CHAPTER 6

DEVELOPMENT OF KNOWLEDGE BASED LOW VOLUME AUTOMOTIVE MANUFACTURING (KBLVAM) MODEL: STAGE 1 (PLANNING)

6.1   Introduction

This chapter focuses on the detailed development of the KBLVAM Model for the Stage 1 as shown in Figure 6.1. It explains all levels in the Planning Stage (Strategic Level) of the structure of the KBLVAM System as described in Chapter 5. It involves capturing the specific requirements for each module in term of knowledge rules and their knowledge structure for the KB System. The flowcharts and KB rules are developed based on literature review, industry experts, supervisors and books (so called knowledge acquisition). These KB rules are then re-formatted and structured into a series of KB questions within the Expert System.
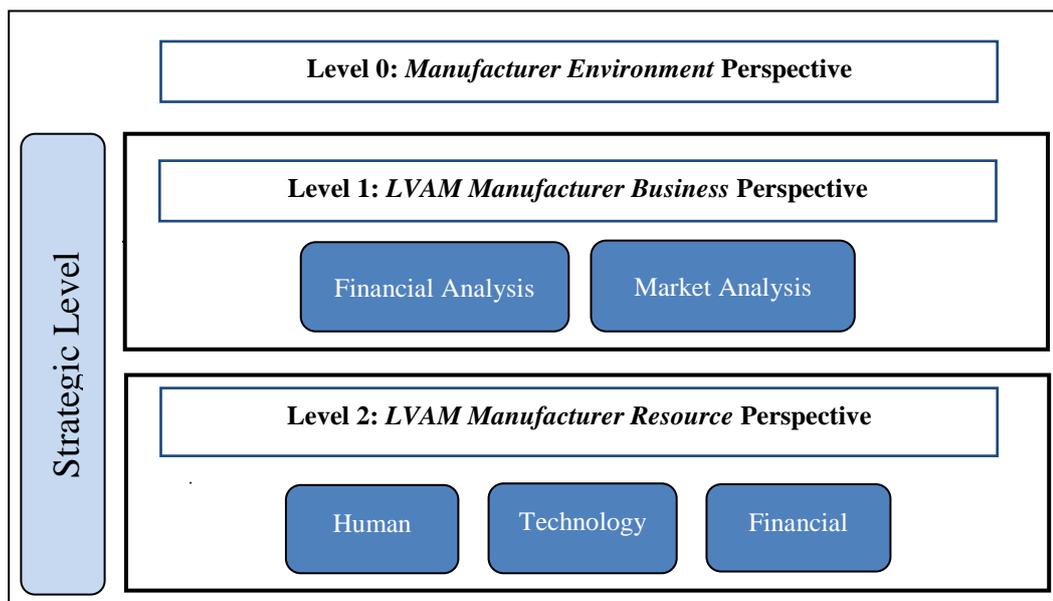

Figure 6.1: Structure of KBLVAM – Stage 1

Thus, the KBLVAM System provides a series of KB question that requires the user to give the relevant manufacturer's input related to the KB questions. These questions measure both qualitative and quantitative information on the manufacturer's existing environment for all levels of the developed KBLVAM System through a Gauging Absences of Pre-requisites (GAP) analysis. This embedded analysis and the Analytic Hierarchy Process (AHP) is then applied to determine the priorities and identify factors from every perspective for performance improvement towards KBLVAM development and implementation to a benchmark standard.

The KBLVAM System also provides detailed explanations to the specific KB rules, if the user is unsure about some of the questions and needs clarification about these elements. The *Explanation* facility offers guidance to the user in understanding the questions and clarifying the problems that may come up, and is significantly important aspect of the KBLVAM, as it contains additional knowledge. It is envisaged that this will then help the KBLVAM in reaching a realistic solution. The KBLVAM System will then evaluate the answers from the user through a sequence of knowledge rules.

Over 2,400 KB rules have been developed and structured for the complete KBLVAM System. However, this chapter covers only Level 0 to Level 2 (6 modules covering 950 KB rules). For illustration purposes, each module discussed will not show the full KB rule set because it involves too many KB rules; only the key KB rules will be shown.

The generic example of a typical rule-base implemented in this research is briefly shown as follows:

IF   *the manufacturer does have Human Resource Development (HRD) programmes* (**Yes**: GP; **No:** BP**, PC-1**)

AND	*the manufacturer's Human Resource Development (HRD) programmes includes helping employees develop their personal skills (**Yes**: GP; **No:** BP**, PC-1**)*
AND	*the manufacturer's Human Resource Development (HRD) programmes includes helping employees develop their organisational skills (**Yes**: GP; **No:** BP**, PC-1**)*
AND	*the manufacturer's Human Resource Development (HRD) programmes includes helping employees develop their knowledge and abilities (**Yes**: GP; **No:** BP**, PC-1**)*
AND	*the manufacturer practices Key Performance Indicator (KPI) for setting the company's target (**Yes**: GP; **No**: BP, **PC-1**)*
AND	*the manufacturer does have Performance Measurement System (**Yes**: GP; **No**: BP, **PC-3**)*
THEN	*the manufacturer's achievements in HR development programme is good and capable to improve human resources capability*
OR	*the manufacturer needs to review its HR development programme to improve human resources capability*

The above KB questions in the KBLVAM Model are designed and developed in a stepwise manner. It is important that the questions are clearly defined in order to maximise the LVAM user's understanding of the subjects. Based on the user responses to particular KB questions, different questions may be subsequently asked. Another key aspect of the KBLVAM System (besides the KB rules and the explanation facility) is the correct assigning of the *Problem Categories* to negative responses (so called 'GAP'). As discussed in Chapter 5, this *Problem Category* assignment determines the importance of each KB rule and hence the future assignment of priorities to its resolution. The correct *Problem Category* assignment was achieved through literature review and discussion with industry and university experts.

An example of print screen in the KBLVAM Model in questioning the LVAM user is shown in the Figure 6.2.
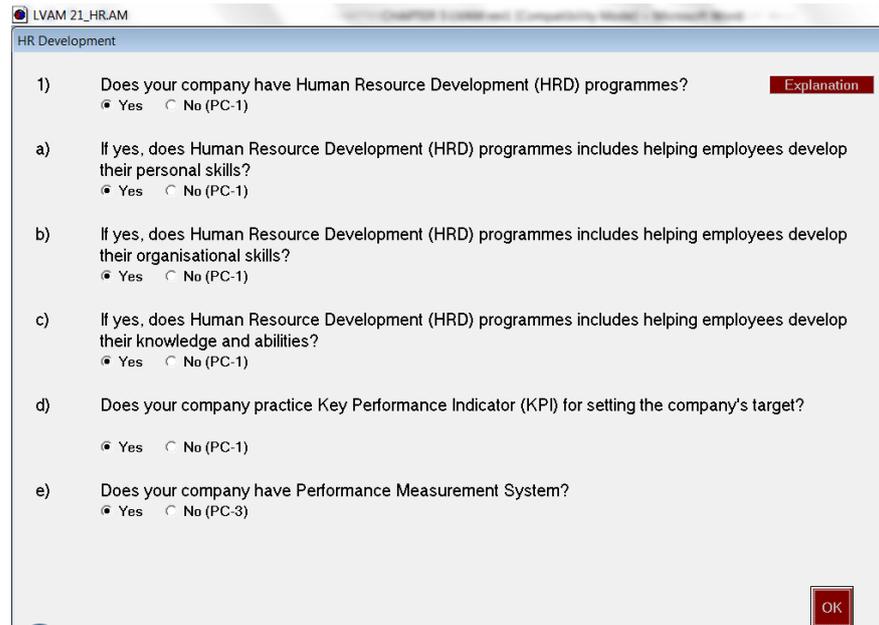
Figure 6.2 Example of questions in KBLVAM model

The Figure 6.2 shows the example of the questions relates to the HRD programme for LVAM environment. From the above rules, the KBLVAM starts asking the user of a LVAM manufacturer, whether it has a formal Human Resource Development (HRD) programmes. There are two choices of answers, if the user answers 'Yes' then the programme will execute further KB question of the sequence (Question 1(a)). If the user responds as 'No', this implies that this is a Problem Category to each question is a crucial aspect of KBLVAM Model, as this assigns the seriousness of the GAP existing in the current environment. This task has been as important as the rule-base development, and again the use of expert knowledge has been applied to determine each Problem category rating. Each negative answer has been prioritised in terms of importance, through categorisation of the problem into nine areas (*Problem Category* 1 to 9). *Problem Category* 1 (PC-1) is assigned to this question because it indicates a very serious problem if the particular LVAM manufacturer does not have any HRD programme which is the important element of the HRD system.

