CHAPTER 2
Literature Review

2.1 Chapter Overview

This chapter reviews the related theories of the research. All of these theories are applied to develop the knowledge management game based framework. These theories discussed in this chapter consist of professional development, human resource development, learning method, capability maturity model and knowledge engineering.

The first sections present the professional development concept. The meaning of professional development is described. The professional development in engineering is reviewed in this section. The final part of this section explains the PEA professional development methods.

In the first sections, the human resource development methods in various industries are shown. In this section, the research will define the problem of the existing HRD method. Learning method will also be mentioned in this section. This chapter will show some important learning theories related to HRD effort.

Second section of this chapter presents the Capability Maturity Model (CMM). This CMM methodology is used in various ways to develop and enhance the capability of the organization. This research applied CMM in order to group the capability of trainees at each level and provide a suitable level for newcomers to the knowledge game.

The third section presents theories related to knowledge engineering. Some of the knowledge engineering methodologies discussed and reviewed include CommonKADs, MIKE, and PROTÉGÉII. The rationale for choosing CommonKADs over MIKE and PROTÉGÉII, in this research is explained. The CommonKADs framework is used for eliciting the knowledge from subject matter experts.

2.2 Professional Development

Professional knowledge can be defined as an occupation that workers apply in their work based on an abstract body of knowledge and techniques. The workers acquired these knowledge and techniques through training and experience. These workers have a service orientation and distinctive ethics and have a great deal of autonomy and prestige. Hoye and John (1995) identified the professions as occupations that are self-governing, requiring a level of knowledge at or above represented by a higher education and have traditions of autonomy, ethics and independent judgment. Examples of professions include medicine, law, accounting, teaching, and engineering. In many professions, a credential such as licensure or certification is required for an individual worker to practice in the field. Generally, the individual must meet the specific criteria in order to get credentials include attainment of a degree certificate, a given level of practical experience, and a passing score on an examination. Therefore, the professionals are the workers who are adequately proficient and have the ability to enhance their ability by suitable manner (Marquand, 1997). As the status of a professional is based on the ability to apply a body of knowledge, it is critical that professionals keep current with updated knowledge and techniques in their field. Therefore, the professional requires the worker to engage in continuing education to maintain the credentials. Continuing education opportunities are offered by college and universities, professional association, and the organizations that employ professional.

Continuing professional development (CPD) is becoming emphasized by organization as essential for ensuring their employees remain up to date their professional competence (Jones and Fear, 1994). The Institute of Personnel and Development (1993) stated that CPD should be owned and managed by the learner while reflecting appropriate corporate needs. Madden and Mitchell (1993) defined CPD as

"The maintenance and enhancement of the knowledge, expertise and competence of professionals throughout their careers according to a plan formulated

with regard to the needs of the professional, the employer, the professional and society".

"The aim of effective CPD is to provide a profession where members are fully trained and competent to perform the tasks expected of them throughout their careers."

Welsh and Woodward (1989) stated CPD as the activities which have the objective to maintain and improve professional competency of a specific job. Bentley (1990) argues that the continuing professional development is the investment in performance of an individual. John Wall (2008) presented that CPD can be considered as the plan to acquire the knowledge, experience and skills and the development of individual ability for the execution of professional and technical duties, encompassing both technical and non-technical.

2.2.1 Professional Development in Engineering

The engineers refer to individuals who have received formal and specialized technical training. They use this training as a basis for career development in the engineering and engineering management field. The role of the professional institute or organization is to foster this development and provide opportunities that the engineers take advantage to broaden their experience and knowledge.

In Thailand, the Engineering Institute of Thailand (EIT) is responsible for professional development of Thai engineers. It defines the CPD as the activities causes the development of knowledge, skill, experience and capability of individuals in order to enhance the potential and keep up-to-date with the latest technological development and engineering knowledge. This will result in the development of the profession of the engineer in Thailand. All members of EIT have to participate in CPD activities and receive CPD score. These scores are used to promote the professional level and certificate. The examples of CPD are formal courses and training activities, informal learning activities, professional memberships, conferences and meetings, presentation and papers, and services in professional bodies.

2.2.2 Professional Development in Provincial Electricity Authority

Provincial Electricity Authority (PEA) states the PEA Professional Development as the development of human resources in a professional manner in accordance with the plan with development consistent with Technical Competencies. The aim of these activities is to develop employees to become experts in their work and provide methods to enhance essential knowledge, skill and experience of their task. The development, which focuses on the staff being responsible for their own professional development and be realised because the concerned person will know the skills they lack in any matter and will be able to formulate plans to counter these shortage in skills and knowledge. However, these development plans have to support the objective and policy of the organization. The framework of professional development in PEA is as shown in Figure 2.1.
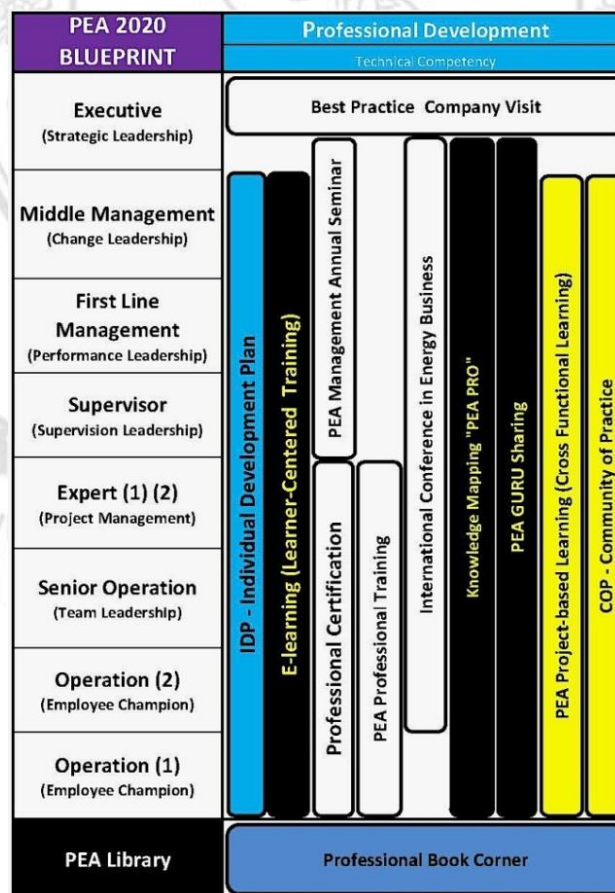

Figure 2.1 PEA Professional Development Framework

Source: PEA HRD Blueprint Project, 2010

The vertical axis of framework shows that PEA classifies their staff into 8 groups include operator (1), operator (2), senior operator, supervisor, expert, first line manager, middle manager, and executive. The horizontal axis of framework shows the development methods. Each group has its own methods to develop the profession knowledge and skill. In the professional aspect, the personnel development plan to be professional and consistent with technical competency suggested methods as follow:

1. IDP (Individual Development Plan)
2. e-Learning
3. Professional certificate
4. PEA Professional Training
5. PEA Management Annual Seminar
6. International Conference in Energy Business
7. Knowledge Management
8. PEA Guru Sharing
9. PEA Project-based Learning
10. CoP (Community of Practice)

2.3 Human Resource Development

Human resource development is the set of systematic and planned activities designed by an organization for its employees. It is used to provide the employees in organization to learn necessary knowledge and skills to meet job demands. Normally, human resource development activities begin when a newcomer starts his job and carry on until he leaves the organization. McLagan (1989) identified that HRD consists of three primary functions:

- Training and Development

  The training and development is done for changing or enhancing the skill, knowledge, and attitudes of employees. The training activities provide opportunity for the employees to obtain the knowledge and skill required to complete specific tasks. The development activities are the long-term program in order to develop employees' performance. Both

activities focus in increasing the employees' capabilities for performing their tasks.

- Organization Development

  This process is used for enhancing the effectiveness of an organization. The function provides method to change the mindset of employees to the organization's need.HRD is involved in this process as a change agent.

- Career Development

  This function is a continual process. It is a process to manage learning and working. It involves individual planning for setting up the method to develop proper knowledge and skill of each employee. Normally, it consists of 2 processes: career planning and career management.

Paul Bernthal and his colleagues (2004) proposed the workplace learning and performance wheel. The wheel presents all of the human resource development methods and other disciplines to support the business strategy. ASTD uses this wheel to show how workplace learning and performance fits onto the whole picture of human resource management and other areas of organization management.

The business strategy is located on the center of wheel. The spokes of the wheel represent traditional HRM disciplines, other organizational disciplines, and workplace learning disciplines. In order to contribute to an organization's success, these disciplines must be aligned with the organization strategy. Finally, the left side of the wheel is workplace learning and performance. It depicts an expanded view of human resource development contained with the core functions of HRD: training and development, career development, and organization development. However, it emphasizes on learning and development rather than training and development. This wheel, shown in Figure 2.2, provides an excellent picture of the HRD as well as how it links with other organizational functions to meet the business strategy.

Figure 2.2   Learning and Performance Wheel

Source: Werner and DeSimone, 2006

Werner and DeSimone (2006) mentioned that there are five challenges currently facing the field of HRD. These challenges include:

1)   increasing workforce diversity

2)   competing in a global economy

3)   eliminating the skills gap

4)   meeting the need for lifelong individual learning, and

5)   facilitating organizational learning.

2.3.1 History of Human Resource Development

Evolution of human resource development began since ancient times. If we look at ancient human civilizations, we can see evidence of ancient human beings teaching his teams to hunt and developed their arms. The term human resource development has been commonly used since the 1980s although the concept has been developed much longer than that. In order to apply this concept, it is helpful to know about the history of this field.

29

The HRD can be traced back to the eighteenth century. During that time, small shops sold goods such as furniture and clothing produced by skilled artisans. When the businesses expand, the owner had to employ additional workers who had no skills. Therefore, the owner had to train them to know the required knowledge and skills. After that, the worker who mastered all the necessary skills leaves their master and established their own shops. This was the beginning of HRD.

In 1809, the first vocational school was established in New York City. It provided occupational training to unskilled people. This is the prototype of the vocational education. In 1917, Congress approved the Smith-Hughes Act and granted funds in order to set up the programs in agricultural trades, home economics, industry, and teacher training.

In the late 1800s, machines began to replace the hand tool. Industrial sectors need more specific skills in order to operate the machine. They engineer, machinists were required to design, build, and repair the machines. To meet this demand, factories created mechanical and machinist training programs, referred to as the factory school. In 1872, the first factory school was established, a New York manufacturer of printing presses. After that Westinghouse founded the factory school in 1888, General Electric in 1901, and then Ford, Western Electric, Goodyear set up their schools as well.

During World War 2, the industrial sector was asked to support the war effort. The federal government established the Training Within Industry (TWI) to coordinate training programs across defense-related industries. TWI also trained the employees to be instructors to teach this program in each factory. When the war finished, these companies established their own training department, which designed, organized, and coordinated training across the organization. After that, in 1942, the American Society for Training Directors (ASTD) was established. The aim of this establishment is to set up the standards within this emerging profession.

During 1960s and 1970s, professional trainers found that their role is beyond the training activities. They realized that the training competencies expanded to include interpersonal skills such as coaching, facilitation, and problem solving. This result was the motivation for ASTD to change itself to be American Society for Training and Development in 1964.

In 1980s, Human Resource Development was approved by ASTD to encompass this field growth and change. The influential books were published in the late 1980s which helped to clarify and define the HRD field. Presently, the effort is made to strengthen the strategic role of HRD. They try to find how HRD links to and supports the goals and objectives of the organizations.

