing* Perspective, 15.9% (25 out of 157) of the responses were *Bad Points*, with most of them are categorised as serious problems (13 PC1 and 4 PC2) compared to only 8 PC4 (not serious problems). In the Level 3: *Competitive Priorities* Perspective, 24.0% (37 out of 154) of the responses were *Bad Points*, with 11 of them were PC1. The *Quality* and *Flexibility* Modules found to be in serious problems with 4 and 5 PC1 respectively.

It can also be seen in Table 7.32 that 26 out of 106 (representing 24.5%) responses in Level 4: *Resources* Perspective were *Bad Points*, with all 5 out of 6 PC1 were contained in *Technology* Module. Lastly in Level 5: *Process* Perspective, 17.0% (8 out of 47) of the responses were *Bad Points*, most of them contained in *Employee Involvement* Module. However, the problems were not as serious as problems found in the other two modules, *Waste Elimination* and *Continuous Improvement* Modules.

Table 7.33: Summary of AHP Priority Vector Values for PHN

Perspective	Module	Priority Vector	Sub-Module (with Priority Vector)		
Level 2: Lean Manufacturing	Product Design for Manufacture	0.1638	Conceptual Design 0.3119	Design Tools for Analysis 0.1976	Product Development **0.4905**
	Internal Lean Chain	0.2973	Internal Continuous Improvement 0.3333		Internal Process Control **0.6667**
	External Lean Chain	**0.5390**	**Integration with Suppliers 0.7500**		Integration with Customers 0.2500
Level 3: Competitive Priorities	Quality	0.2357	Quality in Supply 0.2000	Quality in Production **0.6000**	Quality in Delivery 0.2000
	Time	0.1274	Time in Supply 0.3119	Time in Production 0.1976	Time in Delivery **0.4905**
	Flexibility	**0.3611**	**Flexibility in Supply 0.5571**	Flexibility in Production 0.3202	Flexibility in Delivery 0.1226
	Value	0.1801	Material Cost 0.1976	Production Cost **0.4905**	Resource Cost 0.3119
	Supply Chain	0.0957	Location 0.5000		Logistics 0.5000
Level 4: Resources	Human	0.1976	Development 0.2973	Support 0.1638	Values **0.5390**
	Technology	**0.4905**	Technology Management 0.1111	Process Technology 0.1111	**Information Technology 0.7778**
	Financial	0.3119	Financial for Human 0.3119	Financial for Technology 0.1976	Financial for Implementation **0.4905**
Level 5: Process	Employee Involvement	0.3119	Measurement & Benchmark **0.6667**		Evaluation, Diagnosis & Action 0.3333
	Waste Elimination	**0.4905**	Measurement & Benchmark 0.3333		**Evaluation, Diagnosis & Action 0.6667**
	Continuous Improvement	0.1976	Measurement & Benchmark 0.3333		Evaluation, Diagnosis & Action **0.6667**

Table 7.33 shows the summary results for the AHP Analysis in terms of *Priority Vector* values. The bold figures show the priorities for each perspective. For example in the Level 3: *Competitive Priorities* Perspective, PHN needs to focus first on improving the *Flexibility* activities (0.3611), and within this

module it needs to focus on *Flexibility in Supply* sub-module (0.5571). For the other levels, key results with first priority module and sub-module are: Level 2: *External Lean Chain* Module (0.5390) with *Integration with Suppliers* sub-module (0.7500), Level 4: *Technology Resource* Module (0.4905) with *Information Technology* sub-module (0.7778), and Level 5: *Waste Elimination* Module (0.4905) with *Evaluation, Diagnosis & Action* sub-module (0.6667).

Based on both AHP and GAP Analysis results provided by the KBCLMM, Figure 7.10 shows the summary of identified areas or activities that need priority improvement for PHN. In Level 2, *External Lean Chain* is the module needs to be in the first priority for immediate improvement mainly *Integration with Suppliers* activity. For Level 3, PHN needs to prioritise first on *Flexibility* especially on *Flexibility in Supply*. In Level 4, PHN needs to focus first on *Technology Resource* with special attention to *Information Technology*. Finally in Level 5, *Waste Elimination* module needs attention with priority on *Evaluation, Diagnosis & Action Plan* activity. As the cases of PROTON and PERODUA, all the high level, mid level and low level modules can be analysed in a step-by-step, prioritised manner to improve the CLMM of PHN.