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Then, the following questions (Questions 1(a), 1(b), and 1(c)), ask whether the existing HRD programme helps to develop employees in the areas of personal skills, organisational skills, and knowledge. If the user answers 'Yes' then the programme will execute the further question of the sequence (Question 1. d). If the user responds as 'No', KBLVAM Model assigns *Problem Category* 1 (PC-1) to these questions (Questions 1(a), 1(b), and 1(c)), because they indicate the HRD programme is not properly implemented and thus is considered as a very serious problem to the overall HRD system.

The KBLVAM System also assesses if the management practices *Key Performance Indicator* (KPI) for setting the company's target as well as *Performance Management System* (PMS) for employees' yearly evaluation by asking Questions 1(d) and 1(e). Failure to comply with these requirements will result in PC-1 and PC-3 respectively. *Problem Category* 1 (PC-1) is assigned to question 1(d), because they indicate very serious problems, if the KPI is not considered in the yearly manufacturer target. *Problem Category* 3 (PC-3) is assigned to question 1(e) because it indicates a major problem if the particular LVAM manufacturer does not have any PMS, which is the requirement under the *Benefits* which includes salary and career development in the HRD system. Finally, based on the user responses, the KBLVAM model will determine whether the manufacturer's achievements in development programme is good and capable to improve human resource capability, or the manufacturer needs to review its development programme to improve the human resources capability.

In order to overcome any fuzziness in the understanding of the KB questions, the KBLVAM Model uses *Explanation* facility. The current research has not used fuzzy logic or Bayesian probabilities for determining and eliminating any uncertainty

in the KB rule's understanding. Instead, this has been achieved by having an *Explanation* facility which contains additional KB to assist the user in clearly understanding the KB questions. An example of a typical explanation is shown in Figure 6.3.
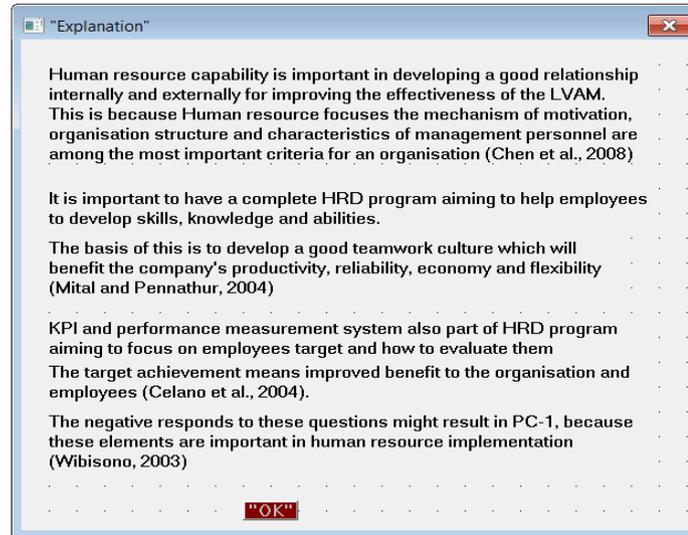

Figure 6.3: Example of *Explanation* facility to questions

As part of the model, it contains additional knowledge to assist the users in understanding the question and help them in choosing the possible answers. While the questions are worded as explicitly as possible, certain questions may include terms, which may mislead the user. Any misunderstanding of the question could lead to an incorrect answer, and, ultimately, wrong diagnosis by the KBLVAM Model. The following sections will describe each of the inter-related elements of the Planning Stage in detail.

6.2   Level 0 – *Manufacturer Environment* Perspective

The *Manufacturer Environment* is the first module used to compile the data from the manufacturer specifically on the general information and background. At this stage, the GAP analysis is not involved, because the purpose of this module is to

assess the current status of the manufacturer and its environment. The process flowchart of this module is shown in Figure 6.4, which consists of a series of KB rules, structured as questions, which require responses from the user on general information, organisation background, type of automotive product, size of organisation, number of employees, age of organisation, number of suppliers, number of customers, number of competitors and LVAM investment activities.
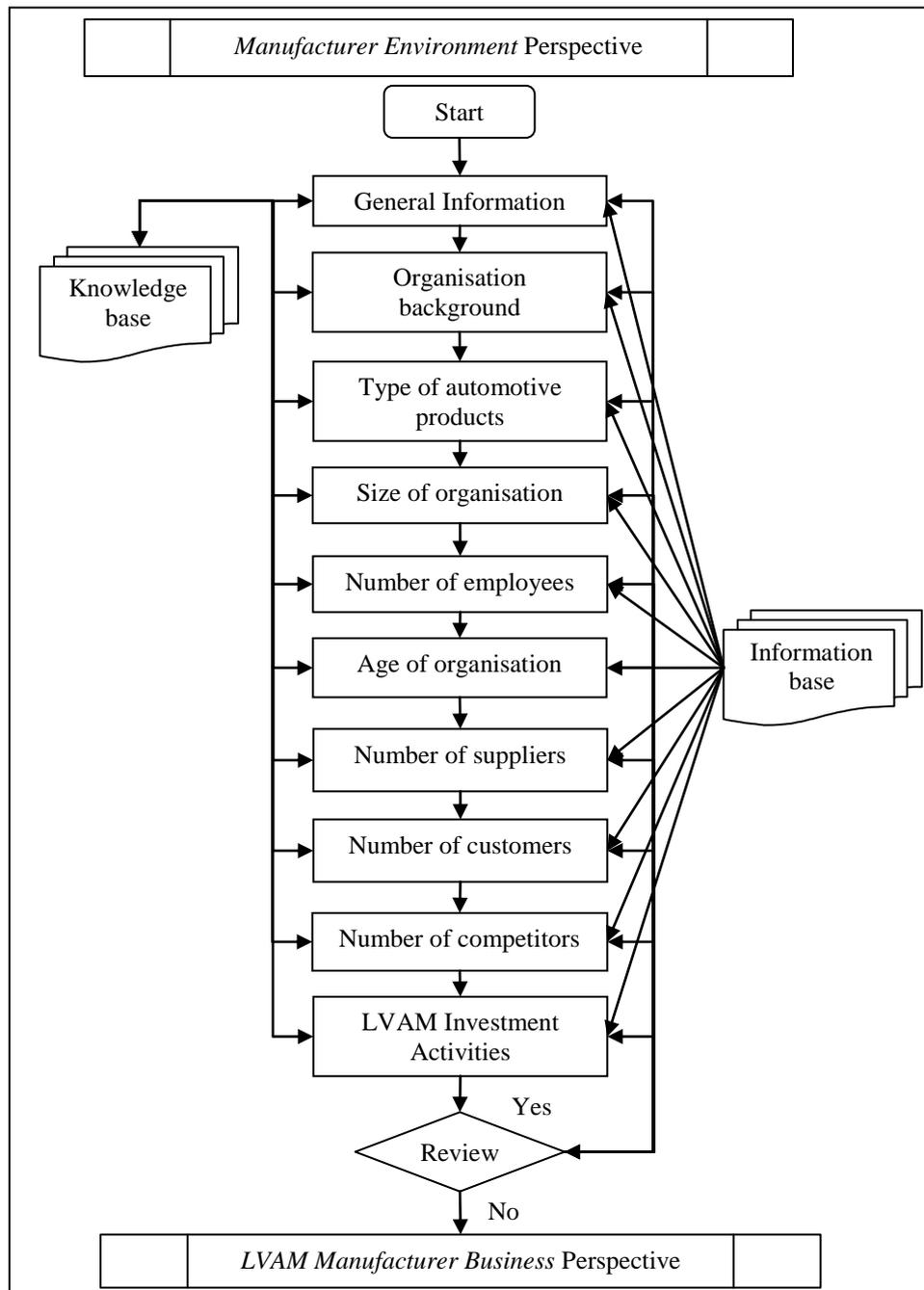