2.3.2 Human Resource Development Framework

HRD process can be used to solve various problems in an organization. It uses to orient the new employees into the company, provide the skill and knowledge. It also can be used to improve the behavior of employees. The organization has to pay attention to design and manage the HRD program in order to ensure that the organization's goals are achieved. Werner and DeSimone (2006) presented in their book that the HRD process involves four steps including needs assessment, design, implementation, and evaluation, respectively. The whole HRD process is shown in Figure 2.3.
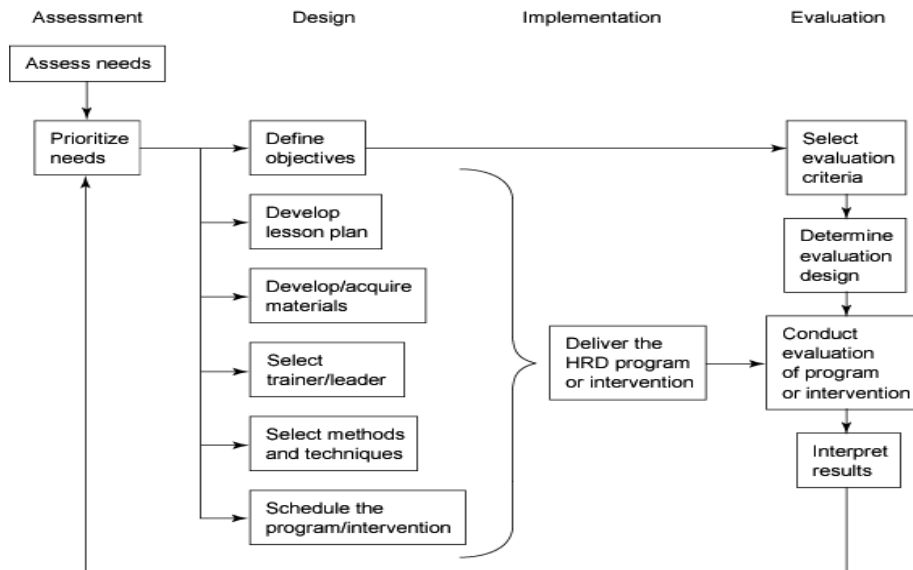
31

Figure 2.3 HRD Process Framework
Source: Werner and DeSimone, 2006

Needs Assessment Phase

Normally, HRD processes are used to address some knowledge needs or skill gap within an organization. Needs assessment is the process that organization uses to identify:

- an organization goal
- gap between employees' skills and the skills required for current job effectively
- discrepancies between the current skills and the skills need for future job
- the conditions under which the HRD activity will occur

Werner and DeSimone (2006) stated in their book that the need of training assessment should be performed at three levels. Organizational level assessment identifies where in the organization training is needed and under what condition it will occur. Task level assessment presents what must be done to perform a job. Individual level assessment shows who needs to be trained and what kind of training they need.

The needs assessment at the organizational level is carried out by performing an organizational analysis. By this process, the HRD staff will understand the

characteristics of the organization for determining where training and HRD process are in need.

Task analysis is a data analysis of a specific job for determining that what an employee should know to perform the optimal performance. The results of this assessment include with the standards of performance, how tasks should be performed to meet the standards, and the knowledge, skills, and abilities that employees need to meet the standards.

The training needs of the individual employee are done by determining the person analysis. It focuses on how well each employee is performing key job tasks. The person analysis may identify HRD needs. An effective person analysis should consist of two components: summary person analysis and diagnostic person analysis. Summary person analysis involves determining the overall success of the individual employee's performance. Diagnostic person analysis tries to discover the reasons behind the employee's performance.

Design Phase

The second phase of the training and HRD process involves designing the HRD program. The output data from needs assessment phase are used to as input data to design the training and development program. The key activities of the design phase are:

- setting the specific objectives
- developing an appropriate lesson plan
- developing the appropriate materials and media
- selecting the trainer
- selecting the most appropriate methods to conduct the program
- scheduling the program

After assessing the needs, the results of the needs assessment phase are translated into clear objectives for creating the HRD programs. This should facilitate the development of clear lesson plans. Then the teacher or trainee who will deliver the knowledge to employees is selected. The selection has to consider various factors such

as knowledge, ability, availability, and their willingness. The design phase also involves the program content development. The trainee or HRD staff has to select the suitable method for development program such as on-the-job training, in-class training, seminar, brain storming, e-Learning. The training and development program should define the appropriate techniques used to facilitate learning such as lectures, discussions, role plays, and simulations.

Implementation Phase

After finishing the needs assessment phase and design phase, the HRD program must be carried out by HRD department. The HRD department and trainer have to implement actual HRD program following the HRD plan.The proper implementation assumes that an important need for training has been identified and that program objectives have been spelled out. There are many activities related to the implementation phase. There are three primary methods for training delivery: On-the-job training, classroom, and self-learning. Each method has a number of appropriate techniques for particular situations. The trainer has to select the method or combined two or more techniques to maximize the trainees' learning. Moreover, it is very important to provide the physical environment which supports employees' learning.

Evaluation Phase

Program evaluation is the final process of HRD program development. HRD evaluation is defined as the process for collecting the information to analyze the effectiveness of the training program. The evaluation process provides the information on trainees' feedback to the program. This information includes how much they have learned, how the knowledge learned has been applied in their jobs, and whether the program improved the organization's effectiveness.

Upon reviewing existing literature, several evaluation frameworks were found to be prevalent. Kirkpatrick (1967) presents an HRD program evaluation framework which is the most popular and powerful framework. He proposed to evaluate the training efforts with four criteria: reaction, learning, job behavior, and results. Galvin (1983) proposed the CIPP framework. It categorizes evaluation into 4 levels: context,

input, process, and product. Brinkerhoff (1987) defines the evaluation into 6 stages: goal setting, program design, program implementation, immediate outcomes, intermediate or usage outcome, and impact and worth. The most widely used frameworks for evaluating the training program are as presented in Table 2.1.

Table 2.1 HRD Evaluation Models and Framework

Model/Framework	Training Evaluation Criteria
1. Kirkpatrick (1967)	Four Levels: Reaction, Learning, Job Behavior, and Results
2. CIPP (Galvin, 1983)	Four Levels: Context, Input, Process, and Product
3. Brinkerhoff (1987)	Six stages: goal setting, program design, program implementation, immediate outcomes, intermediate or usage outcome, and impact and worth.

Table 2.1 HRD Evaluation Models and Framework (Continued)

Model/Framework	Training Evaluation Criteria
4. Kraiger, Ford, and Salas (1993)	A classification scheme that specifies three categories of learning outcomes (cognitive, skill based, affective) suggested by the literature and proposes evaluation measures appropriate for each category of the outcomes.
5. Holton (1996)	Identifies five categories of variables and the relationships among them: Secondary Influences, Motivation Elements, Environmental Elements, Outcomes, Ability/Enabling Elements.
6. Phillips (1996)	Five levels: Reaction and Planned Action, Learning, Applied Learning on the job, Business Results, Return on Invesment.

Source: Werner and DeSimone (2006)

2.3.3 Competency Based Development

Presently, the competency-based development is regarded as one of the most important methods in human resource development (HRD) intervention. It is the means for developing the employees to achieve higher standards of performance through training activity, reward management, and another HRD intervention. The competency terminology was firstly presented by McClelland in 1973. His research "Testing for Competency Rather than Intelligence" stated that the performance of individual staff cannot be predicted by academic aptitude, academic grade, or IQ. Important factors which influence job performance are person's competencies and characteristics. There are several literatures devoted on defining the meaning of competency.

- Woodruffe (1992) stated that competency is the set of behavior patterns that incumbent needs to bring to position in order to perform its tasks and functions with competence.
- Kochanski (1996) defined competencies as the success factors in an employee's organization and profession.
- Huang (1996) presented that competency is the capability of employees for doing their job. It is a combination of knowledge, skills, behaviors, and attitudes related to personal effectiveness.
- Marrelli, Tondora, and Hoge (2005) defined the competency as a measurable personnel capability that is required for effective performance. It is comprised of knowledge, skill, and personal characteristics.
- Cardy and Selvarajan (2006) classified competencies as belonging to one of two categories: personal or corporate. Personal competencies are possessed by individuals and include knowledge, skills, abilities, experiences and personality. Corporate competencies belong to the organization and embedded processes and structures that tend to reside within the organization.

Knowledge is defined as an understating of principle related to a particular subject. Skill is capability to apply the knowledge in order to complete the task and relates to the action. Ability is a physical capability to successfully perform a task. It requires time and effort to develop ability. (McCelland, 1973); (Werner and DeSimone, 2006); (Marrelli, 1998)

Nowadays, many HRD scholars explore the possibility to apply the competency concept in order to enhance the employees' performance such as Kudngaongarm and Sujivorakul (2012). They developed the competency framework for civil engineers in Thailand. The competency is a set of knowledge, skills, and attitudes related to effective job performance. It can be measured and evaluated. It can be improved through training program (McLagan, 1983; Richey et al., 2001; Berge et al, 2002). Competency is used as a guideline to suggest relevant development intervention for the employees (Ley et al., 2008). Hackett (2001) states the purpose of competency-based training is to ensure that the trainees attain specific skills practice to establish the working standards.

Competency model is the important tool for the present HRD activity. It is a set of competencies which are analyzed from experts' performance for doing a specific task (Draganidis and Mentzas, 2006). Many scholars proposed the competency model development framework. Harzallah, (2002) presents that the function competency model development includes 4 steps:
  (1) analyze work or job,
  (2) derive the behaviors and performance of the tasks,
  (3) define the required individual characters, and
  (4) evaluating.

Draganidis and Mentzas (2006) present the steps to develop competency including the identification of the performance metrics, the development of the tentative competencies list, defining the competencies indicators, the development of the initial competency model, cross-checking the initial model, refining the model, validating the model, and performing the finalized model. Serpell and Ferrada (2007)

developed the competency-based management framework. Its steps include the analysis of business processes, identification of critical labor functions, development of the competency profile, evaluation of competencies, design of the training plan, execution of the training plan, and evaluation. Marrelli, Tondora, and Hoge (2005) present seven steps for competency modeling. These include defining the objectives, obtaining the support of a sponsor, developing and implementing a communication and education plan, planning the methodology, identifying the competencies and creating the competency model, applying the competency model, and evaluating and updating the competency model.

As reviewed above, these frameworks can be used as the guideline to develop the competency model. However, it is found that most frameworks need more effort of experts in order to develop the competency model and competency profile of each job position. The skills of experts in job analysis, job description and narrative are necessary in order for knowledge elicitation. Moreover, these competency models are used to evaluate the competency gap by comparing the present ability level of individual staff and the standard competency level of the job position that the employee should be. This evaluation may not be an effective development method of maintenance operators in the real industry. This is because most maintenance operators have learned and developed their performance based on their work. Some of them can develop their ability faster, therefore, their abilities may be higher than the proficiency level of their job position. It means they will likely not get the opportunity to develop their ability until promoted to higher position. Instead, the competency model proposed in this paper is based on the learning pattern of experts rather than relying solely on proficiency level of job position.

PEA defines the competency model as the set of knowledge, skill, and attributes which is used to facilitate human resource activities. These activities include recruitment, training and development, performance appraisal, career path development, talent management, and organization culture rebranding. The PEA competencies are divided into core competency and functional competency. Presently, PEA has developed both core competency and functional competency. PEA applied

38

the Spencer's framework for developing the current competency model (Spencer and Spencer, 1993). The processes to develop the competency model are divided into 7 steps as follows:

(1) organization analysis,

(2) competency model study,

(3) share value study and core competencies,

(4) functional competency specification,

(5) competency dictionary development,

(6) proficiency level development, and

(7) proficiency description.

