An Overview of the Development of a Computerised Employee Performance Measurement Tool – *ECAS*

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ABSTRACT

It is always said that the employee is the most important asset to a company in K-economy, especially in the Information Technology (IT) industry. However, many companies are not able to measure the real value of this so called "most important asset". Today, there are various development tools that can help IT professionals develop software more efficiently. There are, however, not many tools or performance evaluation systems that can be used to quantify employees' contribution to the company. Flawed or weak performance evaluation system fails to reward star performers, fails to provide encouragement and guidance to borderline workers and fails to give proper feedback to those whose work is substandard (Johnson, 2001). This paper highlights the establishment of a measurement model, the Balanced Appraisal Model (BAM) and the development of an automated competency measurement tool, Employee Competencies Appraisal System (ECAS) to measure the competencies of employee involved in software development such as analyst programmer, software engineer and system analyst. This model measures an employee's performance from three different perspectives - personal traits, business competencies and technical competencies.

Key words: Performance appraisal, Balanced Appraisal Model, BAM, Employee competencies, Employee Competencies Appraisal System, ECAS

INTRODUCTION

The most important asset to an IT company is the knowledge of their staff but yet still many companies do not know how to measure the real value of this so called "most important asset". A survey conducted by McKinsey on a poll of managers at big companies found that only 16% said their employer could even recognise the difference between star employees and slackers (Jenkins, 2001). A lot of companies use the same performance evaluation system for all staff in the company, regardless from which department they are. This one-size-fits-all evaluation system is not only unable to evaluate ability of software development staff, but also creates a lot of dissatisfaction among employees because the evaluation is based on some factors that are not related to their work. Unfortunately, this is the normal practice in most companies. Some companies may have the performance evaluation form that focuses on personal attributes of employees. This kind of evaluation form is easier to fit into all departments because it does not measure the values required for a specific job function.

Without a suitable measure, a company is not able to decide on appropriate compensation and benefits for employees. Employees who are capable and dedicated may end up being compensated with the same amount or even less, compared to their not-so-competent peers. This unhealthy practice may discourage the top performer from contributing to the company and ends up as an average employee. In the worst case, the company may lose the best employee but keep the low performers.

A research that focuses on establishing an appropriate competency model namely, Knowledge, Attitude and Practice Model (KAP Model), that can be used to measure the competency level of employees involved in software development was developed by Ow and Yaacob (Ow and Yaacob, 1998). Based on the KAP Model, a balanced competency model known as *Balanced Appraisal Model* (BAM) was established and can be adopted to measure the competency of employee involved in software development. An associated automated tool was also developed to support the complicated measurement process of the model. Adoption of this model hopefully can help companies identify and retain the best employees, conduct training program that are best suited for the employees and identify the low performers in the company.

This model consists of a set of metrics that are tailored for employees playing the role as Analyst Programmer, Software Engineer, Software Developer or System Analyst. This model measures competencies of employees from three different perspectives, namely, Personal Traits, Business Competencies and Technical Competencies. Personal traits measure the personal attributes of employee such as initiative, flexibility and creativity. Technical competencies are the skills or functional knowledge, which are directly related to employee job function such as programming skills, requirement study and database design. Business competencies refer to the set of skills that are not directly related to the job function of employee but are important in the business environment such as communication skills, time management and leadership skills. IT professionals involved in software development should have a balance of these three sets of competencies. Besides measuring the past performance, this model also emphasises on future development of employees.

BALANCED APPRAISAL MODEL (BAM)

The measurement of an employee using the BAM model is conducted, using an electronic performance appraisal form that evaluates competencies from different perspectives. The electronic performance appraisal form is divided into three sections: Personal Traits, Business Competencies and Technical Competencies. As this research is focusing on employee competencies in software development, the competencies in this model are more relevant to employees involved in software development. They include analyst programmer, software developer, software engineer and, to some extent, system analyst and project leader. However, the business competencies and personal traits may also be applied to other job functions with slight modification because the competencies in these two sections are common across all job functions, especially the personal traits.

Each section is further divided into several key competency areas (KCAs). For example, the Technical Competencies section includes Requirement Study, Programming and Training in the key competency areas. Each key competency area consists of a set of key competencies (KCs) which are the major elements or end results for a job, often obtained as the answers

to the questions "What is the purpose of the job?" or "Why does the job exist?" (RajKumar, 2002). Each key competency has 5 corresponding key competency levels (KCLs) and each key competency level is given a score ranging from 0 to 4, with 0 as the lowest score and 4 as the highest score. The score starts with 0 instead of 1 because the unacceptable level should be given 0 score instead of 1. Scoring from 1 to 5 with 3 being the middle score also encourages appraisers to 'play safe' by choosing the 3 as the middle point. The relationship among KCAs, KCs and KCLs is shown in Table 1.