Figure 6.4: Flowchart of *Manufacturer Environment*

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From the Figure 6.4, it can be seen that the KB System initially asks for the general information and organisation background. Based on the designed KB rule questions, the user then needs to respond such as name of the participant, job designation, and address of the manufacturer. The KB System further asks the user to provide the types of the automotive products, followed by the annual sales and number of employees, which indicate the size of the manufacturer in the last three years (Smecorp, 2011). From the user responses to the questions, the KB System analyses the answers through a series of knowledge rules, shown below as an example that related to *Manufacturer Environment*.

IF *the company annual sales turnover is more than £5 million*
OR *the number of full time employees is more than 150*
THEN *the company is classified as a large size company*
OR *the company annual sales turnover is between £2 million and £5 million*
AND *the number of full time employees is 150 or less*
THEN *the company is classified as a medium size company*
OR *the company annual sales turnover is between £50,000 and £2 million*
AND *the number of full time employees is at least 5*
THEN *the company is classified as a small size company*
OR *the company is classified as a micro size company*

The data related to the age of organisation is needed to assess the period of the manufacturer involved in the automotive industry. Then, the KB System asks the questions related to the number of suppliers, customers, and competitors to identify the strength of their relationship and the LVAM investment activities, which could indicate the long term planning of the manufacturer towards LVAM. The KB System also can provide explanation for the questions, should the user need further clarification. An example of user responses is shown in Table 6.1.

Table 6.1: Example of user responses in *Manufacturer Environment*

Variables Description	Data		
Name of user (the interviewee)	Kamal Rusulan Mohamed		
Post	Lead Engineer		
Department	Stamping Engineering, Production Engineering		
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	> £1,883.68 billion		
Number of Employees	> 12,000		
Branch	2		
Position in Automotive Industry	Original Equipment Manufacturer (OEM)		
Products	Passenger Cars Manufacturing		
Age of Organisation	28 years (1983)		
	Age of Relationship		
	< 5 years	**5 – 10 years**	**> 10 years**
Number of Suppliers	> 200	> 200	> 200
Key Market - Local	All classes	All classes	All classes
Key Market - Global	Asean, Europe, Middle East, Australia	Asean, Europe, Middle East, Australia	Asean, Europe, Middle East, Australia
	(1-5 Years)	**(6-10 Years)**	**> 10 years**
LVAM Capabilities:			
Car Body Parts Design	Capable	Capable	Capable
Car Body Parts Manufacturing	Capable	Capable	Capable
Car Body Assembly	Capable	Capable	Capable

From the user responses to the questions, the KB System analyses the answers through a series of knowledge rules by using the inference engine to process the information given and deduce the results as shown below as an example:

IF *the organisation is involved in the Original Equipment Manufacturer (OEM)*
AND *the organisation is involved with producing passenger cars*
AND *the organisation number of employees is more than 10,000*
AND *the age of organisation is more than 15 years*
AND *the relationship with most of the suppliers is more than 10 years*
AND *the relationship with most of the customers is more than 10 years*
AND *the organisation has focused on LVAM investment activities*
THEN *the organisation is classified in medium size automotive products producer*
AND *the organisation has good relationship with suppliers*
AND *the organisation has good relationship with customers*
AND *the organisation has demonstrated good LVAM practices*

The use of the KB rules for this module could support the manufacturer in identifying the general information of the company based on the automotive industry

competitiveness data. The information gathered in this module is then stored in the KBLVAM System and can be loaded to the other modules to positioning the LVAM manufacturer compared to the benchmark standard.

6.3   Level 1 - *LVAM Manufacturer Business* **Perspective**

The *Business Perspective* is the second module used to compile the data from two sub-modules, namely *Financial Analysis* and *Market Analysis*. The purpose of this module is to assess the current financial status and market position of the organisation. The structure of these two sub-modules is shown in Figure 6.5. Each of the elements in the sub-modules is explained in the following sections.
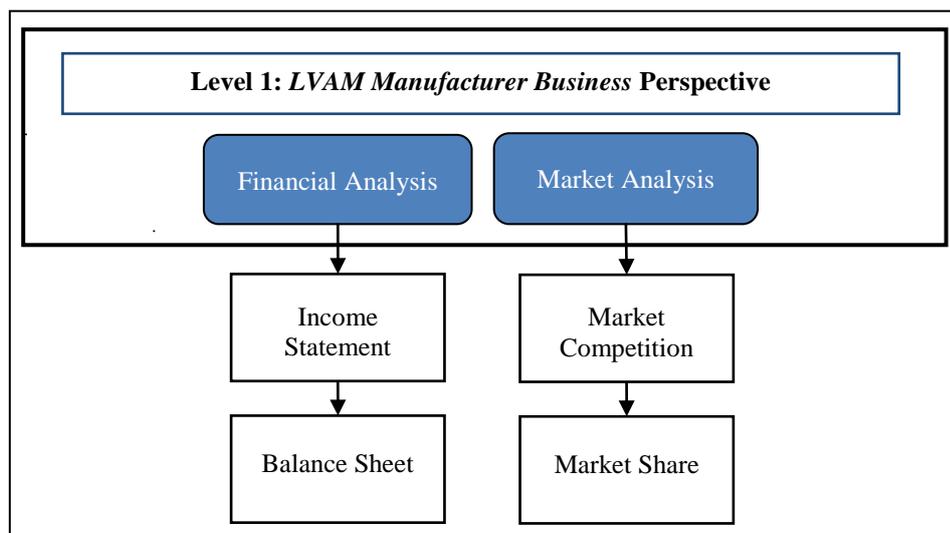
Figure 6.5: *LVAM Manufacturer Business* Perspective