The first three steps are core competencies development which the data collecting processes were done by reviewing the mission, vision, policy and core value and executive meeting method. The functional competency is divided into managerial competency and technical competency. The managerial competency is only specified to management level. The technical competency is assigned to both management and operation level. PEA has developed the functional competency models for every staff which cluster by job families. The data colleting process of this data was done by job description reviewing, focus group meeting and benchmarking. For the substation maintenance staff, PEA set up the competency model comprise of 5 competencies. Each competency is divided into proficiency level of 5 levels by 5patterns. Then the competency model is validated by line executive peer review. After competency models are set up, they are used to evaluate the competency gap of individual staff and use this information to set up the individual development plan (IDP).

2.3.4   Human Resource Development in Energy Industries

This section reviews the Human Resource Development of Energy Company to understand how they enhance their employees' performance. The companies are selected to study are Royal Dutch Shell PLC., RWE, Petroliam Nasional Berhad (PETRONAS), Tenaga Nasional Berhad (TNB), and PEA.

Royal Dutch Shell PLC. (Netherland)

Royal Dutch Shell PLC. (Shell) is the biggest oil and gas supplier company in the world. It was established in 1907. It has expertise in all stages of oil and gas business, from the oil exploration, refining, production, transportation, trading and marketing. Its business is operated in over 90 countries. The number of employees is more than 97,000. The core values are stated,*"Shell employees share a set of core values – honesty, integrity and respect for people. We also firmly believe in the fundamental importance of trust, openness, teamwork and professionalism, and pride in what we do"*.

Shell realizes that employees are most important asset of the organization. It emphasizes in HR processes. The recruitment, training, and compensation are based on people strategy as follows:

- Assuring sources of talent now and in the future
- Strengthening leadership and professionalism
- Enhancing individual and organizational performance
- Improving systems and process

According to people strategy, it provides the learning programs for employee in order to build and extend professional both in technical and management skills. It focuses on building technical capabilities and safety competencies and skills. Its training program is developed based on its competencies model. The training method is different in each business. Each staff in Shell has to develop the IDP by determining their skills and behavior needed and select the method to build them. Shell supports individuals to manage their career path, create a high performance work culture, and foster personal development linked to corporate strategy and goals. Shell has 5 concepts of human resource development which can be summarized as follows:

1) Shell assesses the staff to know their weaknesses and strengths. Then individuals and their manager have to plan and select the method to develop themselves.

2)   The individual development plan objectives harmonize with business objectives. They have to know their own individual development plan.

3)   Each staff has to know his strengths and his individual development plan. Shell supports employees develop their functional competency, personal competency and leadership competency.

4)   Shell believes that job assignment is the effective method to develop the personal knowledge and skill. Each employee is assigned 2 different projects within 3 years since they start to work with Shell.

5)   Each employee has a personal coach for introducing the career path.

The training and development methods that Shell uses for enhancing their employees performance are:

- Workplace learning
- Training and Certified
- Individual Development Plan
- Coaching and Mentoring

In order to proper knowledge and skill development of each employee, Shell divides their staff into 3 groups as follows:

- Management Level: This group is developed by site visit, training program, action learning, workshop, job assignment, and job rotation.

- Talent: This group is focused to develop in leadership skills. The development method of this group is training programs, cross function work program.

- Professional: Shell applies many methods to develop this group.

- Shell developed the "CP Functional Excellence" training program for enhancing contracting and procurement staff. Moreover, it provides the e-Learning program and virtual workplace program for developing this career group as well.

- Shell develops the training program for the new staffs name "Welcome to Shell". Then, it goes on personnel development with "Early Career Development Program". This program uses the job assignment, job rotation, discussion, and coaching to develop the employees' knowledge.

RWE (Germany)

RWE is one of Europe's leading electricity and gas companies. It is the biggest power producer in Germany, No. 2 in the Netherland and No.3 in the United Kingdom. Its expertise lies in oil, gas and lignite production, electricity generation, and electricity and gas transmission and selling.

The number of employees is around 72,000. RWE sets up the core corporate values to provide the framework in order to develop the corporate culture to date. These core values include Performance, Forward-thinking, Trust, and Customer focus.The meaning of core values are shown as follows:

- Performance: RWE's employee performs the job with high performance and professional competence.

- Forward-thinking: RWE's vision focuses on innovative, sustainable development. It not only achieves corporate objectives, but also is equally beneficial to society and to the environment.

- Trust: RWE place a high priority on open and honest communication, both amongst itself and in dealing with third parties.

42

- Customer Focus: RWE's focus to serve its customer with high quality service.

RWE provides the training and development program based on diversity and equal opportunity. It analyzes and develops theIDP for enhancing its employees' capability and skills. In addition, a multi-faceted training programsare developed in order to keeps staffs knowledgeup to date, both in technical and non-technical terms. RWE develop the Model of Competence (MoC) to describe which leadership competencies are required for executives. The MoC is comprised of:

- Leading Business
- Leading People
- Leading Change
- Leading Self

SCHEME – MODEL OF COMPETENCE

LEADING BUSINESS
> Demonstrate Commercial Judgement
> Turn Strategy into Results

LEADING PEOPLE
> Engage People
> Build Effective Teams
> Develop People

LEADING CHANGE
> Innovate
> Make Change Happen

LEADING SELF
> Take Personal Responsibility
> Show Passion and Drive
> Learn and Grow

FUNCTIONAL SKILLS AND EXPERTISE

Figure 2.4 RWE Competence Model
Source: www.rwe.com

This MoC defines what RWE expect from its employees. MoC is also used to assess the personal performance and identify the strength of individual. In order to

define individual development, each employee and his manager have to discuss and set up the individual development plan.

RWE's process the HRD Program by starting with Potential Appraisal Program "Discoveries". The results of this program are utilized to form the succession plan. The potential appraisal form has been developed based on MoC.
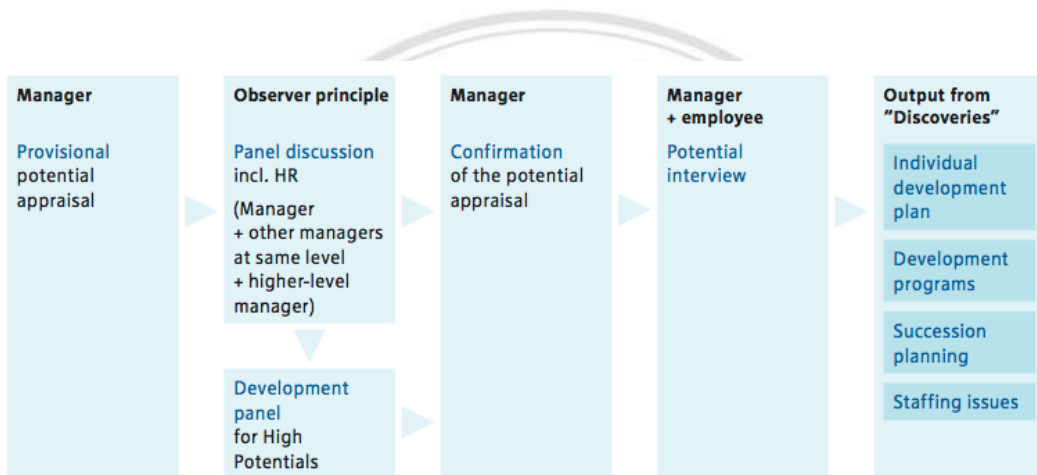

Figure 2.5 RWE's Potential Appraisal Program "Discoveries"
Source: www.rwe.com

RWE develop various development methods to provide employees opportunity in order to develop themselves. RWE's Staff can select these various methods depending on their needs and challenges. These methods are shown as follows:

- Broadening Current Job
- Job Assignment
- Job Rotation
- Learning from Experts
- Coaching
- Mentoring
- 360 degree Feedback
- Learning at the workplace (e.g. e-Learning)

Moreover, RWE set up the special program "the Corporate Talent Program (CTP)" for developing their talent group competencies. To build up the competencies for preparation the talent group to next step of their career. The RWE development training and development center for setting up the development programs "Progressive Perspective" and "Perfecting Performance" for talent group. Moreover, RWE give the talent group opportunity to criticize with executive board members via "The Talent Forum".

Petroliam National Berhad: PETRONAS (Malaysia)

PETRONAS is a Malaysian oil and gas company which owned by government. Its vision is to be a international leading oil and gas company. Its business activities cover exploration and production of crude oil and natural gas, sale and transportation, refining and marketing of petroleum products, shipping and logistics. The number of employees of PETRONAS is over than 43,000.

The shared- values embedded in its culture are:
- Loyalty: Loyal to nation and corporation
- Integrity: Honest and upright
- Professionalism: Committed, innovative and proactive and always striving for excellence
- Cohesiveness: United in purpose and fellowship

PETRONAS realizes that human resource development is the sustainable development of organization. It supports employee enhancement by creating the development framework for developing the knowledge, skill, and leadership competencies. It provides various training and development program to bring about a favourable change in mindset includes education transformation based on industry engagements. PETRONAS create the environment for promoting the continuous professional development (CPD). PETRONAS's human resource development program covers several of methods and training facilities.

45

PETRONAS establishes the various training institutions for operating the relevant training programs. These training institutions are responsible for transferring the strategies of organization to the employees via the training method. The training institutions which established by PETRONAS are as follows:

- Universiti Teknologi PETRONAS (UTP) is the institutions of higher learning in science and technology. It provides the students with opportunities for chasing the knowledge, expertise and advance technologies in the engineering, science and technology. UTP's emphasis is on the role of academic staff as facilitators of learning rather than lecturers.

- Akademi Laut Malaysia (ALAM) is the training center for maritime knowledge. Its training course is developed for training the employees in both sea-based and land-based personnel. It provides training courses covering all process of the maritime industry and its related fields.

- PETRONAS Leadership Centre (PLC) is the training center for providing the know-how to enhance leadership skills of executive level. PLC also provides the learning consultancy and advisory services.

- Institut Teknologi Petroleum PETRONAS (INSTEP) is a technical training service provider. It owned by PETRONAS Technical Training Sdn. Bhd. INSTEP is responsible for training the technicians and operators in petroleum industry. It has three main areas training program which focuses on professional development program, bridging programs for technicians and operators, and competency-based assessments and certifications.

Tenaga Nasional Berhad : TNB (Malaysia)

Tenaga Nasional Berhad (TNB) is the electricity utility in Malaysia. TNB is responsible for generation, transmission, distribution and retail in Peninsular Malaysia, Sabah and Labuan. The number of employees of TNB is over than 33,500. The vision of TNB is "*To be among the leading corporations in energy and related businesses globally*". TNB sets up the 4-shared value as Integrity, Customer Focus, Business Excellence, and Caring for create the organizational culture.

In order to invest in human capital, TNB provides the training and development program for enhancing their workforce to ensure that the capability level of their staff is appropriate for their function. TNB develop its employees through various training and development method such as training program, experiential learning, cross function and job rotation. The projects that TNB use for enhancing their employees performance are presented as follows:

1) Experiential Learning: This project is use for exposing the employees to cross-cultural situations and different disciplines. By this project, TNB employees are able to see the bigger picture in managing the business.

2) Talent Management Enhanced: TNB develops the assessment tool for identifying the potential leaders. This assessment is done by measuring the employees competencies and readiness for greater responsibilities. It establishes the Corporate Talent Pool (CTP) and provides the special development program for them.

3) Engaged workforce for higher productivity: TNB sets up four aspects of engagement namely, communication by leaders, career opportunities, recognition, and performance management. The program for engaging the employees including with Management by Walking About (MBWA), job rotation, job assignment, reward,and workshop on performance management.