Table 1. BAM Model framework and relationship among KCAs, KCs and KCLs.

Functional Competency		
Key Competency Areas (KCAs)	**Key Competencies (KCs)**	**Key Competency Levels (KCLs)**
Requirement Study	Requirements Study Awareness	0 - Not sensitive to giving priority to requirements study and tends to make requirements decisions during programming. 1 - Usually makes requirements decisions during design phase. 2 - Makes requirements study as the first step in developing software. 3 - Reviews the documented requirements together with other team members. 4 - Reviews the documented requirements together with all stakeholders and gets approval from them before proceeding to the design phase.
	Project Score Estimation	0 - Usually does not define goals and objectives of a project. 1 - Project goals and objectives are usually poorly defined. 2 - Project goals and objectives are clearly defined. 3 - Defines features that are to be part of the final project scope. 4 - Clarifies and spells out features that will not be included in the project.
	User's Interview	0 - Not able to get necessary information from users during interview. 1 - No clear objective for the interview but still able to get some required information. 2 - Set clear objectives and goals set for the interview to get all required information. 3 - Able to guide interviewees to focus back to the scope when interviewees go out of scope. 4 - Able to control the interview and keep it in focus within the scope to elicit the required information in the shortest time possible.

Score calculation

The score calculation formulae used in BAM are derived from the Knowledge, Awareness and Practice (KAP) model (Ow and Yaacob, 1998). The formulae used to calculate score in BAM are as follow:

a. Score given for a KC, S_K

$$S_K = W_K \times P_K \quad \text{for } K = 1, 2, 3,\ldots, n$$

Where, K = the Kth KC in the performance appraisal
n = Total number of KCs in the performance appraisal
W_K = Weightage for the Kth KC
P_K = Point given to the Kth KC

b. Total score obtained by an employee, S_E

$$S_E = \sum_{N=1}^{N=n} S_K \quad \text{for } N = 1, 2, 3,\ldots, n$$

Where, n = Total number of KCs in the performance appraisal

c. Total score of performance appraisal form, S_T

$$S_T = \sum_{N=1}^{N=n} (W_K \times P_M) \quad \text{for } N = 1, 2, 3,\ldots, n$$

Where, n = Total number of KCs in the performance appraisal
W_K = Weightage for the Kth KC
P_M = Maximum points for the Kth KC

d. Competency score for employee, CS

$$CS = (S_E / S_T) \times 100\%$$

Where, S_E = Total score obtained by employee
S_T = Total score of performance appraisal

The weightage of the KCs can be changed according to the organisation needs. In fact, weightage setting is a very efficient method to align employee's focus to reflect department and organisation's goals. The competencies that are important for achieving the department's goals should be emphasised by giving higher weightage. This weightage should be communicated to employees in advance so that the employees know what to focus on.

The result from the competency scores can contribute to compensation plan, training need analysis and job assignment. This model adopted the forced-ranking system, a model that is adopted by a lot of industry leaders such as Microsoft, GE, Ford, and so on. Table 2 shows the grading system proposed in this model. It ranked employees into 5 different grades, based on the competency score obtained. Compensation will be distributed to employees according to the grading scheme. The higher-graded employees will receive bigger share of benefits compared to the lower-graded counterparts. The top 10% will be ranked as grade A and will be rewarded nicely while the lowest 10% or grade E employees will be given attention.

Table 2: BAM grading scheme

Grade	Competency score	Competency level
A	Top 10%	High
B	Next 15%	Fairly high
C	Next 50%	Average
D	Next 15%	Fairly Low
E	Lowest 10%	Low

Training need analysis is applied to all employees, no matter they are grade A or grade E employees. This model uses the score obtained for each KC as the input to training need analysis instead of the total competency score because the total competency score cannot tell exactly what are the areas employees need to be trained. Appropriate training can be established and targeted to the right group of employees based on the score obtained from KC. The KC scores from this model can also be used as a reference to job assignment and selection of project group members. Employees with strength in different areas can be selected to form project group where the skills of each employee can complement each other's.