6.3.1   Financial Analysis

The *Financial Analysis* is the module to gather the financial information of any organisations. The process flowchart for the *Financial Analysis* module is shown in Figure 6.6.
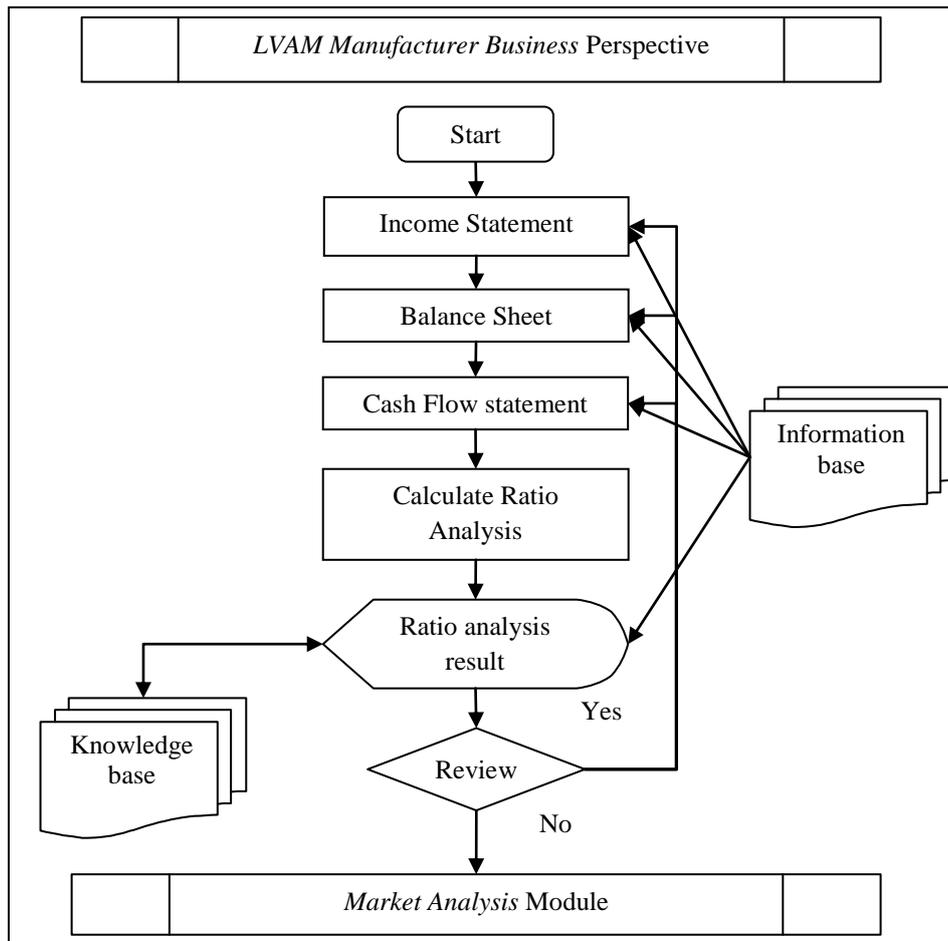
Figure 6.6: Flowchart of *LVAM Manufacturer Business* Perspective

From the Figure 6.6, it can be seen that the KB System assesses the financial analysis in this module is based on the *Income Statements, Balance Sheet* and *Cash Flow Statement* of the organisation for the last three years. Based on this financial information, detailed financial analysis can be made based on *Leverage ratio, Liquidity ratio* and *Profitability ratio.* Based on these performance ratios, the KB System gives an indication of trends in the last three years whether the manufacturer's performance is improving, deteriorating, fluctuating or steady. Examples of the rules that related to financial analysis are shown below.

IF *the Net Profit Margin Year to date (YTD) > previous year* (**Yes**: GP; **No**: BP, **PC-2**)
AND *the Net Profit Margin in YTD > previous year* (**Yes**: GP; **No**: BP, **PC-2**)
AND *the value of Net Profit Margin in YTD is positive* (**Yes**: GP; **No**: BP, **PC-1**)
AND *the value of Net Profit Margin in YTD-1 is positive* (**Yes**: GP; **No**: BP, **PC-1**)
AND *the value of Net Profit Margin in YTD-2 is positive* (**Yes**: GP; **No**: BP, **PC-1**)
AND *the Sales to Total Assets (STA) in YTD > YTD-1* (**Yes**: GP; **No**: BP, **PC-2**)

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AND *the Sales to Total Assets (STA) in YTD-1 > YTD-2* (**Yes**: GP; **No**: BP, **PC-2**)
AND *the Inventory Turnover (IT) in YTD > YTD-1* (**Yes**: GP; **No**: BP, **PC-2**)
AND *the Inventory Turnover (IT) in YTD-1 > YTD-2* (**Yes**: GP; **No**: BP, **PC-2**)
AND *the Return on Total Assets (ROA) in YTD > YTD-1* (**Yes**: GP; **No**: BP, **PC-2**)
AND *the Return on Total Assets (ROA) in YTD-1 > YTD-2* (**Yes**: GP; **No**: BP, **PC-2**)
AND *the Return on Equity (ROE) in YTD > YTD-1* (**Yes**: GP; **No**: BP, **PC-2**)
AND *the Return on Equity (ROE) in YTD-1 > YTD-2* (**Yes**: GP; **No**: BP, **PC-2**)
THEN *the organisation STA has increased in three consecutive years*
AND *the organisation IT has increased in three consecutive years*
AND *the organisation ROA has increased in three consecutive years*
AND *the organisation ROE has increased in three consecutive years*

Based on the three years of financial information, the above KBLVAM rules categorise the manufacturer as having a serious problem of PC-2, if the *Net Profit Margin* for the current year is less than the previous year. This indicates a serious problem, which requires appropriate improvement and implementation plan to increase the profit. The PC-2 scenarios are also the same for other ratios including *Sales to Total Assets (STA)*, *Inventory Turnover (IT)*, *Return on Total Assets (RTA)*, and *Return on Equity (ROE)*, if the results for the current year are less than the previous year. The KB System also categorises it as a serious problem of PC-1 if the value of *Profit Margin* in any year for the manufacturer is negative, meaning that they are making financial loss. The relationship between the financial performance and the LVAM decision as revealed by the KBLVAM System will help the manufacturer to improve in certain areas. For instance, if the manufacturer trying to reduce the average inventory levels, this action will reduce inventory expenses, which consequently improves the lean process optimisation practice and indirectly the *Net Profit Margin*. This will encourage the improvement in the *Return on Equity (ROE),* which shows a good standing in the manufacturer's financial status.

6.3.2 Market Analysis

The market analysis is divided into two categories of analysis, *Market Competition* and *Market Share* analysis. In *Market Competition* analysis, the information required about the competitors that are involved in the LVAM environment which includes their level of competencies in the local, regional and global market. On the other hand, the percentage of business received from customers is used for *Market Share* analysis. It is important to measure a LVAM manufacturer's market share relative to its competitors because it analyses the LVAM market share performance and demand from customers (Udin et al., 2006). LVAM manufacturers which do not have any measurement for its market share is categorised as PC-1, based on GAP Analysis criteria. Figure 6.7, is used to show the flow of the Market Analysis for this module. Examples of the rules that related to market analysis are shown below:

IF	*the market competition locally is 5 to 20 companies*
AND	*the market competition regionally is 20 to 40 companies*
AND	*the market competition globally is more than 40 companies*
AND	*its domestic market share 3 years ago is 10% to 20%*
AND	*its domestic market share 2 years ago is 20% to 50%*
AND	*its domestic market share last year is over 50%*
AND	*its domestic market share is unknown (***Yes***: GP; ***No***: BP, **PC-1**)*
AND	*its regional market share is unknown (***Yes***: GP; ***No***: BP, **PC-1**)*
AND	*its global market share is unknown (***Yes***: GP; ***No***: BP, **PC-1**)*
THEN	*this organisation has medium competition locally for the past three years*
AND	*this organisation has made improvements for the past three years.*
AND	*this organisation needs to invest to penetrate regional market*
AND	*this organisation needs information about global market requirements*