47

Moreover, TNB established the academy and training institute in order to enhance their employees' performance. They are the UNITEN and Integrated Learning Solution Sdn Bhd (ILSAS)

- TNB Integrated Learning Solution (ILSAS) is the official training institute of TNB. TMB has expertise in the power utility engineering. It has several training facilities including with combined cycle generator simulators, 33kV distribution line practice field, training workshops, SMART labs, Computer Based Training (CBT) labs and various training rooms.

- Universiti Tenaga Nasional (UNITEN) is the private universities which owned by TNB. It provides both academic programs and engineering technology skills training. The university's programs focused on engineering, information technology, business management and related areas.

In order to motivate their employees, TNB set up the reward and recognition for high performing staff members. The reward and recognition includes promotion, annual increment and bonuses.

PEA (Thailand)

As mentioned in Chapter 1, PEA is a state enterprise responsible for supplying electricity to customers in 74 provinces of Thailand. Its vision is to be a leading organization of international standard, doing business in energy, services and related businesses. In 2011, the number of employees of PEA is 27,784. In order to enhance the performance of the organization, PEA pays attention in human resource development. As shown in their policy statements, PEA strives to become an organization that focuses on improving human capital and intellectual capital. PEA promotes continuing learning and knowledge management. It also focuses on developing personnel performance and capabilities in order to accommodate change, leading to work efficiency in response to organizational goal.PEA uses strategies

management and human resource development, measured by competencies, to encourage staff with professional expertise and diversity management principles. Human resource development in PEA is done by various measures such as: Talent Management to development of 'smart' people, Successor to inherit executive positions, Individual Development Plan to set up the development method for each employee.

PEA defines that human resource development is the one of most importance factors to develop the enterprise. In order to enhance the personnel performance both in technical and management skills, PEA forms the competencies model for all positions. The core competencies within the 5 competencies are "TRUST". They are consisting of the values of the leading energy organization as follows:

- Teamwork
- Rush to service
- Under Good Governance Principles
- Specialist
- Technology Savvy

Provincial Electricity Authority (PEA) realizes that the human resource development for enhancing human capital is the key factor to be strategically driven. To provide career development plan implementing in human resource strategies and master plans for the next 10 years has been named as "PEA2020" (PEA2020 HR S&M). It was proposed to design career path system manual and to identify milestones training program method named as "HRD Blueprint". Human Resource Development Plan (HRD Blueprint) refers to the development of human capital systematically and continuously to cover all staff in the organization, so they receive well-balanced development throughout the organization to grow and change in the future, which is the basis of the concept of sustainable development organization. By HRD Blueprint, Human Resource Development Department has a framework and guideline to enhance the knowledge, skill, and attitude of each employee's level in each dimension.

The framework of the human resource development plan covers various aspects of PEA.

1) Comprehensive development of all staff in the organization

An advisory board to consider comprehensive human resource development in the six dimensions includes the level of management (Management), Talent Group (Talent) Professional (Professional), age group (Generation) to support the future of PEA (PEA Incubator) and the people with different working areas (Location Orientation).

2) Continuous Systematic Staff Development

An advisory board considers the development of personnel from their entry into the organization. Growth in the professional levels, until the staff leave the organization.

3) Provide development staff that integrates all aspects for the development of balanced and sustainable development.

PEA applies the Person Development frameworks of the University of Hong Kong which recommends human resource development, and intellectual, physical, social, aesthetic, career, emotional and spiritual developments.

4) Based on the personnel associated with the development of human resources in other areas.

An advisory board to consider systematic ways to link the human development plan with recruitment selection, evaluation of performance, pay and benefits enhancement of PEA culture etc.

5) The framework of the corresponding budget allocation.

An advisory board to consider support in bringing a human development plan into practice (Implementation) and support policy

50

budgets of a set amount to work on the budget requirements and human resource development.

The PEA Board of Advisors schemes a personal development plan with a 5-dimension or 5Ps in the development of different staff groups within the PEA.
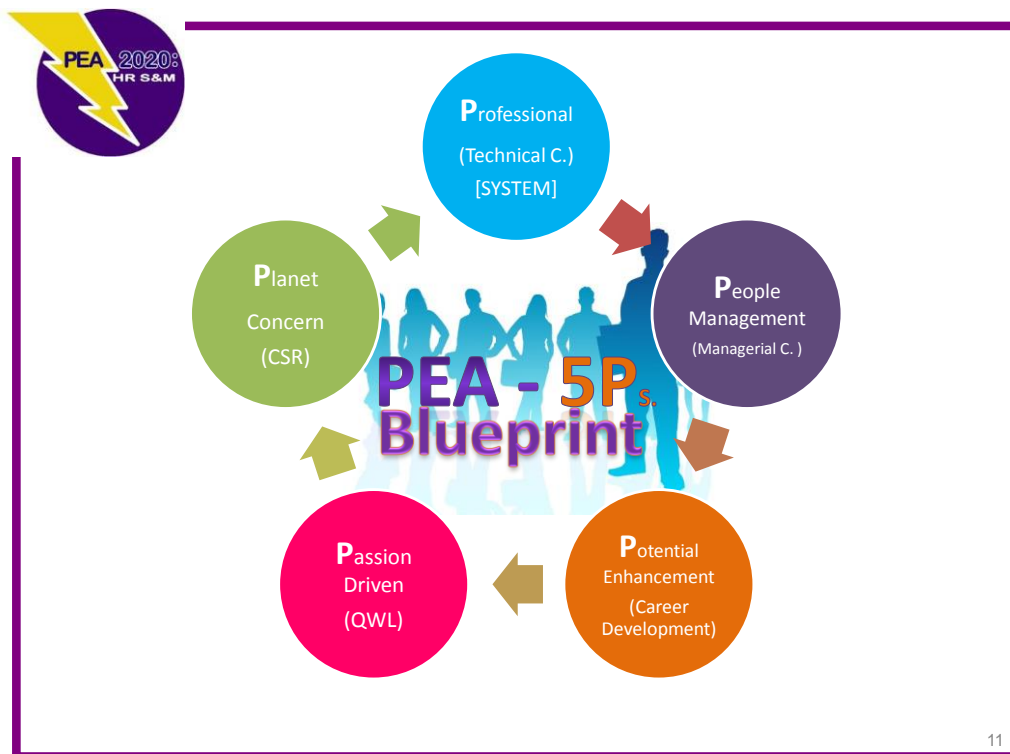

Figure 2.6   5-Dimension of PEA HRD Blueprint
Source: PEA HRD Blueprint Project, 2010

- Professional Development: Development of human resources in a professional manner in accordance with the plan with development consistent with Technical Competencies. The development, which focuses on the staff being responsible for their own professional development and being associated with the development of departmental staff. Projects will actually occur because the person concerned will know the skills that they lack in any matter and be able to formulate plans to counter those lacks.

- People Management: Human resource development for "leadership" which means the ability to manage tasks through others. Therefore, the ability of people management is the skills and abilities that are important to humans at all levels to work with others and this works by directing subordinates.

- Potential Enhancement: The potential of PEA staff to be developed in line with their potential. The development of both the potential to be professionals, and the potential for future administration. PEA is the path consisting of 2 career ladders to use as guidelines for developing a systematic and continuous developmental plan: the development since the first employment of people in the organization, until their retirement.

- Passion Driven: Staff development must balance the physical, mental and spiritual, because PEA has a policy of staff development to ensure their commitment to the organization. Therefore, human resource development should be to ensure better quality of life, which is one in development.

- Planet Concern: Human Resources Development must be responsible in society and have a Governance of strategy and master plan for human resources management of PEA years from 2010-2020 to ensure social responsibility and the moral development from within the organization. This is also used as part of commitment to staff development of PEA (Employee Engagement) as well.

Therefore, the Provincial Electricity Authority's HRD blueprint can be developed is shown in Figure 2.7.
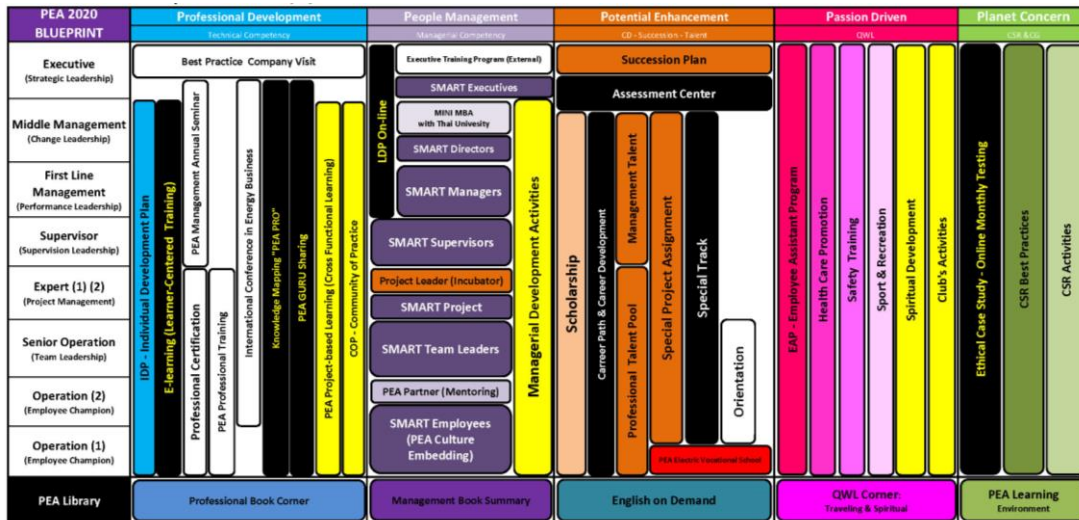
Figure 2.7   PEA HRD Blueprint

Source: PEA HRD Blueprint Project, 2010

2.3.5 Learning Theory

As Werner mentions in his book that learning process is a important aspect of HRD efforts. Due to this, the research proposes to use knowledge game to enhance the employees' performance related to workplace learning. Therefore, it is important to understand about learning theory in order to develop the knowledge game framework. This section reviews some learning theories related to the workplace and HRD effort including with Adult Learning, Gagne's Theory, and Kolb's Learning Style. Finally, this section will present the existing methods which are used to promote learning in workplace.

The learning process is defined as a permanent change in behavior or cognition of learner. It provides the leaner to acquire something new or modify something that already exists. Presently, many researchers interest to study in learning process in various aspects. This section reviews the famous learning theory: Adult Learning, and Gagne's Theory.

Adult Learning

In the beginning of the learning process study, many scholars' developed the different principles of learning and instruction methods for children. However, the adults teaching require using a different set of techniques.

In workplace learning, the adult learning is interested by many researchers. Malcolm Knowles first coined the term andragogy in his book "The Adult Learner" in 1973. Knowles stated that the andragogy or adult learning is different from learning theories of children which was based on the six assumptions as follows:

- Adults need to know why they should learn.
- Adults are self-directed learner.
- Adults have more experiences. They can provide their own learning. They can also resist new ideas.
- Adults are willing to learn something if they know that it is relevant to them.
- Adults are motivated to learn and expect to immediately apply.
- Adults learners respond to some external motivations such as promotion, salary increasing.

Daley (1984) compares the Pedagogy and Andragogy in seven issues which are listed in Table 2.2.