FUNCTIONALITY OF ECAS

ECAS is a competency measurement tool specifically designed for IT professionals involved in software development. This competency measurement tool, however, can be extended to cater for other job functions by adding in competencies, specifically designed for the targeted job function. ECAS will be utilised by two types of users: administrator, who maintains the system and employee, who uses the system to do performance evaluation. The main functions of ECAS are illustrated with two sets of Use Case diagrams – one for administrator and one for employee. Figure 1 shows the Use Case diagram for administrator and Figure 2 shows the Use Case diagram for employee.

Administrator

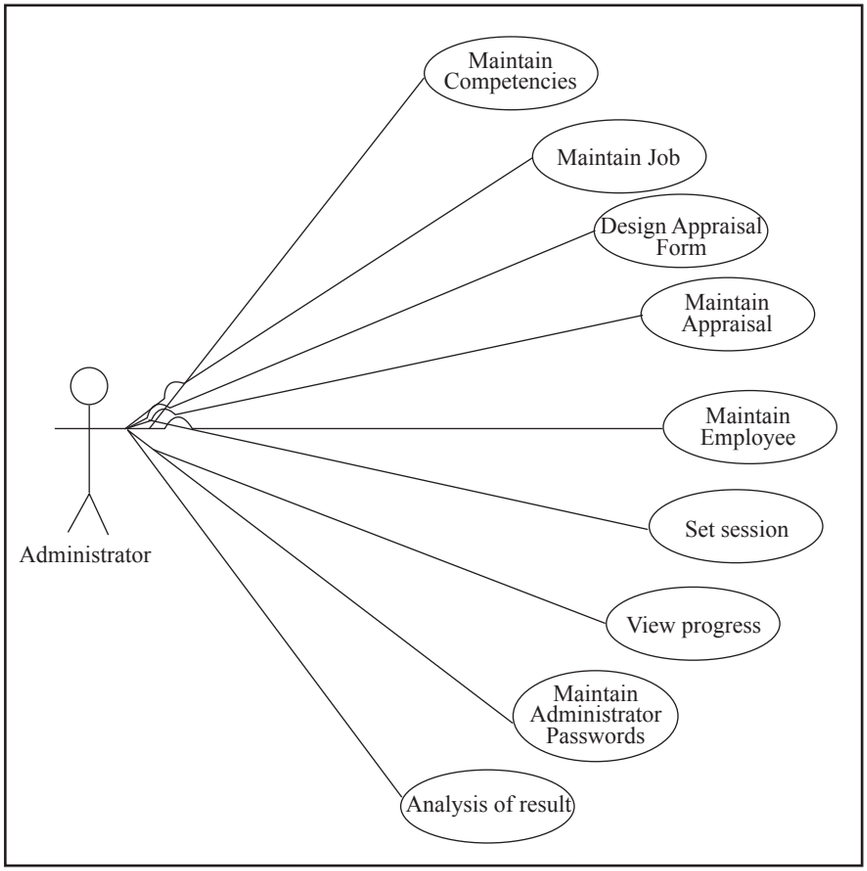

Figure 1. Administrator Use Case diagram

1. Maintain Competencies

Administrator is able to add, edit or delete competencies in the database. By default, ECAS comes with a set of competencies for IT professionals involved in software development. The competencies are categorised into 3 sections: Personal Traits, Business Competencies and Technical Competencies. ECAS is flexible enough to allow an administrator to add more categories of competencies into the system besides the three categories mentioned. The competencies in each category will be further broken down into key competencies area (KCA) and key competencies (KC). Each KC has five associated key competency levels (KCLs). Each KCL is given a point, ranging from 0 to 4. ECAS is not limited to measure performance of IT professionals involved in software development. If the competencies from other job perspectives are added into the database, the measurement of employee competency for the specified job can also be conducted using ECAS.

2. Maintain Department

An administrator is allowed to maintain departments in this system. Each employee must be associated to one department in the system. No employee can exist without a department.

3. Manintain Job

An administrator can add job function into the system. Analyst Programmer, Software Engineer and Software Developer are the default job title since this measurement tool is designed specifically for professional involved in software development Administrator can add other job title into the system in order to measure competency of other job function with ECAS.

4. Design appraisal form

In designing appraisal form. relevant competencies are selected from the pools of competencies in the database. The competencies are divided into different sections. Competencies for each section are selected according to their category. Each category is further broken down into Key Competency Areas. Each Key Competency Area consists of a set of Key Competencies. When designing the appraisal form, different weightage can be assigned to each key competency.

5. Maintain appraisal

ECAS supports both 180-degree appraisal system and 360-degree appraisal system. The appraisal process starts with self-appraisal. After the employee has completed with the self-appraisal, the appraisal form will flow to the superior of the employee. After the superior has completed the performance evaluation together with the employee, the form will automaticall flow back to system administrator. Besides flowing up, ECAS also supports peer reviews and subordinate reviews. After the employees have completed their appraisal form, they will be given a chance to select the peers and subordinates to review their performance.