KBLVAM uses the above rules to categorise the position of the LVAM manufacturer in term of market status. In this case, the number of competitors between 5 and 20 companies in the LVAM business, the competition is considered as

medium for domestic and regional market. It requires at least 40 competitors in the LVAM business in order to competitive in the global market (Nawawi, 2009).
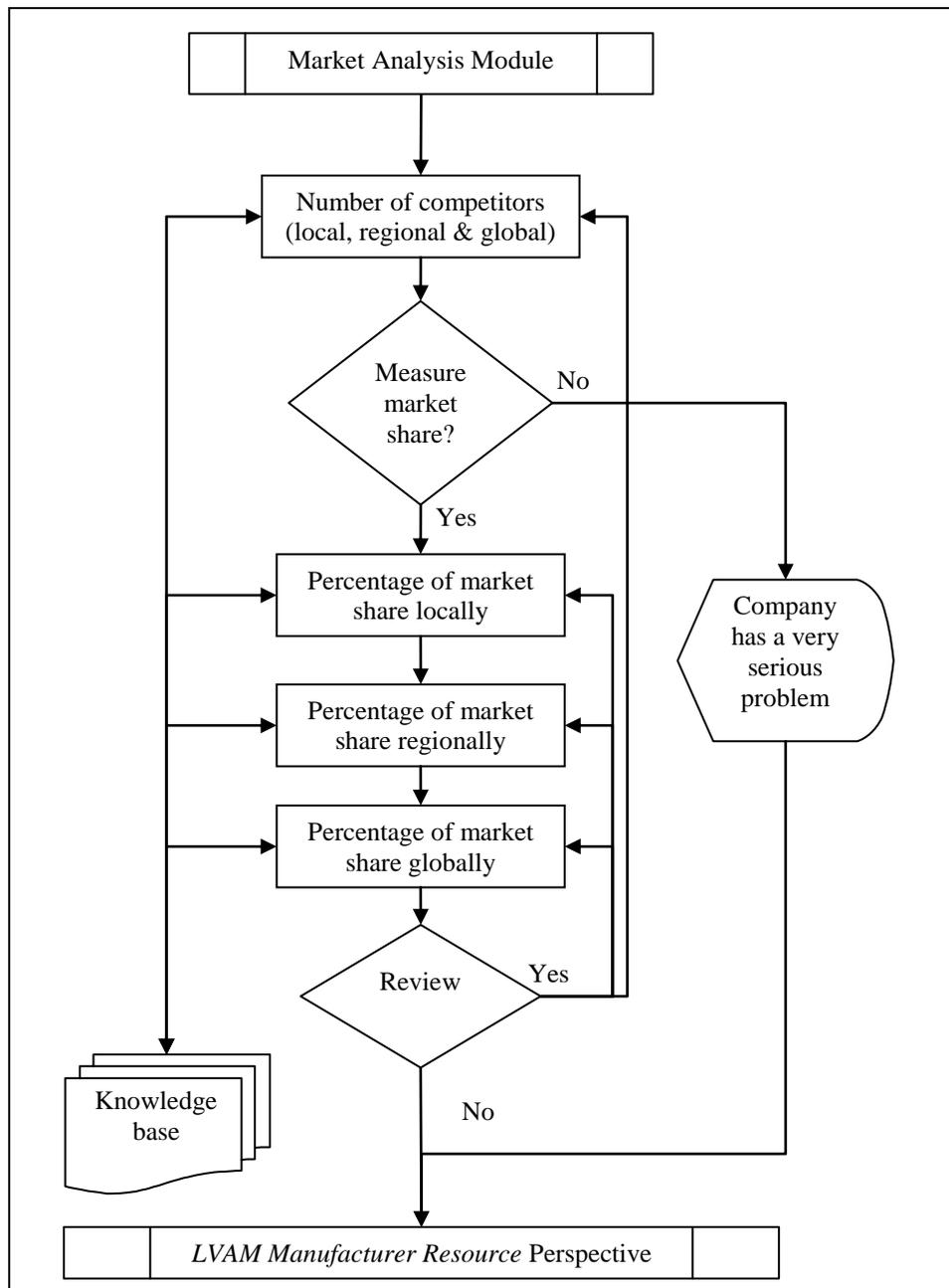

Figure 6.7: Flowchart of *Market Analysis* module

If the LVAM manufacturers do not measure their market share, the KBLVAM categorised them as serious problems under PC-1. This is because market share indicates the position of the LVAM manufacturers relative to their competitors, and can be used as a strategy to capture bigger market.

6.4   Level 2 - *LVAM Manufacturer Resource* Perspective

The LVAM Manufacturer *Resources Perspective* is divided into three modules as described in Chapter 5: *Human Resource*, *Technology Resource*, and *Financial Resource* (Mital and Pennathur, 2004). The function of these modules is to gauge the existing manufacturer capability towards LVAM implementation. The detailed structure of this *Resource* Perspective is shown in Figure 6.8 with three modules are supporting the analysis activities.
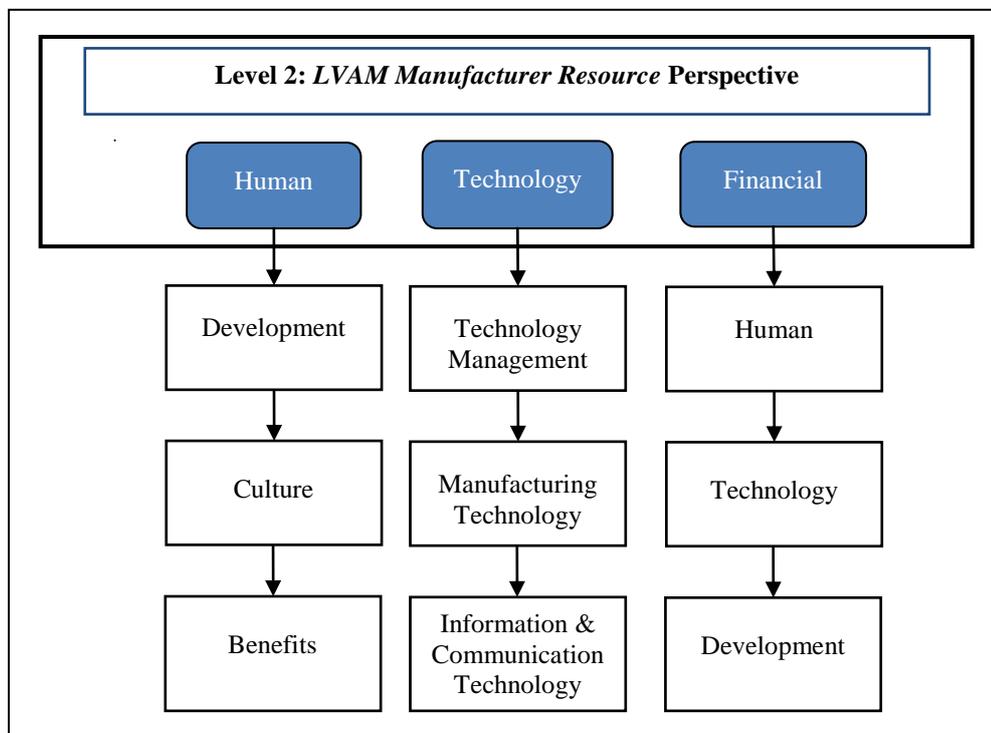

Figure 6.8: Detailed Structure of KBLVAM - Level 2

Referring to Figure 6.8, there are three sub-modules used to analyse the manufacturer's commitment towards *Human Resource* activities; *Development*, *Culture*, and *Benefits*. For *Technology Resource* module; *Technology Management*, *Manufacturing Technology*, and *Information & Communications Technology* are the sub-modules contained. Finally, in the *Financial Resource* module, three sub-modules are discussed; *Financial for Human*, *Financial for Technology*, and

Financial for Development. Each of these modules and sub-modules are discussed in the following sections.