54

Table 2.2 Comparing Pedagogy and Andragogy

Characteristic	Pedagogy	Andragogy
Structure	Based on aging process Rigid format Subject centered Rules, procedures, laws	Flexible, open, broad Responsive Interdisciplinary Developmental
Atmosphere	Authority oriented Formal, low trust Competitive Win-lose	Relaxed, trusting, mutually respectful Informal Collaborative, supportive Win-win
Leadership	Teacher dominant High task, low relationship Controlling Does not value experience Low risk	Innovative, creative High task, high relationship Interdependent, mature relationship Experience High risk
Planning	Administration and teacher Emphasizes rationale Policies, plans, and decisions Highly political	Administration, faculty, and student Mutual assessment Collaborative needs assessment Mutual Negotiation
Motivation	External rewards and punishments	Internal incentives (curiosity), Self-directed, Learning contracts
Communication	One-way downward Transmittal techniques Feelings repressed	Two-way Mutually respectful Feelings expressed, Supportive
Evaluation	Teacher Norm-referenced Grades Subjective	Criterion-based Objective and subjective Jointly chosen standards by student, peer, and teacher

Source: Daley, 1984

55

Gagne's Theory

This theory focuses on what people learn and how they get acquire knowledge. It presents that different learning outputs are gotten by different learning method. It means that there is no one best way to learn everything. Gagne (1985) proposed that human performance could be divided into five categories. The categories are:

1) Verbal information or declarative knowledge: This is the ability to state or declare something, such as a fact or an idea.

2) Intellectual skills: They are procedural knowledge which includes rules, concepts, and procedures that people follow to accomplish tasks.

3) Cognitive strategies or strategic knowledge: They are the skills used to control learning, thinking, and remembering.

4) Attitudes: They are internal processes of the mind that can influence behavior. These are not learned simply by hearing the facts from others. Attitudes are often highly resistant to change.

5) Motor skills: These involve using the bodies to manipulate something. These skills are developed by practicing and doing.

Gagne and his colleagues suggested the nine steps, or instructional events that should be used in training and development design. The instructional events are:

1) Gaining Attention
2) Informing leaner of objective
3) Stimulating recall of prerequisites
4) Presenting the stimulus material
5) Providing learning guidance
6) Providing feedback
7) Assessing performance
8) Enhancing retention and transfer of information

2.3.6 The Motivation in Training

The key factors, which affect the trainees' behavior, can be divided into 2 categories. These include (1) external force and (2) internal force. Motivation is one of the most important elements of human behavior. Thomas M. Green (2006) states that the motivation is an internal force which conducts the action and lead the direction of that action. Mark Prensky (2001) defines motivation as the internal process that activates, guides, and maintains behavior over time. It is the most important factor when designing the learning activity. Trainees can learn almost everything when they are motivated. The understanding of motivation is critical to human resource development. The successful HRD intervention is to motivate the employees to learn and use what is learned to improve their performance. Terry Mitchell (1982) synthesized the definitions of work motivation as

"[...] the psychological processes that cause the arousal, direction, and persistence of voluntary actions that are goal directed."

It means that the motivation pertains to the causes of voluntary behavior. It focuses on several processes affecting behavior include energizing, direction, and persistence. Motivation is usually seen as an individual phenomenon because all people have unique needs, desires, attitudes, and goals.

The motivation of training activity is concerned with many factors. Csikszentmihalyi (1990, 1996) presents "Flow theory" which defines the situation of people engagement in learning. Duke Hyun Choi and his colleagues (2007) summarizes the Csikszentmihalyi's theory that the factors of flow can be categorized into 9 characteristic: clear goals, immediate feedback, potential control, the merger of action, suitable challenges with personal's skills, concentration, loss of self-consciousness, time distortion, and autotelic experience. One of the factors which can be applied in the training design process is the suitable difficulty level of task compared to the personal skill. Engeser and Rheinberg (2008) stated that flow state can be defined by 6 components where one of them is a balance between personal's

skills and difficulty of the activity. The original flow model shows the relation between personal skills and challenge of activity. From the train's perspective if skill is higher than difficulty, the trainee feels more comfortable sometimes making the trainees uninterested in the training program. On the other hand, if skill is lower than difficulty, the trainees feel anxiety and sometimes they give up that training program. Therefore, it is very important to consider and design the difficulty level of training course. The trainers have to design the training course by concerning about the difficulty of training contents which should match up with trainees' skills, knowledge and abilities.

2.4 Digital Game Based Learning

Iuppaand Borst (2010) stated that at the present, a new type of technologyhas the potential to effect to the workplace. The new technology tools replace the former tools. This situation may challenges the organization as many aspect as follows:

- The transfer of training, educational, or pedagogical material to employees or volunteers
- The task of motivating social change or changing social behaviour
- The challenge of attracting new business or new customers

The training and development has been impacted with this situation as well. In the past, the traditional training and development program has taken place in several methods:

- On-the-job training
- Classroom training
- Coaching
- Site visit
- Pencil-and-paper training
- Workshop

58

The traditional workplace has typically been advocated in these ways:

- One-way media: flyers, pamphlets, public service announcements, print advertisements, radio and television commercials, and other attention-getters.
- Two-way interaction via training classes, focus groups, or one-to-one meetings.
- But a new generation - the Millennial (Net generation) has been immersed in interactive media since childhood.
- Digital social networking has been available for a substantial part of their lives.

They are visually intuitive and respond better to experiential and collaborative learning methodologies than traditional "skill-and-drill" and text-based learning. In short, the old ways of training are going to be less successful for the new era. The several evidence exists that applying entertainment videogame mechanics and techniques to learning and communication objectives can pay dividends. James Paul Gee (2003) stated that:

"It dawned on me that good games were learning machines. Built into their very designs were good learning principles, principles supported, in fact, by cutting-edge research in cognitive science."

Digital game-based learning refers to computer applications which adapt the digital games to produce educational content and learning environment. It provides the learning process through game playing. Digital game-based learning creates fun and engaging and the coming together of serious learning and interactive entertainment. Games are the effective tools in order to teach, train, and to educate. Games can bring people together. Games can reveal and build character. Games can retain and promote the learning process.

Stephen Tang (2007) stated that digital game refers to the computer application created for entertainment purposes. It takes advantage of multimedia and computer

59

technology to enable the players to experience goal-directed game playing in a virtual environment. Prensky (2001) states that computer games can be characterized by six key structural elements. These elements include rules, goals and objectives, outcomes and feedback, conflict/competition/challenge/opposition, interaction, and story. Salen and Zimmerman (2004) propose that the digital game should comprise of 3 elements: rules, play, and culture. Rule represents the operational constraints within the game. Play represents the experiential aspect of the game via some activity. Culture interprets the beliefs and norms represented in the game world. Therefore, the game is composed from a set of rules within a defined cultural context to support the activity of play.

Digital game-based learning is also the computer applications which apply the digital games technologies to create educational content through game playing and storytelling. The computer-based educational games can be beneficial to trainees than other types of training because of game can provide the various experimentation, feedback, and reflection of mistake to the player. There are many researchers and educators who set hypotheses in their work that video games can be used to increase student motivation in learning tradition academic outcomes (Garris et al., 2002; Gee, 2005; Habgood et al., 2005; Prensky, 2001; Kafai, 2001).

Digital game-based learning is not limited to simple games. These games have a purpose other than entertainment and can be used in any field of study, such as military, government, healthcare and education. The importance about digital game-based learning is that these games are developed to increase the way of learning or training.

Figure 2.8 Digital Game-based Learning

At the present, many scholars use the various digital media in the learning process. There are many types of digital media for learning as shown in Figure 2.8. Some of them are explained as follows:

Edutainment: Edutainment applies the multimedia in the education and learning context. It uses several types of media in training and development purposes. These medias include television programs, radio, video games, animation, websites and computer program. These multimedia are used to promote learning in a fun and engagement.

Education Game: Education game is a subset of edutainment. It is a computer application which applies game technologies for developing the learning content. The player learns the education content through game playing. Usually, education games are used as learning tools for encouraging the children.

61

Digital Game-Based Learning: Digital game-based learning is an adaptation of education games in formal learning environment. It is an active e-Learning method for promoting experiential learning. This digital media is used for learning purpose.

Simulator: Simulators are computer technologies which used for modelling and observing the system behavior and machine characteristic. The systems are modelled based on mathematical modeling over period of time.

Serious Game: Serious games are the digital game application that used for non-entertainment purposed. The serious games development requires theoretical understanding of learning, cognition, emotion, and play. During the game design period, serious games need content and pedagogy expertise, design research, and impact research.

Prensky (2001) states that the computer game consists of 6 key structural elements including rules, goals and objectives, outcomes and feedback, competition and challenge, interaction, and story. Moreno-Ger (2007) argues that digital games-based learning can be beneficial to trainees by providing the various experimentation, feedback, and reflection of mistake to the player.

2.4.1 The opportunities in the Digital Game-Based Learning Revolution

Presently, there are many scholars who are interested in applying digital game in many fields. The digital game-based learning is an alternative method that is being used with amazing and increasing success. It is the method to learn by play. "Edutainment", a new learning paradigm, is gradually emerging, such as:

- Preschoolers learn the alphabet and reading by using computer games. The example programs are Sesame Street Letters, Jump start Learning Games ABC's.
- High School students play a multiplayer online game name "AOL's President' 96" and Reinventing America to learn electoral politics.

- Financial traders use "Straight Shooter" for bank policy training.

- Policymakers play a Sim Health game developed by the Markle Foundation to understand the health care system.

- Military trainees flight realistic battles in video game-like simulators such as SIMNET tank simulators.

- The Army uses the simulator game "Saving Sergeant Pabletti" to train more than 80,000 soldiers each year in team skill.

- The U.S. Navyuses the Submarine Skills-Training Network (SubSkillsNet) for training their staff.

Game-based learning has become with the rise of computers the learning wave of the future. Prensky (2001) states that the good computer and video game which can engage player to play should comprise of fun, form of play, rules, goals, interactive, outcome and feedback, adaptive content, conflict/competition/opposition, problem solving, interaction, and representation and story.

2.4.2 Serious Game Development

Serious Game is the subset of digital game-based learning. It is an alternative training method which keeps the balance between theory and practice. A serious game provides opportunities for the students and trainees to be involved in the education or training process and creates an active learning (Sun, 1998). Serious game is an experience-based media which feasibly constructs player knowledge through game playing (Fu, 2008). It creates a fun and interactive virtual learning environment that promotes experience learning. A serious game is a tool that provides trainees to learn by doing. The trainees can play game many times as desired. They are free to explore, to try difference approaches, without fear of breaking the equipment, with the guidance and feedback provided by the simulation itself.

The benefit of a serious game is the players' engagement through direct experience with the virtual world. It provides the players a chance for reflecting, exploring, testing their hypothesis and constructing objects (Kiili, 2005). The most important advantage of the serious game is to motivate the players to learn by game.

63

The essential factors for motivating the players in game are fun and challenge. These factors make the serious game more beneficial than other e-learning platforms and traditional training methods. It is important that the challenge of the game should be matched to the skill level of the player. If the challenge is greater than player's skill level, he may feel anxiety. In the other hand, if challenge is lower than player's skill level, he may feel bored (Kiili, 2005).

Presently, serious games can be found in many areas, like military, healthcare and education. Sun (1998) designed a game for the education and training of production/operations management. Moreno-Ger (2007) develops a game for learning in clinical procedure. Ebner and Holzinger (2007) used the online game in civil engineering education. Although, there is growing interest in serious game development, there are few systematic methodologies to guide and organize game design. Seager and his colleagues (2011) adapted the applied cognitive task analysis method combine with additional knowledge representation to develop the game design process.