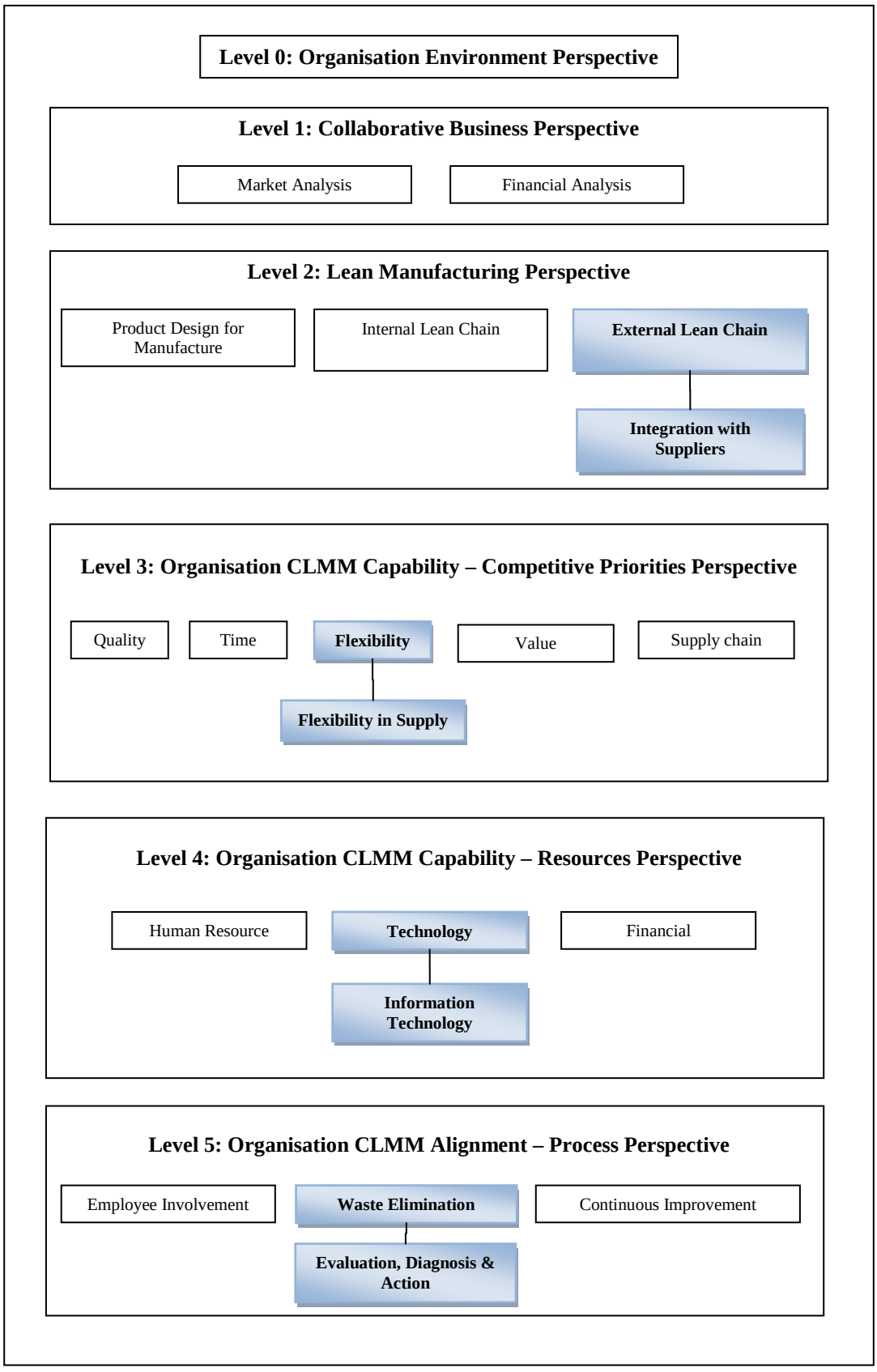

Figure 7.10: The Immediate Improvement Areas or Activities for PHN Based on AHP/GAP Analysis Embedded in KBCLMM

7.3.4 Summarised Analysis for PROFEN

Based on the detailed inputs and outputs of GAP and AHP results for PERODUA as depicted in Appendix E, the summary results of KBCLMM Model Verification and validation in terms of GAP Analysis are shown in Table 7.34. There were 304 *Good Points* and 160 *Bad Points* (representing 34.5%) out of 464 KB rules that were responded. This higher percentage of *Bad Points* (compared to previous three organisations) indicates the larger performance gap of the organisation relative to the best practice.

Table 7.34: Summarised GAP Analysis Results for PROFEN

Perspective	**Module**	**No of Questions**	**GAP Analysis**						
			GP	BP	Problem Category				
					1	2	3	4	5
Level 2: Lean Manufacturing	Product Design for Manufacture	76	66	10	2	0	0	8	0
	Internal Lean Chain	49	30	19	13	1	1	4	0
	External Lean Chain	32	22	10	3	7	0	0	0
	Total	**157**	**118**	**39**	**18**	**8**	**1**	**12**	**0**
Level 3: Competitive Priorities	Quality	52	32	20	10	4	2	4	0
	Time	33	14	19	9	4	4	2	0
	Flexibility	29	22	7	4	1	2	0	0
	Value	25	18	7	4	0	3	0	0
	Supply Chain	15	15	0	0	0	0	0	0
	Total	**154**	**101**	**53**	**27**	**9**	**11**	**6**	**0**
Level 4: Resources	Human	51	34	17	4	11	2	0	0
	Technology	34	19	15	14	1	0	0	0
	Financial	21	4	17	3	5	7	2	0
	Total	**106**	**57**	**49**	**21**	**17**	**9**	**2**	**0**
Level 5: Process	Employee Involvement	21	15	6	0	5	1	0	0
	Waste Elimination	11	4	7	2	4	1	0	0
	Continuous Improvement	15	9	6	4	2	0	0	0
	Total	47	**28**	**19**	**6**	**11**	**2**	**0**	**0**
	Grand Total	**464**	**304**	**160**	**72**	**45**	**23**	**20**	**0**

From Table 7.34, it can be seen that in the Level 2: *Lean Manufacturing* Perspective, 24.8% (39 out of 157) of the responses were *Bad Points*, with most of the PC1 (13 out of 18) are contained in the *Internal Lean Chain* Module. In the Level 3: *Competitive Priorities* Perspective, 34.4% (53 out of 154) of the responses were *Bad Points*, with most of the serious problems found in the *Quality* (10 PC1 and 4 PC2) and *Time* (9 PC1 and 4 PC2) Modules. In the Level 4: *Resources* Perspective, 49 out of 106 (representing 46.2%) were *Bad Points*,

with 14 PC1 were contained in *Technology* Module, compared to 4 PC1 in *Human* Module and 3 PC1 in *Financial* Module. Lastly in Level 5: *Process* Perspective, 40.4% (19 out of 47) of the responses were *Bad Points*, with 6 PC1, 11 PC2 and 2 PC3. This indicates that most of the *Bad Points* were considered as serious problems.