6.4.1 *Human Resource* Module

As discussed in Chapter 5, human resource capability plays an important role in developing a good relationship both internally and externally for improving the effectiveness of the LVAM environment. As the nature of the LVAM is slow in production, the manufacturer needs to emphasise the human resource development aspects, such as training programme, team development, management support, and development as the company-wide culture (Celano et al., 2004). It is important that the human factor is considered for LVAM as it is part of the manufacturing leanness (Bayou and de Korvin, 2008). A good LVAM manufacturer will ensure the human development, culture and incorporation of benefits to all the staff as a total package for manufacturing improvement. The purpose of KBLVAM System is to identify the status of human resources development in the manufacturer that relates to LVAM environment, in order to suggest activities for human resources improvement. There are three sub-modules identified in this study that involve with human resources: *Development*, *Culture* and *Benefits*. The process flow of *LVAM Manufacturer Resource* Perspective is shown in Figure 6.9.

In the *Human Resource* module, KB System starts to access a LVAM manufacturer on the employee development in term of human resource aspects such as the selection of employee, training programmes, and how to retrain the employees in order to be competitive. The KB System then assesses the *Culture* aspect

implemented in the company, which involves the management participation and the employees.
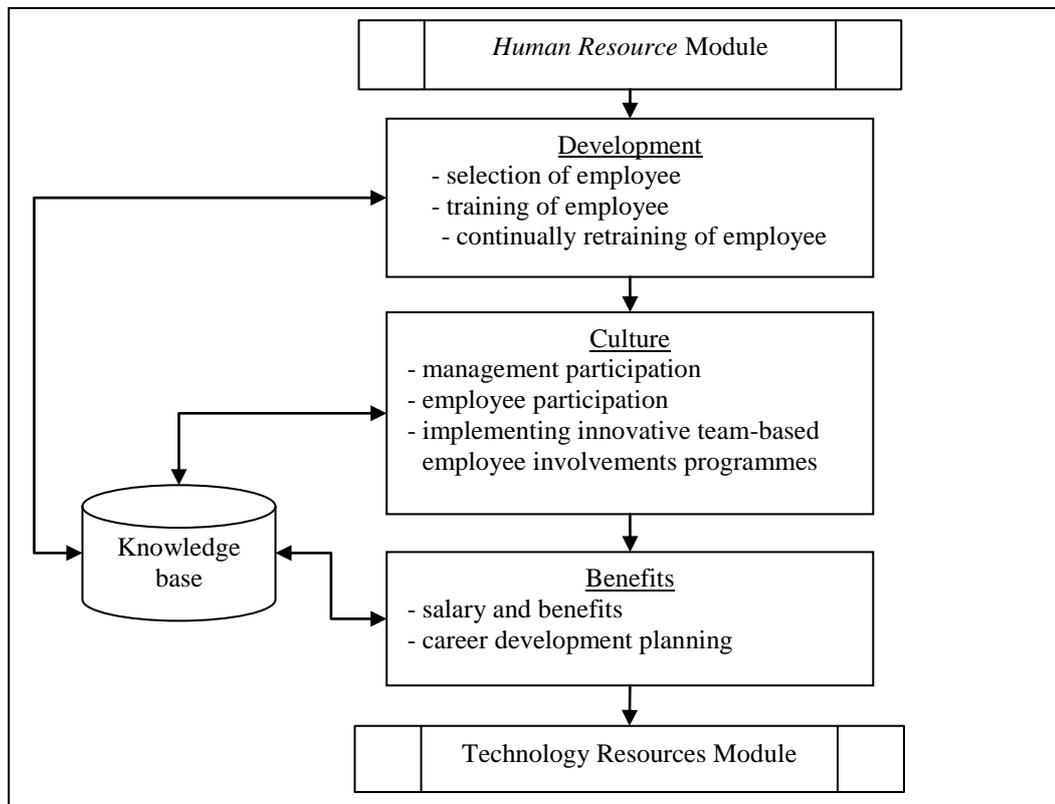

Figure 6.9: Flowchart of *Human Resource* module

On the *Benefits* aspect, the KB System assesses the level of salary and benefits, as well as the career development planning for the employees compared to the competitors in the LVAM environment (Chen et al., 2008). Based on the assessment of the *Human Resource* module, KB system, using the AHP approach embedded in the model, then determines what improvement priority should be taken by the manufacturer. The example of a rule-base implemented in this module is briefly shown as follows.

IF *the manufacturer does have Human Resource Development (HRD) programmes* (**Yes**: GP; **No:** BP**, PC-1**)
AND *the manufacturer's Human Resource Development (HRD) programmes includes helping employees develop their personal skills* (**Yes**: GP; **No:** BP**, PC-1**)
AND *the manufacturer's Human Resource Development (HRD) programmes includes helping employees develop their organisational skills* (**Yes**: GP; **No:** BP**, PC-1**)
AND *the manufacturer's Human Resource Development (HRD) programmes includes helping employees develop their knowledge and abilities* (**Yes**: GP; **No:** BP**, PC-1**)

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AND *the manufacturer practices Key Performance Indicator (KPI) for setting the company's target* (**Yes**: GP; **No**: BP, **PC-1**)

AND *the manufacturer does have Performance Measurement System* (**Yes**: GP; **No**: BP, **PC-1**)

THEN *the manufacturer's achievements in development programme is good and capable to improve human resources capability*

OR *the manufacturer needs to review its development programme to improve human resources capability*

From the above rules, the KBLVAM starts probing the manufacturer whether it has a formal Human Resource Development (HRD) programmes. This reveals the manufacturer's commitment towards the HRD programme. Failure to have a proper HRD programme will result in serious problems of category PC-1. The proper HRD programme helps to develop employees in the areas of personal skills, organisational skills, and knowledge. The evaluation process will determine whether these elements are incorporated in the programme or otherwise they are considered serious problems of PC-1. The System also assesses if the management practices *Key Performance Indicator* (KPI) for setting the company's target as well as *Performance Measurement System* for employees' yearly evaluation. Failure to comply with these will result in PC-1.

6.4.2 *Technology Resource* Module

This module is developed particularly to assess the existing status of the LVAM manufacturer on technology resources. Technology resources and human skills are very important elements to the success of manufacturing flexibility (Wiendahl et al., 2007). Hence, in the *Technology Resource* module, the assessment of existing technology resource applications is done to gauge the gap between the existing situation and the benchmarked implementation of the manufacturer. In *Technology Resource* module, there are three sub-modules to be evaluated, which include *Technology Management*, *Manufacturing Technology* and *Information and*