6. Maintain Employee

Administrator is allowed to maintain employees' information in ECAS. Each employee will be given a user name and password to login into the system.

7. Review Period Maintenance

Administrator is able to set when to start and end the appraisal session. Once the administrator starts the session, appropriate appraisal forms will automatically flow to all employees. Employees are allowed to do the performance appraisal within the session period. Employee will be notified through email on the performance appraisal date.

8. View progress

After the appraisal session starts, administrator is able to see the status of all appraisal forms. Administrator can see which appraisal forms have been completed and which forms are still pending so that appropriate actions can be taken.

9. Maintain Administrator password

The default administrator user name and password are FSKTM and FSKTM respectively. Administrator is advised to create a new user name and password once they login into the system for the first time. Once a new password has been created, the default user name and password will be deactivated.

10. Analysis of result

Administrator can perform analysis of results by comparing the competency score obtained by employees. Various kinds of reports and graphs will be available to administrator to do analysis on the results.

11. Training Need Analysis

System administrator is able to analyse employees' needs on training, based on the score they obtained in each key competency. Employees who fit into the training need criteria, supplied by system administrator, will be listed out.

Employee

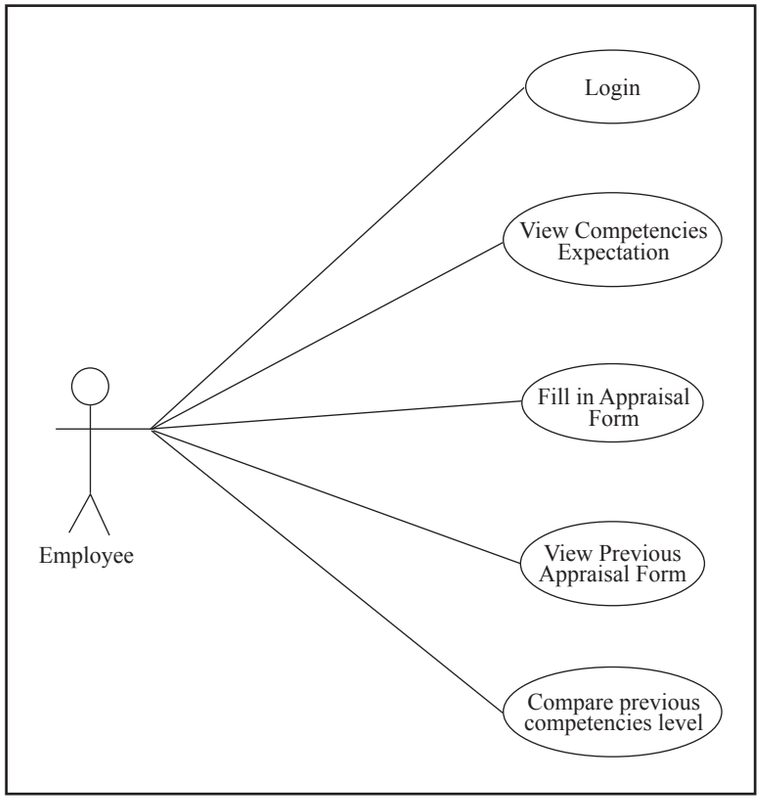

Figure 2. Employee Use Case diagram

1. Login

Ony authorized employees can have an access to ECAS. Every employee will be give a user name and password created by the administrator. Employees can change their password but cannot change the user name.

2. View Competencies Expectation

Employees can view the key competencies and the expected competencies level set in the appraisal form throughout the year. Employees can also see weightage for each key competency. This open concept is to let employees know in advance what are the areas that

they need to focus on.

3. Fill in Appraisal Form

Employees can also do self-appraisal, peer review, subordinate review and superior review with ECAS. Once the administrator sets to start the appraisal session, appraisal forms will be sent to employees. Employees can open the appraisal form that is available to them and start the appraisal. After they have completed and submitted the appraisal form, the appraisal form will be rerouted to other appraisers such as superior, subordinates and peers for reviews. The contents of the self-appraisal will only be available to the employee's superior. The competencies score will be calculated automatically once the appraisal form is submitted.

4. View Previous Appraisal Form

Previous appraisal form will be kept as a reference for employees. Employees can view previous appraisal form throughout the year.

5. Compare Previous Competencies Level

Employees can view the difference of the competencies level among all the previous appraisal forms. This will give feedback to employees on which areas they have improved and which areas they are not doing well.