Table 7.35: Summary of AHP Priority Vector Values for PROFEN

Perspective	Module	Priority Vector	Sub-Module (with Priority Vector)		
Level 2: Lean Manufacturing	Product Design for Manufacture	0.1416	Conceptual Design 0.3119	Design Tools for Analysis 0.1976	Product Development **0.4905**
	Internal Lean Chain	**0.5247**	**Internal Continuous Improvement 0.7500**		Internal Process Control 0.2500
	External Lean Chain	0.3338	Integration with Suppliers **0.7500**		Integration with Customers 0.2500
Level 3: Competitive Priorities	Quality	0.2369	Quality in Supply 0.2000	Quality in Production **0.6000**	Quality in Delivery 0.2000
	Time	**0.3920**	**Time in Supply 0.5438**	Time in Production 0.1103	Time in Delivery 0.3460
	Flexibility	0.1322	Flexibility in Supply 0.1667	Flexibility in Production **0.6667**	Flexibility in Delivery 0.1667
	Value	0.1708	Material Cost 0.1226	Production Cost 0.3202	Resource Cost **0.5571**
	Supply Chain	0.0681	Location 0.5000		Logistics 0.5000
Level 4: Resources	Human	0.1199	Development 0.1373	Support **0.6232**	Values 0.2395
	Technology	**0.6080**	Technology Management 0.0703	Process Technology 0.3496	**Information Technology 0.5801**
	Financial	0.2721	Financial for Human 0.0812	Financial for Technology 0.1290	Financial for Implementation **0.7898**
Level 5: Process	Employee Involvement	0.1416	Measurement & Benchmark **0.6667**		Evaluation, Diagnosis & Action 0.3333
	Waste Elimination	**0.5247**	**Measurement & Benchmark 0.6667**		Evaluation, Diagnosis & Action 0.3333
	Continuous Improvement	0.3338	Measurement & Benchmark **0.6667**		Evaluation, Diagnosis & Action 0.3333

Table 7.35 shows the summary results for the AHP Analysis in terms of *Priority Vector* values. The bold figures show the priorities for each perspective. For example in the Level 5: *Process* Perspective, PROFEN needs to focus first on improving the *Waste Elimination* activities (0.5247), and within this module it needs to focus on the *Measurement & Benchmark* sub-module (0.6667). Similar to these, key results for the other levels with first priority module and sub-

module are: Level 2: *Internal Lean Chain* Module (0.5247) with *Internal Continuous Improvement* (0.7500), Level 3: *Time* Module (0.3920) with *Time in Supply* sub-module (0.5438), and Level 4: *Technology Resource* Module (0.6080) with *Information Technology* sub-module (0.5801).

Based on both AHP and GAP Analysis results provided by the KBCLMM, Figure 7.11 shows the summary of identified areas or activities that need priority improvement for PROFEN. In Level 2, *Internal Lean Chain* is the module needs to be in the first priority for immediate improvement mainly *Internal Continuous Improvement* activity. For Level 3, PROFEN needs to prioritise first on *Time* especially on *Time in Supply*. In Level 4, PROFEN needs to focus first on *Technology Resource* with special attention to *Information Technology*. Finally in Level 5, *Waste Elimination* module needs attention with priority on *Measurement & Benchmark* activity. Similar to the previous organisations' cases discussed in the previous sub-sections, all the high level, mid level and low level modules can be analysed in a step-by-step, prioritised manner to improve the CLMM of PROFEN.