Communications Technology. The process flow of LVAM Manufacturer Resources Perspective - *Technology Resource* module is shown in Figure 6.10.
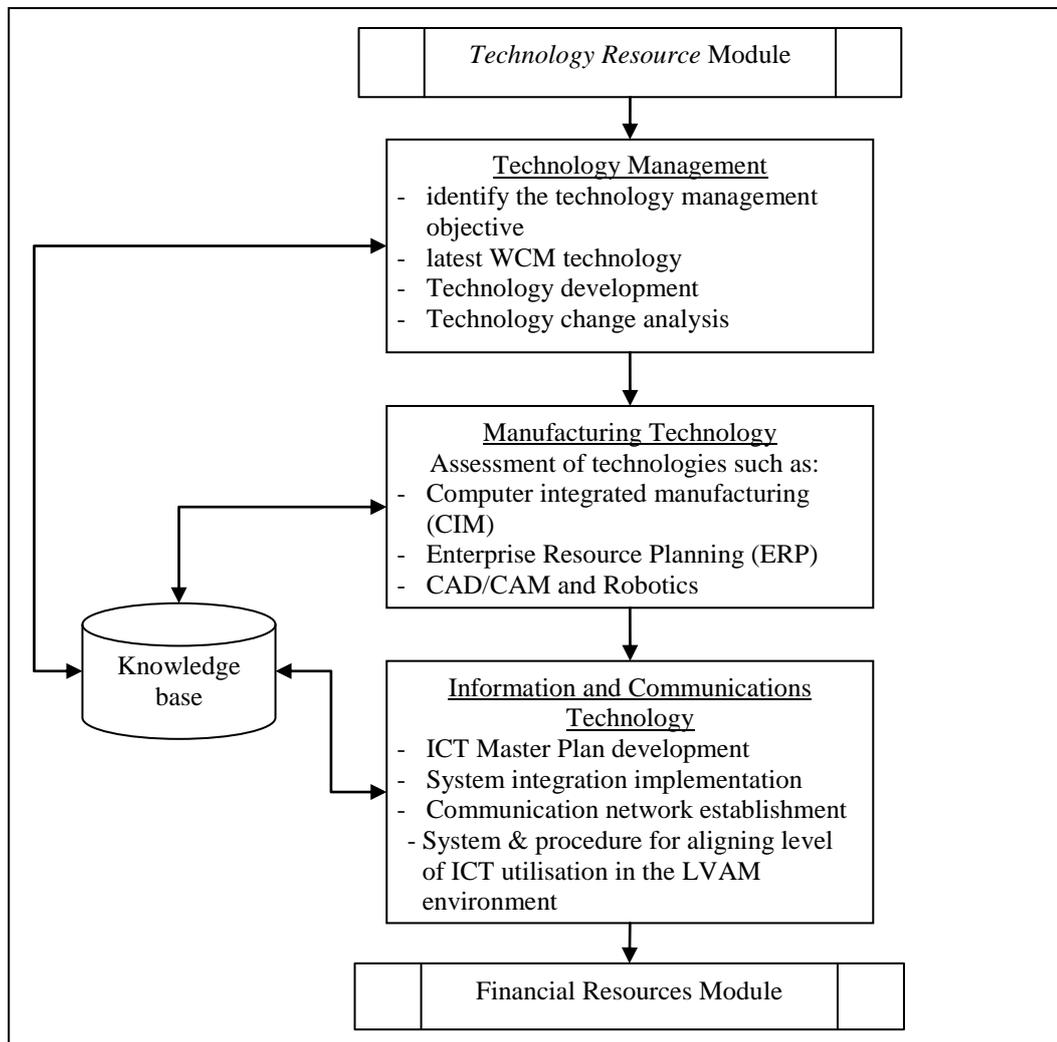

Figure 6.10: Flowchart of *Technology Resource* module

In the *Technology Resource* module, KB System begins to access on the *Technology Management* implementation in the LVAM environment. The assessment covers the technology management objective, technology implementation in the company including the latest World Class Manufacturing (WCM) technology. The KBLVAM also identifies the technology development in the LVAM environment from design, tooling and manufacturing areas, which also includes the technology change analysis. On the manufacturing technology, the overall

assessment will covers the application of manufacturing technology in the manufacturing process (Miltenburg, 2008). This will include the implementation of Computer integrated manufacturing (CIM), Enterprise Resource Planning (ERP), and CAD/CAM and Robotics. In the *Information and Communications Technology* (ICT), the assessment will focus on the management, development, and integration of ICT in the LVAM environment (Chryssolouris et al., 2008). KB system uses the assessment of the *Technology Resource* to decide on what kind of improvement priority should be taken by the manufacturer in this module. The example of a rule–base applied for *Technology Management* procedure in this module is briefly shown as follows.

IF *the manufacturer considers various methods of technology management as the main focus in LVAM manufacturing* (**Yes**: GP; **No:** BP**, PC-1**)

AND *the manufacturer always try to meet customer expectation in the technology management for LVAM manufacturing* (**Yes**: GP; **No:** BP**, PC-1**)

AND *the manufacturer always try to improve productivity in the technology management for LVAM manufacturing* (**Yes**: GP; **No:** BP**, PC-1**)

AND *the manufacturer always try to consider latest LVAM techniques in the technology management for LVAM manufacturing* (**Yes**: GP; **No:** BP**, PC-1**)

AND *the manufacturer always try to consider latest technology specification in the technology management for LVAM manufacturing* (**Yes**: GP; **No:** BP**, PC-2**)

AND *the manufacturer always try to consider World-Class Manufacturing methods in the technology management for LVAM manufacturing* (**Yes**: GP; **No:** BP**, PC-2**)

THEN *the manufacturer's achievements in implementing information technology programme is good*

OR *the manufacturer needs further assessment on the implementation of information technology programme*

Based on the above rules, it is important in LVAM environment, for manufacturer to consider various methods of technology management to meet customer expectation. KBLVAM categorises it as a serious problem of PC-1 if the manufacturer does not focus on technology management in LVAM activities. Besides, the manufacturer must also improve productivity by applying the latest technology in order to become a World-Class LVAM manufacturer. The absence of these elements shows that the technology management is isolated to the LVAM implementation and considered as a serious problem of PC-2.

6.4.3 *Financial Resource* Module

The *Financial Resource* Module is designed to assess the current status of the LVAM manufacturer on financial resources. The elements of technology and financial resources help to enhance manufacturer on environmental and operational performance (Sueyoshi and Goto, 2007). Furthermore, the human factor also plays an important role in the improvement of the manufacturers. Therefore, it is essential that the KB System assesses the manufacturer on the level of financial resources for human, technology and LVAM implementation to gauge the LVAM implementation. The System will determine whether the financial resources in the manufacturer towards the LVAM activities are according to the benchmark standard. To evaluate these activities, KB System requires the statistics of annual budget allocation for each element to enable the complete GAP analysis. The process flow of LVAM Manufacturer Resources Perspective - *Financial Resource* Module is shown in Figure 6.11.