Iuppa and Borst (2010) presented in their book "End to End Game Development" that the game development approach can be divided into 6 sections that roughly correspond to phases of the project. They are (1) setting up game development, (2) determining project goals, (3) game design – the creative, (4) game design – the technical, (5) production and authoring, and (6) finish line. They are represented in Figure 2.9.
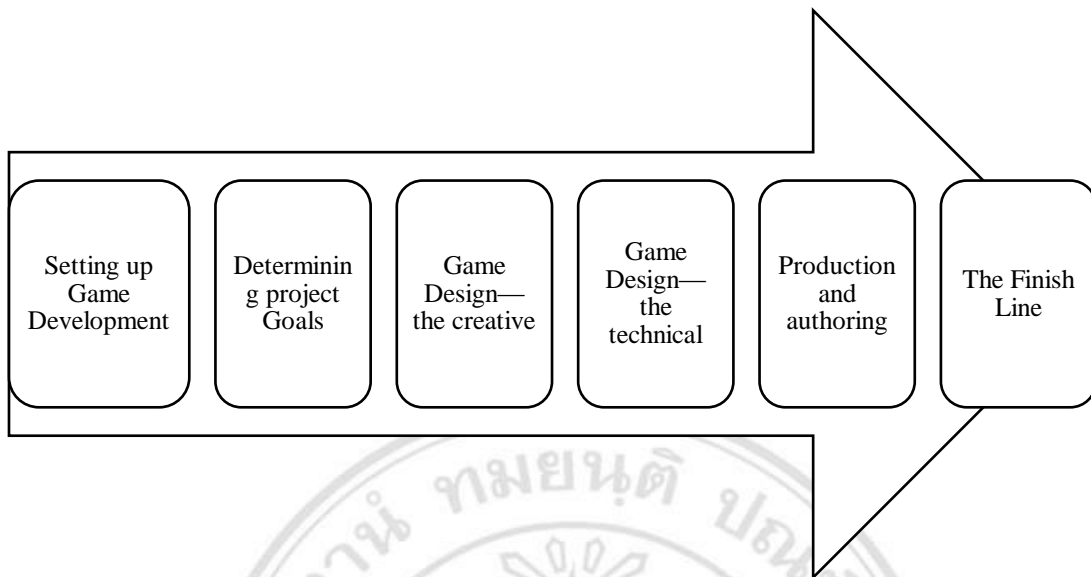
64

Figure 2.9 Serious Game Development Process
Source: Iuppa, and Borst, 2010

Section 1: Setting up game development

This section discusses the process of setting up game development. It analyzes the process from the initial entrepreneurial or leadership itch to client acquisition and management, legal issues, staff hiring and team building, and project planning and management.

Section 2: Determining project goals

This section analyzes the instructional design. Due to serious games and simulations should address specific problems or issues or promote specific causes or products. Instructional design can nail down a client's or user's needs, set goals that answer those needs, and develop scoring and testing mechanisms to give both the user and the client immediate feedback on the progress of the user.

Section 3: Game Design – the creative

After develop the instructional design, this stage design the simulation activities, evaluate, and then translate the concept into effective gameplay and game mechanics.

65

Section 4: Game Design – the technical

The instructional design may have made a delivery platform and selection of development tools. But often, concepts may work on several platforms, and a plethora of software tools can help build the application. This stage selects the appropriate platform and tool in order to create the final version of game.

Section 5: Production and authoring

This stage applies a design concept to develop gameplay. The artists, programmers, and other creatives can get to work producing the game. The development also includes graphics production, audio and video production, and how programmers and game designers produce core gameplay, user interfaces, and stable builds of the application.

Section 6: The finish line

When the final version is produced, the serious game or simulation needs packaging, distribution, and marketing.

In order to develop the effective game, educators and game designers need the input and direction provided by empirical studies to make good choices in applying the lessons of video games to learning activities(Tennyson and Jorczak, 2008).Presently, there are many researches present that games can efficiently promote learning (Cordova and Lepper, 1996; Henderson *et al.*, 2000; Moreno and Mayer, 2005; Ricci *et al.*, 1996), but these researches have not been focused in regard to how games can promote learning. According to research of O'Neil and Fisher (2004), it was found that the number of empirical studies, which provided evidence of increased motivation, enhancement of cognitive processes and improved learning outcomes, was very small.

This research proposes the game development framework. It focuses on how to develop the instructional design which is used as a guideline for developing game engine, avatar, game environment, and the interface.

2.4.3 Game Evaluation

The game design evaluation is the importance process for game designer in order to understand the efficiency of game from the player's point of view before start the game technology development process. This process uses the data to analyze the objective of the serious game. Fu, Su, and Yu (2008) presented as the method to collect the data which is the opinion of the game player and then analyzed the efficiency of the serious game. They proposed the EGameFlow as the assessment tool for evaluating the game efficiency. The EGameFlow is the survey questionnaire to measure the game enjoyment and knowledge improvement. The EGameFlow is based on GameFlow theory which is the series of the criteria to measure the enjoyment of the game. Fu, Su, and Yu (2008) reformatted the GameFlow to be the questionnaire and added the factor for measuring the increasing of the knowledge into the questionnaire. This survey questionnaire assesses the 8 factors. These factors include concentration, goal clarity, feedback, challenge, autonomy, immersion, social interaction, and knowledge improvement. The EGameFlow questionnaire is shown in Appendix J.

2.5 Capability Maturity Model

This section presents the methodology which be applied in this research. It is used to provide the knowledge game levels. Capability Maturity Model (CMM) was developed by Software Engineering Institute of Carnegie Mellon University. This project was sponsored by the US Department of Defense Software Engineering Institute (SEI). The initiative purpose of CMM development was to develop a tool for evaluating the ability of software contractors of the federal government. Even though CMM was developed based on area of software development, it can be used widely to apply in various fields as a general model of the maturity of process.

This methodology describes essential attributes that would be expected to characterize an organization at a particular maturity level. A maturity level is a well-defined evolutionary period toward achieving a mature process. Each maturity level provides a layer in the foundation for continuous process improvement. Each level comprises of a set of process goals that when satisfied, stabilize an important component of the software process. Achieving each level of the maturity framework establishes a different component in the software process, resulting in an increase in the process capability of the organization. Kim and Grant (2010) stated that CMM offers guidelines about essential requirement and component of each maturity level.

The CMM organizes the capability of software process development into five levels and prioritizes improvement action for increasing software process maturity (Paulket al., 1993). The CMM levels can be explained as follows:

- Initial: The process in this level is characterized as ad hoc and chaotic. The organization operates without procedures, cost estimates, and plan. The organization cannot maintain the process. The software process capability of initial level organization is unpredictable as the process is changed or modified as the work progress. Process performance depends on the capabilities of individuals and varies with their skill, knowledge and motivation. The processes success depends on an individual effort.

- Repeatable: In this level, the organization sets up the policies for managing the project and procedure. The basis of project management is processed. The process approach is developed based on the repeat of successful similar project in the past. The planning and monitoring of project is stable and post similar project successes can be repeated.

- Defined: The process for developing and maintaining the project is documented, standardized, and integrated into a standard process of

68

the organization. Processes established at the defined level are used to help the managers and technical staff perform more effectively. An training program is carried out to ensure that staff and manager have knowledge and skills required for perform the effective process. All projects use an approved, tailored version of the organization's standard process for developing and maintaining the project. The process capability of defined level organization can be summarized process procedure as standard and consistent.

- Managed: At this level, the organization sets the goal for both products and process. The process and product quality are measured in this process for improving propose. The capability of managed level organization can be called as predictable process because the process is measured and operated within measurable limits. An organization in this level has the capabilities to predict trends in process and product quality.

- Optimizing: In this level, the continuous process improvement is considered. The weaknesses and strengthen of the process can be identified. Data on the process effectiveness is utilized to perform cost benefit analyses of new technologies and proposed changes to the process. Innovations are identified and transferred throughout the organization. The lessons learned are disseminated to other projects.

CMM is a method for evaluating the ability of the organization. Although CMM is originally developed for software development, it can be used in various fields as a general model of the maturity of process. These include for example, software engineering CMM, and people CMM (Williams, 2008). Siemens AG (2002), for instance, developed the Knowledge Management Maturity Model (KMMM) based on CMM. Siemens AG uses the KMMM as the instrument for defining current position and driving long-term corporate development. The KMMM defines five maturity levels of knowledge management as follows:

69

- Initial: In this level, the KM process in organization is not consciously controlled. The successful of the related activities are not as the result of planning.

- Repeatable: At this level, organizations have realized the importance of KM Activities. The KM process are utilized in the organizational processes. With pilot projects the probability of success of the projects are discussed within the organization. If results of process are favorable, these activities are the beginning of KM process in organization.

- Defined: At This level, there are practiced KM activities which are supported from individual part of the organization. These activities are implemented in the work processes of individual part of the organization.

- Managed: There are common strategy and standards KM approaches in an organization. The indicators for measuring the efficiency of KM activities are set up. These activities are conducted long-term and organization-wide.

- Optimizing: Organization can develop and adapt the KM activities in order to meet their new requirements or new challenge. The measuring tools are used in combination with other measuring tools for organizational strategic control.
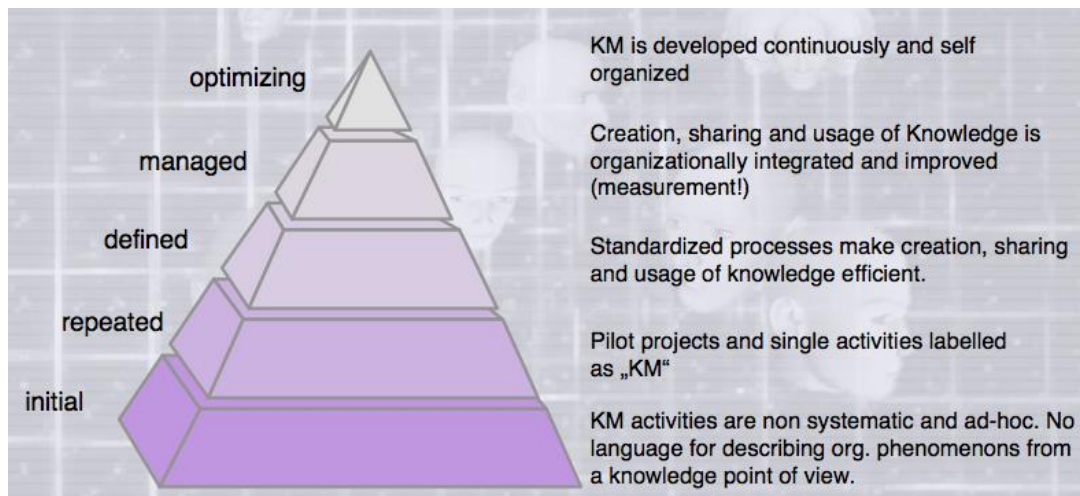
The KMMM framework is as shown in Figure 2.10.

Figure 2.10 KMMM Framework
Source: Siemens AG, 2002

2.6 Knowledge Engineering

Knowledge engineering has evolved at late 1970s from the art of building expert systems, knowledge-based systems, and knowledge-intensive information system. Knowledge engineering is the methodology which is used to emphasize the acquisition of knowledge about the process and representing it in knowledge-based systems. It is a field within Artificial Intelligence (AI) that develops knowledge-based systems. Such systems are computer programs that contain large amounts of knowledge, rules and reasoning mechanisms to provide solutions of problems. The goal of knowledge engineering is tuning the process of constructing knowledge-based system from the art into an engineering discipline. This requires the analysis of the building and maintenance process and the development of appropriate methods, languages and tools for developing KBS.