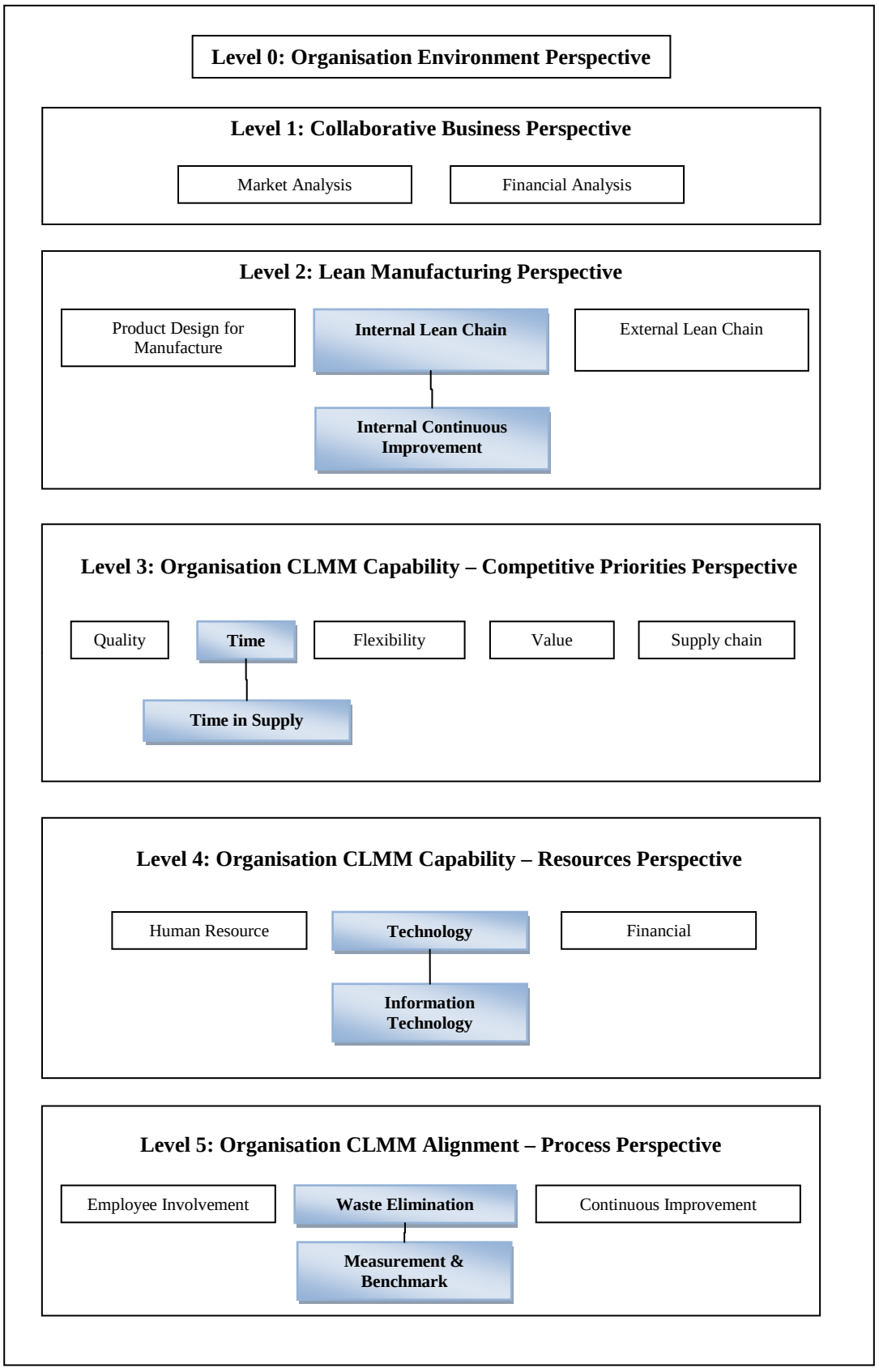

Figure 7.11: The Immediate Improvement Areas or Activities for PROFEN Based on AHP/GAP Analysis Embedded in KBCLMM

7.3.5 Lean Value Chain Gap in CLMM Identified by KBCLMM

In addition to the verification and validation through individual assessment for each of the organisations, lean value chain gap measurement in CLMM chain is also conducted. This assessment is important to identify activities in the CLMM that have potential opportunity for collaborative development. By performing this assessment, the results will show what the organisations' potential opportunity of their abilities compared to their partners' potential opportunity in the lean chain. In the KBCLMM, the questions and rules were designed in such a way that able to assess the gap between the organisation and its suppliers and customers. The summary of KBCLMM GAP Analysis results with lean value chain gap aspects are shown in Table 7.36.

From Table 7.36, the lean value chain gaps between PROTON and PERODUA (OEMs) and their suppliers can be evaluated. For example, in the *External Lean Chain* for *Integration with Suppliers* activities, there were 6 *Bad Points* (4 PC1, 1 PC2, and 1 PC3) discovered from the PROTON activities. However, in the suppliers' activities, the KBCLMM found that PHN and PROFEN have more serious problems (8 *Bad Points* with 4 PC1 and 4 PC2 for PHN and 9 *Bad Points* with 3 PC1 and 6 PC2 for PROFEN). This shows that there were some gaps between customer and suppliers which could obstruct the CLMM achievement. Both customer and suppliers need to consider the lean value chain gaps revealed by the KBCLMM System by working collaboratively to improve these activities.

Table 7.36: Summary of KBCLMM GAP Analysis for Modules and Sub-Modules with Lean Value Chain Gap Aspects