Referring to Figure 6.11, KBLVAM model starts the process by accessing a LVAM manufacturer on the *Financial Resource for Human* sub-module, particularly the annual budget allocation for staff salary and benefit, staff training and career development planning, and consultation (Ester, 2007). Then, KB System will further investigate the annual budget allocation for technology in *Financial Resource for Technology*. Lack of financial funding on the technology planning and implementation, will result in low scores in the GAP analysis. Finally, on the *Financial Resource for LVAM Development,* KBLVAM System assesses the budget allocation for LVAM development for the past three years in term of car body design, tooling manufacturing, and car body assembly process.
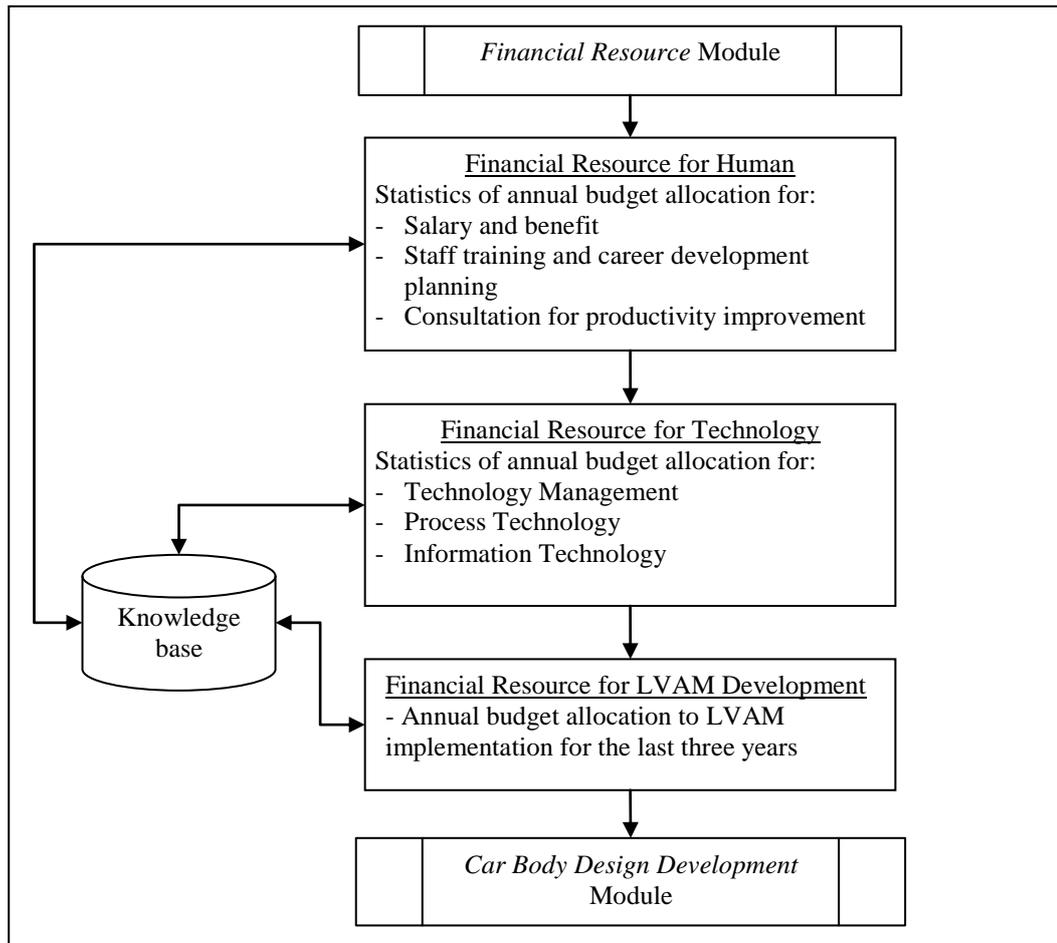
Figure 6.11: Flowchart of *Financial Resource* module

Again, through this assessment, KB System helps the LVAM manufacturer to decide on what improvement priority should be taken by the manufacturer. The example of a rule–base implemented for *Financial Resource for Human* in this module is briefly shown as follows.

IF *the budget allocation for the staff training and career development planning for last year is > 5% (in percentage of sales turnover)* (**Yes**: GP; **No:** BP**, PC-9**)

AND *the budget allocation for the staff training and career development planning for last year is between 2.5% and 5% (in percentage of sales turnover)* (**Yes**: BP, **PC-7**)

AND *the budget allocation for the staff training and career development planning for last year is between 1% and 2.5% (in percentage of sales turnover)* (**Yes**: BP, **PC-5**)

AND *the budget allocation for the staff training and career development planning for last year is between 0.5% and 1% (in percentage of sales turnover)* (**Yes**: BP, **PC-3**)

AND *the budget allocation for the staff training and career development planning for last year is < 0.5% (in percentage of sales turnover)* (**Yes**: BP, **PC-1**)

AND *the budget allocation for the staff training and career development planning for last 2 years is between 2.5% and 5% (in percentage of sales turnover)* (**Yes**: BP, **PC-7**)

AND *the budget allocation for the staff training and career development planning for last 2 years is between 1% and 2.5% (in percentage of sales turnover)* (**Yes**: BP, **PC-5**)

AND *the budget allocation for the staff training and career development planning for last 2 years is between 0.5% and 1% (in percentage of sales turnover)* (**Yes**: BP, **PC-3**)

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AND	*the budget allocation for the staff training and career development planning for last 2 years is < 0.5% (in percentage of sales turnover)* (**Yes**: BP, **PC-1**)
AND	*the budget allocation for the staff training and career development planning for last 3 years is between 2.5% and 5% (in percentage of sales turnover)* (**Yes**: BP, **PC-7**)
AND	*the budget allocation for the staff training and career development planning for last 3 years is between 1% and 2.5% (in percentage of sales turnover)* (**Yes**: BP, **PC-5**)
AND	*the budget allocation for the staff training and career development planning for last 3 years is between 0.5% and 1% (in percentage of sales turnover)* (**Yes**: BP, **PC-3**)
AND	*the budget allocation for the staff training and career development planning for last 3 years is < 0.5% (in percentage of sales turnover)* (**Yes**: BP, **PC-1**)
THEN	*the budget allocation for the staff training and career development planning is good*
OR	*the manufacturer needs to improve the budget allocation for the staff training and career development planning*

Based on the above rules, the KBLVAM measures the *Financial Resource for Human* investment in term of annual budget allocation. For instance, if the budget for staff training and career development planning is more than 5% from the last year total budget, the KB System categorises this as Good Point. Otherwise, the KB System categorises it as PC-9. PC-9 means that it is not really a *Good* or *Bad Point,* the questions associated with this category are primarily asked to identify certain situations in the environment, which upon subsequent probing by succeeding questions may well reveal problems. For example, if the budget for staff training and career development planning are less than 0.5%, then it is a serious problem of PC-1. If the answer is more than 0.5% but less than 1%, the KB System still considers it as a major problem of PC-3, which is likely to have pre-requisites to the budget allocation. If the answer is more than 1% but less than 2.5%, the KB System still considers it as a problem of PC-5, which is likely to produce short-term benefits. If the answer is more than 2.5% but less than 5%, the KB System considers it as not a serious problem of PC-7. Based on the KBLVAM results, the manufacturer needs to take necessary actions to rectify the identified problems in order to improve the budget allocation.

6.5 Summary

This chapter has elaborated the detailed KBLVAM model development for Stage 1 (Planning). The chapter covered three main areas of the strategic level of the KBLVAM system. The *LVAM Manufacturer Environment* is in the Level 0 which is used to compile in the general information and background of the LVAM manufacturer. The purpose of this module is to assess the current status of the LVAM manufacturer and its environment. The input of this module includes organisational background, types of automotive products, size of the organisation, number of employees, age of organisation, Number of suppliers, Number of customers, Number of competitors, and the LVAM investment activities. This information is used for identification purposes and the status of the LVAM manufacturer in the automotive industry.

For Level 1, the *LVAM Business* Perspective was used to gather the data from two modules, namely *Financial Analysis* and *Market Analysis* in order to assess the current financial status and market position of the organisation. Relating to the financial performance, the financial position relative to the manufacturer operations are studied based on financial ratios such as *Leverage*, *Liquidity*, and *Profitability* ratios. Market share and market competition are used to measure market share relative to its competitors in the domestic, regional and global market.

For Level 2, The *LVAM Manufacturer Resources* Perspective has three modules; *Human*, *Technology* and *Financial* with the main focus to determine the current manufacturer condition towards LVAM resources. Each of the modules is described in detail, including the process flowchart and the examples of KB rules. Furthermore, the typical output from each module that summarises the current

implementation level of the manufacturer has been shown by indicating the number of questions, along with the associated Problem Category (PC), which represent the key problem areas that need to be rectified.

Briefly, Chapter 6 has discussed the detailed development of Stage 1 (Planning) of the KBLVAM System that covered three levels; Levels 0, 1 and 2. Chapter 7, will discuss the detail development of Stage 2 (Design - Levels 3, 4 and 5) of the KBLVAM System.