Knowledge engineering is the methodology that can be applied with interviewing method to collect the knowledge and experience of expert in an organization. Basically, knowledge engineering focuses on the acquisition of

71

knowledge about the process, and represents it in the knowledge-based systems. Such systems are computer programs that contain large amounts of knowledge, rules and reasoning mechanisms to provide solutions of problems. Knowledge engineering comprises of several activities such as knowledge acquisition, knowledge representation, knowledge validation, knowledge utilization, and etc. The important knowledge engineering frameworks that have be widely used are CommonKADS (Schreiber et al., 1999), MIKE (Model-based and Incremental Knowledge Engineering) (Angele et al.,1996) and PROTÉGÉII (Eriksson et al., 1995). Studer, Benjamins and Fensal (1998) studied and compared three KE frameworks mentioned above. They stated that CommonKADS is prominent for having defined the structure of the expertise model (knowledge model). MIKE puts emphasis on formal and executable specification of the expertise model as the result of the knowledge-acquisition phase, whilst PROTÉGÉ exploits the notion of ontologies. It provides a modelling tool for ontological analysis of organizational knowledge. Therefore, CommonKADS and MIKE are similar in that a major contribution of the approach is its proposal for structuring the expertise model. In contrary, the PROTÉGÉ is different from CommonKADS and MIKE in the sense that it focuses on organization knowledge level. In this paper, the KE methodology is applied to elicit and model the knowledge of the organization's experts in order to create the competencies of switchgear maintenance task. As a consequence, this research emphasizes on the development of the expertise knowledge (expertise model). Therefore, only CommonKADS and MIKE are suitable for this research.

Under CommonKADS, the organization model, the task model, the agent model, the communication model, the knowledge model, and the design model are distinguished. The first three models are regarded as the context level, which analyses the organizational environment and the corresponding critical success factors for a knowledge system. The knowledge model (or expertise model) and communication model are categorized in the concept level. This level yields the conceptual description of problem-solving function and data that are handed and delivered by knowledge system. The knowledge model is a major contribution of CommonKADS approach. The purpose of this model is to explicate in detail the types and structures of the

knowledge used to perform the task. Finally, the design model is the artifact. This level combines the above levels together in order to construct the requirement specification for the knowledge system (Schreiber et al., 1999).

MIKE (Angele et al., 1996) is the KE methodology, which provides a development process covering all steps of knowledge-based system development. MIKE proposes the integration of semi-formal specification and formal specification techniques and prototyping to develop the expertise model. The first process of MIKE is knowledge elicitation to create the knowledge protocols, which is expressed in natural language. Methods, like structured interviews, are used to elicit the informal description of the knowledge in this elicitation process. Then, the knowledge protocols are represented in a semi-formal form of the expertise model. This representation provides an initial structured description, and can be used as a communication basis between the knowledge engineer and the expert. This second process is an interpretation process, which transforms the knowledge protocols to be structured model. The structure model is the foundation of the formalization process. The result of the formalization process is the formal expertise model or the KARL (Knowledge Acquisition and Representation Language) model. The KARL model contains the description of domain knowledge and knowledge about the problem-solving method. The KARL model also captures all functional requirements for the final knowledge-based system. Then, the KARL model is used in the design process to consider the additional non-functional requirements. Therefore, the design phase in MIKE constitutes the sufficient detail design. The result of the design process is to transform KARL model to designKARL Model. The design model captures all functional and non-functional requirements for implementing the knowledge-based system in the implementation process.

2.6.1 CommonKADS

CommonKADS is the famous framework which supports structured knowledge engineering methodology (Schreiber et al., 1999). It was developed from KADS. CommonKADS is the EU de facto standard methodology for supporting design and implementation of knowledge systems. It has been used in many projects to develop the knowledge-based system and also widely used to implement the Knowledge Management

73

Project. It is used to support the development of knowledge systems that support selected parts of the business process. CommonKADS or KADS (previous version of CommonKADS) has been broadly applied in the power business, for instances, knowledge management for planning, design, operation, maintenance, asset management and regulatory issues. This method has been developed in CEC Esprit fund projects since 1984.

CommonKADS enables organization to spot the opportunities in how organizations develop, distributes and applies their knowledge resources, and also gives tools for corporate knowledge management. It also provides the methods to perform a detailed analysis of knowledge-intensive tasks and processes. CommonKADS provides a method to model knowledge of the organization and represent knowledge with notation. It gives the benefit to develop the knowledge systems that support selected parts of the business process. It is a complete methodological framework for the development of a knowledge management. In summary, it supports most aspects of a knowledge management development project, such as project management, organizational analysis (including problem/opportunity identification), knowledge acquisition method (including initial project scoping), knowledge analysis and modelling, capture of user requirements, analysis of system integration issues, and knowledge system design. CommonKADS or KADS (previous version of CommonKADS) has been broadly applied in the power business, for instance, knowledge management for planning, design, operation, maintenance, asset management and regulatory issues. KADS can be applied to capture the knowledge and experience from the power system protection design experts and store them in the knowledge management website (Strachan et al., 2001). Moreover, CommonKADS provides the common knowledge model templates to elicit knowledge and experience from experts. These templates can be used as a guideline to set up the questionnaires for the knowledge elicitation process. These templates can be categorized into two groups of analysis task group and synthesis task group. Analysis tasks take input data about the system and produce some characterization of the system as output. On the other hand, synthesis task, the system does not exist. The purpose of the task is to construct a system description by requirement data input.

A basic characteristic of CommonKADS is the construction of a collection of models, where each model captures aspects of the KBS. The CommonKADS consists of 6 sub-models: Organization Model, Task Model, Agent Model, Knowledge Model, Communication Model, and Design Model. The CommonKADS model suit is shown in Figure 2.11. The details of the sub-models are described below.

- Organization Model: This model supports the features analysis of organization to find out the problem and opportunities for knowledge systems, establish the feasibility, and assess the impacts of knowledge action in an organization.

- Task Model: This model relates to subparts of a business process. It analyzes the global task layout, inputs and outputs, precondition and criteria, resource needs and competence.

- Agent Model: This shows the stakeholder of the task which can be human, an information system, and section in the organization. The agent model presents the characteristics of the agents including with competencies, authority, and constraints in this respect.

- Knowledge Model:The knowledge model is used to define the types and structures of the knowledge used to perform task. It provides the description of the role that different knowledge components play in problem solving. Knowledge Model is important for communicating between experts and users about problem-solving aspects of the knowledge system.

- Communication Model: Since several agents may participate in a task, it is very important to show the communicative transactions between agent and the communication model will present this communication.

75

- Design Model: The design model gives the system specification in terms of the architecture, implementation platform, software modules, representation constructs, and computational mechanisms need to implement the functions laid down in the knowledge and communication model.
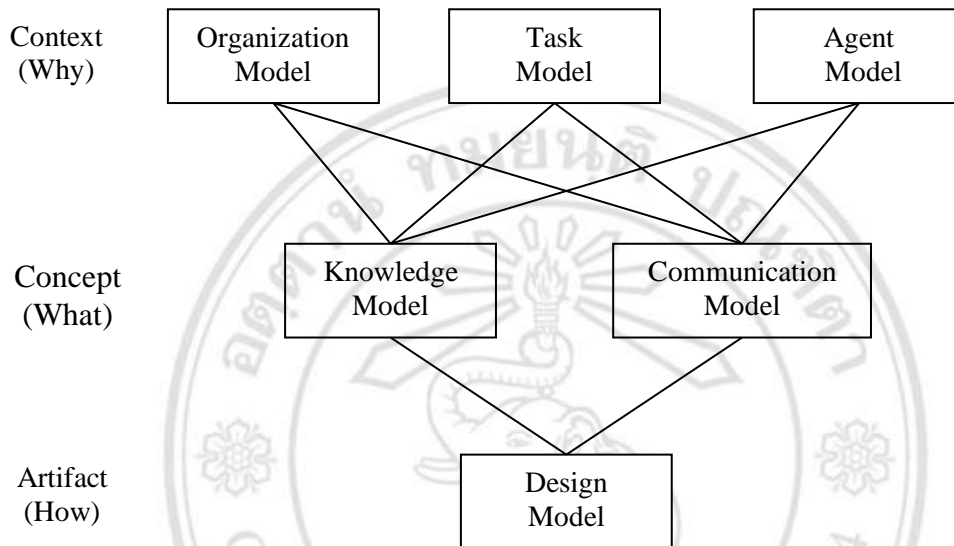

Figure 2.11 The CommonKADS Model Suite
Source: Schreiber et al., 1999

CommonKADS defines the knowledge model with a building block of task, inference, and domain knowledge. It is a tool to clarify the structure of knowledge intensive task and it specifies the knowledge and reasoning requirement of the prospective system. Therefore, the knowledge model can be divided into 3 categories which are shown in Figure 2.12.
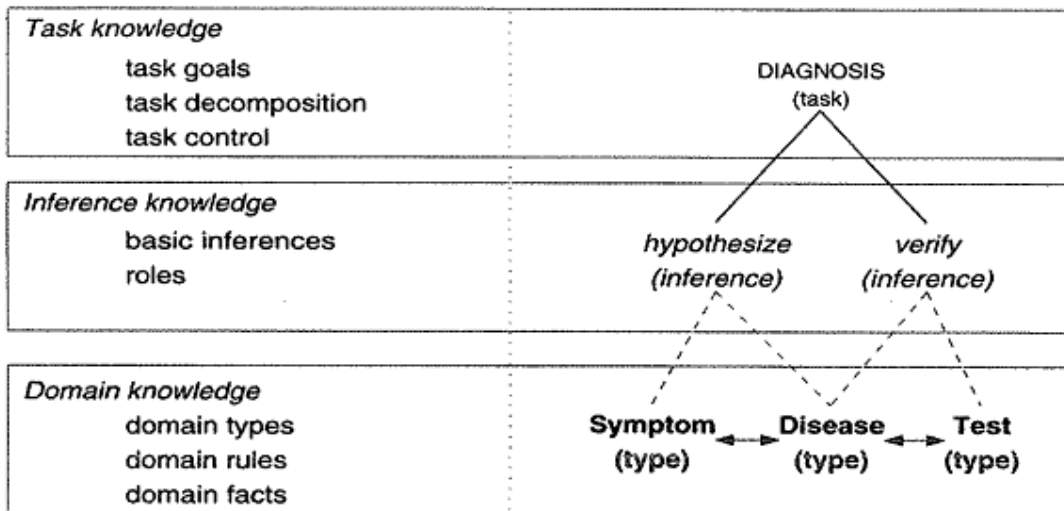
Figure 2.12 Overview of Knowledge Categories of CommonKADS

Source: Schreiber et al., 1999

- Task knowledge: Task Knowledge explains the goals of the application. It defines that how these goals can be realized into inferences. It contains knowledge about how elementary inference can be combined to achieve a certain goal. Task knowledge can commit to achieve a particular goal. Tasks represent fixed strategies for achieving problem-solving goals.

- Inference knowledge is to control knowledge that we abstract from the domain theory and describe the inference that we want to make as rationale in this theory.

- Domain knowledge embodies the conceptualization of a domain for a particular application in the form of a domain theory. Domain knowledge can be viewed as a declarative theory of the domain. In fact, adding a simple deductive capability would enable a system in theory to solve all problems solvable by the theory.