			PROTON								PERODUA								PHN								PROFEN							
Perspective	**Module**	**Sub-module**	NQ	GP	BP	PC1	PC2	PC3	PC4	PC5	NQ	GP	BP	PC1	PC2	PC3	PC4	PC5	NQ	GP	BP	PC1	PC2	PC3	PC4	PC5	NQ	GP	BP	PC1	PC2	PC3	PC4	PC5
Level 2: Lean Manufacturing	Product Design for Manufacture	Conceptual Design	49	42	7	0	0	0	7	0	49	33	16	0	0	7	9	0	41	35	6	0	0	0	6	0	41	33	8	0	0	0	8	0
		Design Tools for Analysis	19	19	0	0	0	0	0	0	19	19	0	0	0	0	0	0	19	19	0	0	0	0	0	0	19	19	0	0	0	0	0	0
		Product Development	16	14	2	2	0	0	0	0	16	14	2	0	2	0	0	0	16	14	2	2	0	0	0	0	16	14	2	2	0	0	0	0
		Sub-total	**84**	**75**	**9**	**2**	**0**	**0**	**7**	**0**	**84**	**66**	**18**	**0**	**2**	**7**	**9**	**0**	**76**	**68**	**8**	**2**	**0**	**0**	**6**	**0**	**76**	**66**	**10**	**2**	**0**	**0**	**8**	**0**
	Internal Lean Chain	Internal Continuous Improvement	31	28	3	1	0	0	2	0	31	29	2	0	0	0	2	0	31	26	5	3	0	0	2	0	31	16	15	10	0	1	4	0
		Internal Process Control	18	13	5	5	0	0	0	0	18	17	1	1	0	0	0	0	18	14	4	4	0	0	0	0	18	14	4	3	1	0	0	0
		Sub-total	**49**	**41**	**8**	**6**	**0**	**0**	**2**	**0**	**49**	**46**	**3**	**1**	**0**	**0**	**2**	**0**	**49**	**40**	**9**	**7**	**0**	**0**	**2**	**0**	**49**	**30**	**19**	**13**	**1**	**1**	**4**	**0**
	External Lean Chain	Integration with Suppliers	24	18	6	4	1	1	0	0	24	21	3	1	1	1	0	0	24	16	8	4	4	0	0	0	24	15	9	3	6	0	0	0
		Integration with Customers	8	6	2	1	0	0	0	1	8	8	0	0	0	0	0	0	8	8	0	0	0	0	0	0	8	7	1	0	1	0	0	0
		Sub-total	**32**	**24**	**8**	**5**	**1**	**1**	**0**	**1**	**32**	**29**	**3**	**1**	**1**	**1**	**0**	**0**	**32**	**24**	**8**	**4**	**4**	**0**	**0**	**0**	**32**	**22**	**10**	**3**	**7**	**0**	**0**	**0**
Level 3: Competitive Priorities	Quality	Quality in Supply	16	14	2	0	1	0	0	1	16	15	1	0	0	0	1	0	16	15	1	0	1	0	0	0	16	13	3	2	1	0	0	0
		Quality in Production	20	14	6	3	1	1	0	1	20	20	0	0	0	0	0	0	20	12	8	4	1	1	0	2	20	6	14	6	2	2	4	0
		Quality in Delivery	16	14	2	0	1	0	0	1	16	15	1	0	0	0	1	0	16	15	1	0	1	0	0	0	16	13	3	2	1	0	0	0
		Sub-total	**52**	**42**	**10**	**3**	**3**	**1**	**0**	**3**	**52**	**50**	**2**	**0**	**0**	**0**	**2**	**0**	**52**	**42**	**10**	**4**	**3**	**1**	**0**	**2**	**52**	**32**	**20**	**10**	**4**	**2**	**4**	**0**
	Time	Time in Supply	11	5	6	0	0	3	0	3	11	5	6	0	0	3	0	3	11	5	6	0	0	3	0	3	11	2	9	4	2	1	2	0
		Time in Production	11	8	3	0	0	0	0	3	11	8	3	0	0	0	0	3	11	8	3	0	0	0	0	3	11	8	3	1	2	0	0	0
		Time in Delivery	11	4	7	4	0	3	0	0	11	4	7	1	0	1	5	0	11	4	7	1	0	0	3	3	11	4	7	4	0	3	0	0
		Sub-total	**33**	**17**	**16**	**4**	**0**	**6**	**0**	**6**	**33**	**17**	**16**	**1**	**0**	**4**	**5**	**6**	**33**	**17**	**16**	**1**	**0**	**3**	**3**	**9**	**33**	**14**	**19**	**9**	**4**	**4**	**2**	**0**
	Flexibility	Flexibility in Supply	7	7	0	0	0	0	0	0	7	7	0	0	0	0	0	0	7	5	2	2	0	0	0	0	7	7	0	0	0	0	0	0
		Flexibility in Production	15	12	3	3	0	0	0	0	15	15	0	0	0	0	0	0	15	10	5	3	0	2	0	0	15	8	7	4	1	2	0	0
		Flexibility in Delivery	7	7	0	0	0	0	0	0	7	7	0	0	0	0	0	0	7	7	0	0	0	0	0	0	7	7	0	0	0	0	0	0
		Sub-total	**29**	**26**	**3**	**3**	**0**	**0**	**0**	**0**	**29**	**29**	**0**	**0**	**0**	**0**	**0**	**0**	**29**	**22**	**7**	**5**	**0**	**2**	**0**	**0**	**29**	**22**	**7**	**4**	**1**	**2**	**0**	**0**
	Value Chain	Material cost	5	4	1	1	0	0	0	0	5	5	0	0	0	0	0	0	5	5	0	0	0	0	0	0	5	5	0	0	0	0	0	0
		Production cost	10	8	2	2	0	0	0	0	10	9	1	1	0	0	0	0	10	9	1	1	0	0	0	0	10	8	2	2	0	0	0	0
		Resources cost	10	5	5	2	0	3	0	0	10	8	2	0	0	2	0	0	10	7	3	0	0	3	0	0	10	5	5	2	0	3	0	0
		Sub-total	**25**	**17**	**8**	**5**	**0**	**3**	**0**	**0**	**25**	**22**	**3**	**1**	**0**	**2**	**0**	**0**	**25**	**21**	**4**	**1**	**0**	**3**	**0**	**0**	**25**	**18**	**7**	**4**	**0**	**3**	**0**	**0**
	Supply Chain	Location	7	7	0	0	0	0	0	0	7	7	0	0	0	0	0	0	7	7	0	0	0	0	0	0	7	7	0	0	0	0	0	0
		Logistics	8	8	0	0	0	0	0	0	8	8	0	0	0	0	0	0	8	8	0	0	0	0	0	0	8	8	0	0	0	0	0	0
		Sub-total	**15**	**15**	**0**	**0**	**0**	**0**	**0**	**0**	**15**	**15**	**0**	**0**	**0**	**0**	**0**	**0**	**15**	**15**	**0**	**0**	**0**	**0**	**0**	**0**	**15**	**15**	**0**	**0**	**0**	**0**	**0**	**0**
Level 4: Resources	Human Resource	Development	26	23	3	0	2	1	0	0	26	24	2	0	1	1	0	0	26	21	5	0	3	2	0	0	26	21	5	0	3	2	0	0
		Support	14	14	0	0	0	0	0	0	14	14	0	0	0	0	0	0	14	14	0	0	0	0	0	0	14	5	9	3	6	0	0	0
		Values	11	11	0	0	0	0	0	0	11	11	0	0	0	0	0	0	11	8	3	1	2	0	0	0	11	8	3	1	2	0	0	0
		Sub-total	**51**	48	3	0	2	1	0	0	**51**	49	2	0	1	1	0	0	**51**	43	8	1	5	2	0	0	**51**	34	17	4	11	2	0	0
	Technology Resource	Technology Management	11	11	0	0	0	0	0	0	11	11	0	0	0	0	0	0	11	11	0	0	0	0	0	0	11	11	0	0	0	0	0	0
		Process Technology	15	15	0	0	0	0	0	0	15	9	6	6	0	0	0	0	15	15	0	0	0	0	0	0	15	6	9	9	0	0	0	0
		Information Technology	8	2	6	5	1	0	0	0	8	8	0	0	0	0	0	0	8	2	6	5	1	0	0	0	8	2	6	5	1	0	0	0
		Sub-total	**34**	28	6	5	1	0	0	0	**34**	28	6	6	0	0	0	0	**34**	28	6	5	1	0	0	0	**34**	19	15	14	1	0	0	0
	Financial Resource	Financial for Human	9	5	4	0	0	0	4	0	9	9	0	0	0	0	0	0	9	3	6	0	0	4	2	0	9	2	7	0	2	4	1	0
		Financial for Technology	9	7	2	0	0	0	2	0	9	7	2	0	0	0	2	0	9	6	3	0	0	2	1	0	9	2	7	0	3	3	1	0
		Financial for Impelementation	3	2	1	0	0	0	1	0	3	3	0	0	0	0	0	0	3	0	3	0	0	2	1	0	3	0	3	3	0	0	0	0
		Sub-total	**21**	14	7	0	0	0	7	0	**21**	19	2	0	0	0	2	0	**21**	9	12	0	0	8	4	0	**21**	4	17	3	5	7	2	0
Level 5: Process	Employee Involvement	Measurement & benchmark	12	9	3	0	0	3	0	0	12	9	3	0	0	1	2	0	12	8	4	0	0	4	0	0	12	7	5	0	4	1	0	0
		Evaluation, diagnosis & action	9	9	0	0	0	0	0	0	9	9	0	0	0	0	0	0	9	9	0	0	0	0	0	0	9	8	1	0	1	0	0	0
		Sub-total	**21**	18	3	0	0	3	0	0	**21**	18	3	0	0	1	2	0	**21**	17	4	0	0	4	0	0	**21**	15	6	0	5	1	0	0
	Waste Elimination	Measurement & benchmark	7	6	1	0	1	0	0	0	7	7	0	0	0	0	0	0	7	5	2	0	1	1	0	0	7	3	4	2	1	1	0	0
		Evaluation, diagnosis & action	4	3	1	0	1	0	0	0	4	3	1	0	1	0	0	0	4	3	1	0	1	0	0	0	4	1	3	0	3	0	0	0
		Sub-total	**11**	9	2	0	2	0	0	0	**11**	10	1	0	1	0	0	0	**11**	8	3	0	2	1	0	0	**11**	4	7	2	4	1	0	0
	Continuous Improvement	Measurement & benchmark	12	12	0	0	0	0	0	0	12	12	0	0	0	0	0	0	12	12	0	0	0	0	0	0	12	8	4	4	0	0	0	0
		Evaluation, diagnosis & action	3	2	1	0	1	0	0	0	3	2	1	0	1	0	0	0	3	2	1	0	1	0	0	0	3	1	2	0	2	0	0	0
		Sub-total	**15**	14	1	0	1	0	0	0	**15**	14	1	0	1	0	0	0	**15**	14	1	0	1	0	0	0	**15**	9	6	4	2	0	0	0
		TOTAL	**472**	388	84	33	10	15	16	10	**472**	412	60	10	6	16	22	6	**464**	368	96	30	16	24	15	11	**464**	304	160	72	45	23	20	0

It also can be seen in Table 7.36 that in the *Flexibility in Supply* activities in Level 3: *Competitive Priorities* Module, the KBCLMM System reveals that both PROTON-PHN-PROFEN and PERODUA-PHN-PROFEN chains could work collaboratively in improving the activities of *Flexibility in Supply* of PHN (2 Bad Points with both 2 PC1), since the other organisations' activities were satisfactorily up to the best practice with all 100% *Good Points* achieved. The System also found that in the Level 4: *Resources* Perspective, PHN (with all *Good Points* responses for *Process Technology* sub-module) could assist its costumer PERODUA (with 6 PC1) and its supplier PROFEN (with 9 PC1) in improving the area of *Process Technology*. On the other hand, PERODUA could provide its assistance in *Information Technology* area (with 100% *Good Points*) to both of its suppliers, PHN and PROFEN (with 5 PC1 and 1 PC2 respectively). As a result, the organisations in the lean chain could work and help each other in collaborative way and this win-win situation will improve their CLMM activities in achieving the best practice standard.

As a final example, in the Level 5: *Process* Perspective, the KBCLMM System found that in the *Waste Elimination* Module, there were more *Bad Points* for PROFEN (2 PC1, 1 PC2, and 1 PC3) in *Measurement & Benchmark* activities compared to its customers, PHN (1 PC2 and 1 PC3), PROTON (1 PC2), and PERODUA (no *Bad Points*). This indicates that either PROTON-PHN-PROFEN chain or PERODUA-PHN-PROFEN chain could collaboratively work especially to improve the PROFEN *Measurement & Benchmark* activities for *Waste Elimination* Module. In essence, the KBCLMM provides not only the assessment individually but also the lean value chain gaps measurement between the organisations involved in the CLMM.

Table 7.37: Summary of KBCLMM AHP Analysis for All Organisations under Study

	PROTON		**PERODUA**		**PHN**		**PROFEN**	
	Module (PV)	**Sub-module (PV)**	**Module (PV)**	**Sub-module (PV)**	**Module (PV)**	**Sub-module (PV)**	**Module (PV)**	**Sub-module (PV)**
Level 2: Lean Manufacturing	External Lean Chain (0.5390)	Integration with Suppliers (0.6667)	External Lean Chain (0.4905)	Integration with Suppliers (0.6667)	External Lean Chain (0.5390)	Integration with Suppliers (0.7500)	Internal Lean Chain (0.5247)	Internal Continuous Improvement (0.7500)
Level 3: Competitive Priorities	Value (0.3591)	Resource Cost (0.5000)	Time (0.3222)	Time in Delivery (0.5390)	Flexibility (0.3611)	Flexibility in Supply (0.5571)	Time (0.3920)	Time in Supply (0.5438)
Level 4: Resources	Technology (0.5889)	Information Technology (0.7778)	Technology (0.5889)	Process Technology (0.7143)	Technology (0.4905)	Information Technology (0.7778)	Technology (0.6080)	Information Technology (0.5801)
Level 5: Process	Waste Elimination (0.4905)	Evaluation, Diagnosis & Action (0.6667)	Waste Elimination (0.4905)	Evaluation, Diagnosis & Action (0.6667)	Waste Elimination (0.4905)	Evaluation, Diagnosis & Action (0.6667)	Waste Elimination (0.5247)	Measurement & Benchmark (0.6667)

From the summary of GAP Analysis, Table 7.37 provides the AHP results for the all four organisations involved. It can be seen that in the Level 2: *Lean Manufacturing* Perspective, the KBCLMM System suggests that all organisations but PROFEN need to focus on *External Lean Chain* for improvement, and within this module they need to give more attention on the *Integration with Suppliers* activities. For PROFEN, it needs to focus on *Internal Lean Chain* (with Priority Vector of 0.5247) with more attention on the *Internal Continuous Improvement* aspects.