Moreover, CommonKADS provide the common knowledge model templates to elicit knowledge and experience from experts. These templates can be divided into two groups of analysis task group and synthesis task group shown in Figure 2.13. Analysis tasks take input data of the system and produce some characterization of the system as output. On the other hand, synthesis task, the system does not exist. The purpose of the task is to construct a system description by requirement data input. Table 2.3 and 2.4 show an overview of the main knowledge model templates.
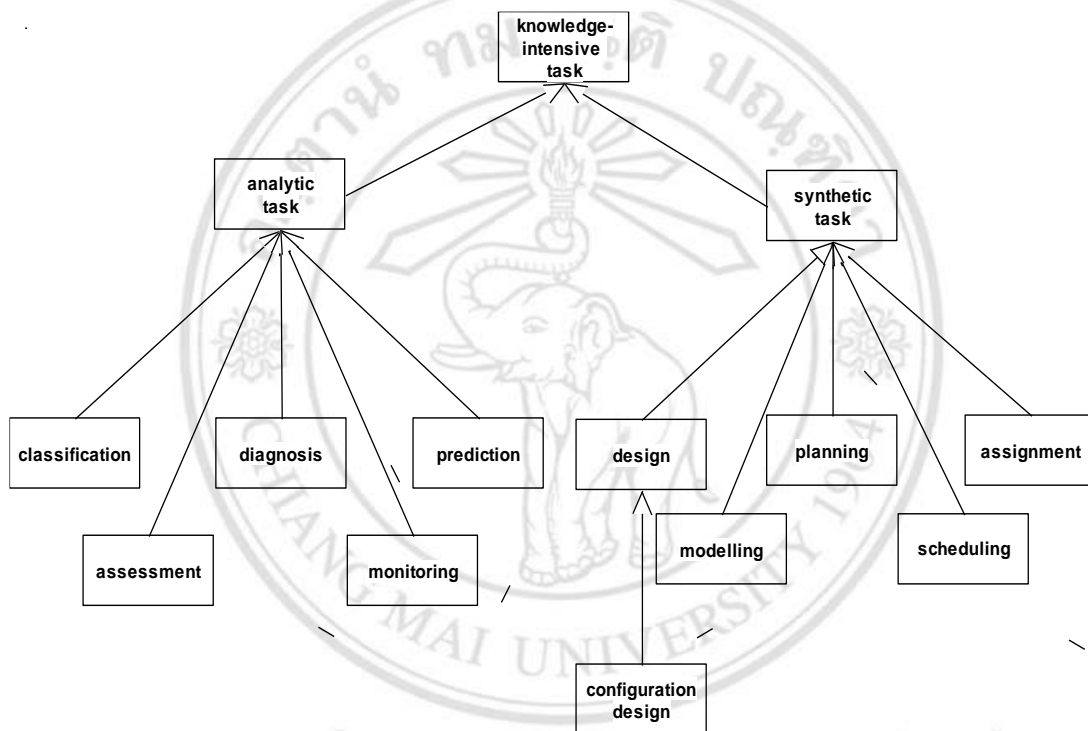

Figure 2.13 Task Hierarchy Diagram
Source: Schreiber et al., 1999

Table 2.3 Overview of Knowledge Model Template of Analytic task

Task type	Input	Output	Knowledge
Classification	Object features	Object class	Feature-class associations
Diagnosis	Symptoms/ complaints	Fault category	Model of system behavior
Assessment	Case description	Decision class	Criteria, norms
Monitoring	System data	Discrepancy class	Normal system behavior
Prediction	System data	System state	Model of system behavior

Source: Schreiber et al., 1999

Table 2.4 Overview of Knowledge Model Template of Synthesis task

Task type	Input	Output	Knowledge
Design	Requirements	Artifact description	Components, constraints, preferences
Configuration design	Requirements	Artifact description	Components, skeletal designs, constraints, preferences
Assignment	Two object sets, requirements	Mapping set 1 → set 2	Constraints, preferences
Planning	Goals, requirements	Action plan	Actions, constraints, preferences
Scheduling	Job activities, resources, time slot, requirement	Schedule = activities allocated to time slots of resources	Constraints, preferences

Table 2.4 Overview of Knowledge Model Template of Synthesis task (Continued)

Task type	Input	Output	Knowledge
Modeling	Requirements	Model	Model element, template models, constraints, preferences

2.6.2 Application of CommonKADS in Capability Classification Model Development and Scenario Development

In this research, the CommonKADS methodology is applied to elicit the knowledge and experience of experts in the organization. These knowledge and experience are resource materials to set up the capability classification model and develop the game scenario. CommonKADS inference templates are used as a guideline to interview the experts. According to the learning model on maintenance tasks, the CommonKADS templates including the planning inference template, the diagnosis inference template, the scheduling inference template, the monitoring inference template, and the assessment inference template (Chandarasupsanget al., 2008) are selected and applied for the knowledge elicitation as shown in Figure 2.14.
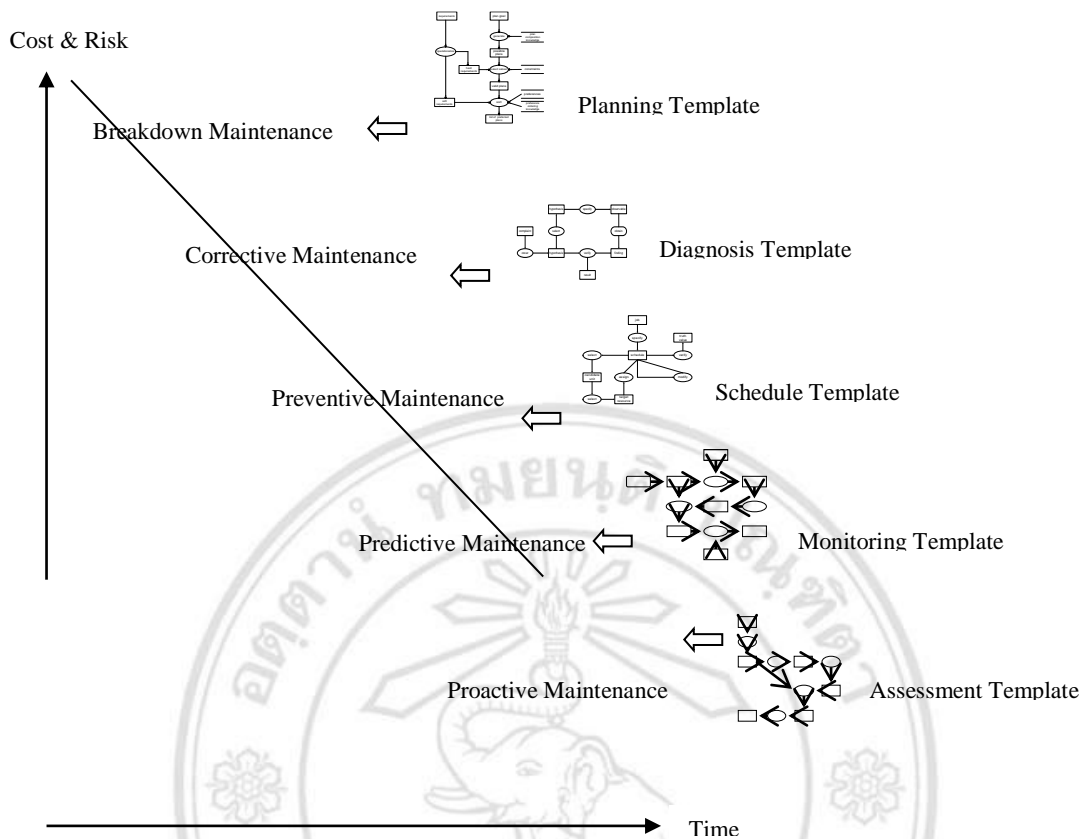
80

Figure 2.14 Organizational Learning Model on Maintenance Activities
Source: Chandarasupsang, Chakpitak, Dahal (2008)

2.7 Game Theory

Game theory is the methodology for considering the rational behavior in interactive situations where the actions relate to one another's outcome. Game theory has been used to study and analyze human behavior. It is concerned with decision-making in organizations where the outcome depends on the decision of two or more autonomous player. Game theory is the theory for studying the dependent and independent decision-making. It is used for analyzing the strategic positions of various parties who engaged in the decision-making game. In the game theory, the individual chooses the strategy that provides the maximum benefit for himself.

Initially developed in economics, the use of game theory in the social sciences has expanded, and it has been applied to political, sociological, and psychological behaviors as well. Game theory also has been used in the knowledge manage

81

research. Alton Chua (2003) used game theory to understand knowledge-sharing in the organization. He defined that knowledge sharing is controlled by the perceived payoff. Examples of this payoff include social, economic and political bearing specific to the one who shares and to the environment where the knowledge sharing occurs.

Normally, the game theory has three components including a set of players, a set of strategies of each player, and a preference over all strategies or pay-off. The payoff is numbers which represent the motivations of the players. It measures how the player does in the possible outcome of a game. It is measured in terms of rewards such as money or the utilities that a player derives from a particular outcome of a game.

The rules of a game theory describe as how one player's behavior impacts on other player's pay-offs. Games are characterized by the order of the player move. Normally, there are 2 main forms used in the study of games. They are normal game and extensive game.

The normal games or strategic games: are the games that players move at the same time or their moves are hidden. The players cannot know the move of the other. The players in this game choose their strategies at the same time. This kind of game is often analyzed by using payoff matrix. The normal game is defined by the three objects:

- The set of players, N = {1, 2, … , n}
- The strategy sets of the players, A1, A2,…, An
- The pay-off functions of the players, f1(a1,…,an), …. , fn(a1,…,an)

The prisoners' dilemma is the one example of normal game. It is presented as follows;

The two suspects (prisoner A and prisoner B) are arrested and placed in separate cells. The police have insufficient evidence for a conviction. Prisoners are interviewed separately and there is no contact between them. They decide individually to confess or deny the crime. The set of players in this game is {prisoner A, prisoner B}. The strategy sets of the players {(confess, confess), (confess, don't confess), (don't confess, confess), (don't confess, don't confess)}. If one prisoner A chooses to confess and prisoner B chooses to deny, prisoner A gets 1 year imprisonment and prisoner B gets 10 years. If both

82

deny, they just get only 2 years in jail. If both confess, they get 5 years imprisonment. The pay-off matrix of this game can be written as follows:

Table 2.5 Pay-offs Matrix of the Prisoners' Dilemma Game

<div align="center">prisoner B</div>

		confess	deny
prisoner B	confess	(5,5)	(1,10)
	deny	(10,1)	(2,2)

From the point of view of prisoner A;
- if B confesses, I should also confess
- if B denies, I should again confess

From the point of view of prisoner B;
- if A confesses, I should also confess
- if A denies, I should again confess

In this game, the dominant strategy of both player are confessed. However, if both prisoners could cooperate successfully, they would get a better outcome for both (2 years imprisonment). But they cannot cooperate, thus, the dominant strategy is the best result that can be achieved when deciding individually.

Extensive games are the games that one player moves first. The other player will see the first player decision. Therefore, he can decide how to respond after first player moves. In this game, we often use game tree for analyzing the play-offs of each player.
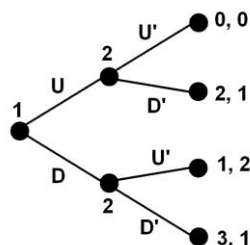

Figure 2.15 Extensive Form or Game Tree

2.8 Chapter Summary

This chapter presents the literature review on related methodology of this research. This chapter starts with the review of HRD methodology. This part explained about the definition of HRD, and its framework. It also presents the existing HRD method in the Power industry companies in the world. In the end of this part, it presents about the learning theory which is related to HRD efforts and workplaces learning. The result of this part can express some problem of existing HRD efforts and give some ideas to create the solution.

As Robert Gagne mentioned in his research, the practice and reinforcement cannot improve performance in any field of training. He represents in three military tasks: gunnery (a motor skill), turning on the radar set (a procedural task), and diagnosing malfunctions in complex electronic device (troubleshooting). With this concept, it can be concluded that some skills cannot be thought by traditional training methods such as visual inspection skill of maintenance processes. However, this skill can be taught with learning by doing method such as on-the-job training, or simulation. Therefore, it gives an opportunity to use the computer game to solve the problems which occur in traditional training.

The last two methodologies, capability maturity model and knowledge engineering, can be used to develop the knowledge game. The capability maturity model gives the idea to classify the level of capability of employees. Therefore, this methodology can be used to be the tools for setting up the game levels. Knowledge engineering is the methodology for using to capture the knowledge and represent it with notations. By this methodology, the scenario and game story can be developed.