In the Level 3: *Competitive Priorities* Perspective, *Time* Module scored the highest Priority Vector values for PERODUA and PROFEN (0.3222 and 0.3920 respectively). However, the System suggests that PERODUA needs to focus more on *Time in Delivery* (0.5390) activities whereas PROFEN on *Time in Supply* (0.5438) activities. At the same time, the System also suggests that PROTON needs to focus on *Value* Module, with attention on *Resource Cost* aspects whilst PHN to focus on *Flexibility* Module, with more consideration in *Flexibility in Supply* activities.

It can also be seen in Table 7.37, in the Level 4: *Resource* Perspective, it was realised that the KBCLMM System found that all four organisations shared the same highest Priority Vector for the *Technology* Module, and within this module they need to focus on the *Information Technology* sub-module except PERODUA which need to focus more on the *Process Technology* sub-module. This means that PROTON, PHN, and PROFEN should work collaboratively with minimum obstruction to improve their information technology aspects. Finally, in the Level 5: *Process* Perspective, the KBCLMM System suggests that all four

organisations to focus first on improving the *Waste Elimination* Module, and within this module they need to focus on *Evaluation, Diagnosis & Action* activities excluding PROFEN which need to focus more on *Measurement & Benchmark* activities. In summary, the KBCLMM provides the suggestions for the organisations involved in this study to choose the area which need to be prioritised in the improvement programs.

7.4 Validation of KBCLMM Model – Published Case Study Data

In addition to industrial case studies, two published case studies are also used to validate the KBCLMM Model. Using the published case studies, only the analytical problem solving accuracy of the system is checked with the results of the case studies. Each case study is briefly described and summarised in the following sub-sections.

7.4.1 Market Analysis Module

Reports regarding Toyota Motor Corporation (TOYOTA) market analysis from various sources [Greimel (2006), TOYOTA (2007), JAMA (2008)] are studied. The inputs of performance for market competition and market share of TOYOTA is listed in Table 7.38, where it can be seen that TOYOTA has steady market competition for the last three years, either locally, regionally or globally. There are no exact percentage figures for regional market share, although the total unit sales for Asia region (excluding Japan and Middle East) are 1.33 million in 2006. As the world leader in automotive industry, TOYOTA has sold 8.43 million units of vehicles worldwide in 2007.

Table 7.38: Inputs of *Market Analysis* for TOYOTA

Main Product: **Passenger Cars**			
Market Competition	**2007**	**2006**	**2005**
Local (Japan)	10 -20 companies	10 -20 companies	10 -20 companies
Regional (Asia)	> 20 companies	> 20 companies	> 20 companies
Global	> 20 companies	> 20 companies	> 20 companies
Market Share	**2007**	**2006**	**2005**
Local	40-50%	40-50%	40-50%
Regional (Asia)	No exact information	No exact information	No exact information
Global	10-20%	10-20%	10-20%
Additional information:	Global market: 8.43 million units sold (2007), 7.92 million (2006), and 7.27 million (2005) 6.4% increase (last year), 8.9% increase (two years ago)		

Based on the inputs given, the KBCLMM concluded that TOYOTA has steady market competition for the last three years, either locally, regionally or globally, as shown in Table 7.39.

Table 7.39: Output of *Market Analysis* for PROTON

		Trend	**Remarks**
Market Competition	Local	Steady for 3 years	
	Regional	Steady for 3 years	
	Global	Steady for 3 years	
Market Share	Local	Steady for 3 years	Sales Increased
	Regional	No information	
	Global	Steady for 3 years	Sales Increased

Although the number of TOYOTA cars sold increases for three consecutive years, the KBCLMM found that the market share for the last three years, are still stable for both local (40-50%) and global (10-20%). In essence, the output from the KBCLMM indicates that TOYOTA proved to one of the major automotive car manufacturer in term of the market share.

7.4.2 Financial Analysis Module

Many financial reports published in the financial textbooks can be used as a case study [Wibisono (2003), Udin (2004)]. However, in this study, the

financial report of Toyota Motor Corporation (TOYOTA) that was published in its 2007 Annual Report [TOYOTA (2007)] is used to validate the *Financial Analysis* module. The reasons are because Toyota is the largest automobile manufacturers in the world, and considered as pioneer of Lean Manufacturing.

Based on the reports of *Income Statement*, *Balance Sheet*, and *Cash Flow Statement* and using the KB system embedded in the system, the KBCLMM System then analyses the company performance financially. These three reports are shown in Table 7.40, Table 7.41, and Table 7.42 respectively.

Table 7.40: Income Statement of TOYOTA (Based on exchange rate of £1.00 = ¥222)

INCOME STATEMENT	**2007 (in '000 £)**	**2006 (in '000 £)**	**2005 (in '000 £)**
Net Sales	107,874,284	94,760,851	83,565,432
Cost of goods sold	- 82,685,833	- 73,582,486	- 65,316,585
Other expenses	- 8,876,392	- 7,261,608	- 6,222,270
Depreciation	- 6,227,901	- 5,455,757	- 4,494,203
Net Interest	1,367,842	1,301,761	707,131
Tax	- 4,046,450	- 3,581,770	- 2,963,559

Table 7.41: Balance Sheet of TOYOTA (Based on exchange rate of £1.00 = ¥222)

BALANCE SHEET	**2007 (in '000 £)**	**2006 (in '000 £)**	**2005 (in '000 £)**
Current Assets			
Cash & short term securities	10,521,811	9,929,126	9,130,077
Receivables	29,488,068	26,551,059	22,816,000
Inventories	8,125,928	7,301,689	5,886,077
Other current assets	4,945,829	4,574,982	4,690,842
Long term assets			
Land, plant & equipment	36,308,644	31,831,658	26,106,279
Other long term assets	57,342,959	49,233,086	40,987,892
Current liabilities			
Short term debt	15,754,014	13,662,248	10,728,950
Payables	13,599,401	12,688,158	11,485,766
Other current liabilities	23,651,856	18,824,077	14,844,770
Long term liabilities			
Long term debt & capital leases	28,785,077	26,035,667	22,969,671
Other long term liabilities	8,797,234	7,986,095	6,570,536
Common shareholders' equity	56,145,658	50,225,356	43,017,473

From these three tables, it can be seen that the KBCLMM Model uses brief types of input for *Income Statement*, *Balance Sheet* and *Cash Flow Statement* that most companies use practically, but is still able to accommodate a company's requirements for financial performance reports. It can be seen in Table 7.42 that the cash flow of TOYOTA in 2007 has increased continuously from the previous years.

Table 7.42: Cash Flow Statement of TOYOTA (Based on exchange rate of £1.00 = ¥222)

CASH FLOW STATEMENT	**2007 (in '000 £)**	**2006 (in '000 £)**	**2005 (in '000 £)**
Net Cash Flow provided by operating activities	14,586,365	11,330,991	10,679,910
Net Cash used in investing activities	- 17,181,883	- 15,204,955	- 13,789,171
Net Cash Flow provided by financing activities	3,971,928	3,950,050	1,889,117
Exchange rate effects	114,545	309,653	111,932
Cash and cash equivalent at beginning of year	7,069,311	6,683,572	7,791,784
Cash and cash equivalent at end of year	**8,560,266**	**7,069,311**	**6,683,572**

Based on these data of *Income Statement* and *Balance Sheet*, the KB system uses its internal rules to produce the output shown in Table 7.43, which present examples of various financial ratios of TOYOTA in terms of leverage, liquidity, and profitability. All the financial ratios are then to be classified into three categories: *Good, Fair,* or *Poor* based on the KB embedded in the systems. The System also presents the trend for the financial ratios for the last three years, to show whether they have improved or deteriorated.

From Table 7.43, the KBCLMM has identified the following performances. TOYOTA has steady *Debt Ratio* in the last three years, and in *Good* category. In terms of *Current Ratio* and *Quick Ratio*, the performances have decreased continuously from the previous years. For the profitability ratios, *Net Profit Margin* has increased from 6.31% in 2005 to 6.52% in 2006 to 6.86%

in 2007. *Sales to Total Assets Ratio* has fluctuated from 0.76 (2005) to 0.73 (2006) to 0.74 (2007). For the *Inventory Turnover*, the performance has decreased continuously but still maintain in *Good* category. For the *Return on Total Assets* and *Return of Equity* ratios, TOYOTA performances are continuously in *Good* category, with *Net Profit* of £7.4 billion in 2007, an increased of almost 20% from £6.2 billion in 2006.

Table 7.43: Output of *Financial Analysis* for TOYOTA

PERFORMANCE RESULTS	**2007**		**2006**		**2005**		**Trend**
	Ratio	Category	Ratio	Category	Ratio	Category	
Leverage Ratio							
Debt Ratio	0.34	Good	0.34	Good	0.35	Good	Steady
Liquidity Ratio							
Current Ratio	1.00	Fair	1.07	Fair	1.15	Fair	Decreased continuously
Quick Ratio	0.75	Fair	0.81	Fair	0.86	Fair	Decreased continuously
Profitability Ratio							
Net Profit Margin (%)	6.86	Good	6.52	Good	6.31	Good	Increased continuously
Sales to Total Assets	0.74	Fair	0.73	Fair	0.76	Fair	Fluctuated
Inventory Turnover	5.36	Good	5.58	Good	6.07	Good	Decreased continuously
Return on Total Assets (%)	5.05	Good	4.78	Good	4.81	Good	Fluctuated
Return on Equity (%)	13.19	Good	12.31	Good	12.26	Good	Increased continuously
Profit Values							
Gross Profit	£25,188 million		£21,178 million		£18,249 million		Increased continuously
Net Profit	£7,406 million		£6,181 million		£5,276 million		Increased continuously

For all of these variables, the KBCLMM system provides indications of the trend in the last three years: in this case either steady, fluctuated or increased/decreased continuously, and from *Good* to *Poor* performance. In summary, the KBCLMM concluded that TOYOTA's financial performance has improved continuously over the period of last three years.

7.4.3 Summary of Published Case Studies

The *Market Analysis* and *Financial Analysis Module* of the KBCLMM are the modules in this model that can be validated completely. This is because the *Market Share, Income Statement, Balance Sheet,* and *Cash Flow Statement* as basic information needed in this module are standardised and readily available from the organisation's annual report.

The validation using published case study data also proved that the system worked as intended and the KB embedded in the system is valid since the performance given by the KBCLMM System gave the same results as the published ones for *Financial Analysis*.

7.5 Summary

The KBCLMM model is validated through four industrial case studies and two published case studies. The purpose of the verification and validation is to ensure that the KBCLMM Model arrived at a decision like human expert while analysing with the real industrial and published case studies information, produce the correct solution, and do not give any error. This chapter has described the details of verification and validation of all the modules in the KBCLMM Model. The results of both industrial and published case studies confirm the validity of the developed system for CLMM in automotive industry environment. One of the industrial case studies, PROTON was discussed in detail to show the KBCLMM capabilities, where the other three industrial case studies were summarised. The results of the GAP and AHP analysis were discussed in detailed, indicating how each could be used to provide internal (to specific module) and external (between modules) priorities for change. The

detail results of other organisation are given in the Appendix E while the summarised results were discussed in this Chapter.

From the verification and validation analysis results, it was found that in the Level 2: *Lean Manufacturing* Perspective, the KBCLMM System suggested that PROFEN needs to focus on *Internal Continuous Improvement* aspects in *Internal Lean Chain* Module while other organisations to focus on the *Integration with Suppliers* activities within the *External Lean Chain* Module. In the Level 3: the System suggested that PERODUA needs to focus more on *Time in Delivery* activities, PROFEN on *Time in Supply* activities, PROTON on *Resource Cost* aspects whilst PHN on *Flexibility in Supply* activities. It was also found that in the Level 4: *Resource* Perspective, the KBCLMM System suggested that all four organisations to focus on the *Technology Resource* Module. Finally, it was found that in the Level 5: *Process* Perspective, the KBCLMM System suggested that all four organisations to focus first on improving the *Waste Elimination* activities.