DEVELOPMENT OF ECAS

Due to the complexity of ECAS, it is necessary to utilise a structured-process model to guide the design, development and deployment of the system. ECAS utilises the Microsoft Solutions Framework (MSF) process model because of its wide adoption by many developers, architects and IT specialists (Bortniker and Conard, 2002).

ECAS was developed based on the 3-tier client server architecture where the system is separated into three logical layers – presentation, application logic and data management. Each layer provides specific function and is used by a layer above it. The presentation layer communicates with the application logic layer which provides specific functionality to the system. The application logic layer communicates with the data management service layer to read and persist data to the data store. This architecture will give advantages to ECAS in terms of scalability, performance and maintainability over the 2-tier client server architecture (Sommerville, 2001).

A database hosted on SQL Server 2000 provides data management services. Microsoft Internet Information Services (IIS) 5.0 Web server provides the application services. Any workstation computer with Web browser can act as the client machine.

The tools and technologies used

ECAS was built on Microsoft .NET, the latest platform for building distributed Web-based applications (Oancea and Donald, 2002). The tools and technologies used in building ECAS includes Windows 2000, Internet Information Services (IIS 5.0), SQL Server 2000, Microsoft .NET Framework, Visual Studio.NET, ASP.NET and VB .NET. There are various Web-based application development tools available to choose from to develop ECAS. VB

.NET and ASP.NET had been chosen to develop ECAS compared to other technologies and tools. The main contestants taken into considerations are Active Server Pages (ASP) with VBScript from Microsoft.

Active Server Pages (ASP) has been the leading Web development tool from Microsoft. Its success is due to its ease of use and flexibility, providing a simple way to create dynamic Web sites. ASP.NET is a new and powerful technology for writing dynamic Web pages which is a much more powerful technology than ASP. It is not just an upgrade of existing technology but is the gateway to a whole new era of Web development (Anderson et al., 2002). There are huge improvements in ASP.NET over ASP in the way applications can be installed, configured and updated. Components are no longer needed to be registered at the Web server. The whole Web application can be moved from one Web server to another by XCOPY command or FTP (Goode et al, 2002).

ASP.NET is able to tailor the HTML output to whatever browser the client is using. ASP.NET also comes with a great set of reusable controls for use in ASP.NET project which can reduce the amount of code that programmers need to write (Goode et al., 2002). ASP is restricted to only using scripting languages, mainly VBScript and JavaScript while ASP.NET allows the use of full programming languages such as VB .NET and C# which are more powerful and efficient. VB .NET has been chosen to develop ECAS as it is arguably the simplest to learn and it can do pretty much anything other languages can do.

According to Microsoft's product unit manager, Scott Guthrie, there is typically 3 to 4 times performance improvement when people rewrite their application from ASP to ASP.NET. A study released from Doculabs, an independent research and consulting firm in Chicago, shows dramatic performance improvements when moving from ASP and VB6 application to ASP.NET and Visual Basic. NET (Kiely, 2003). This performance difference alone is convincing enough to choose ASP.NET and Visual Basic .NET over ASP and VB6. Furthermore, VB6 itself has reached the "glass ceiling" in addressing the requirements of current technology (Connell, 2002; Kiely, 2003).

Programming in Visual Basic .NET requires programmers not only to understand the language itself, but also the .NET Framework and the infrastructure of how .NET programs are assembled. Although Visual Basic .NET requires a steeper learning curve compared to Visual Basic 6.0, Visual Basic .NET has been chosen to develop ECAS over Visual Basic 6.0 in favour of more power, flexibility and robustness (Connell, 2002).

SQL Server 2000 has been chosen over other database management systems because SQL Server 2000 integrated well with the .NET Framework. Microsoft has supplied its own managed provider, specifically designed to improve efficiency when integrating with .NET and Microsoft SQL Server (Bortniker and Conard, 2002).

Logical design of ECAS

ECAS utilises a 3-tier logical architecture. 3-tier architecture divides application into three logical layers or tiers. Tier 1 is the user service tier or sometimes referred to as presentation layers. This layer consists of user interface that user interacts with. From user point of view, this layer is the entire application. User service tier of ECAS consists of browser-based application that allows user to input, view and manipulate data. Simple validation and verification of data are also performed at this layer. This layer was developed from ASP.NET Web Forms that provide graphical user interface to user. Tier 2 is the business service tier, also referred to as business rules or business logic. This layer is responsible for encapsulat-

ing business transaction process, business rules, data access and any other application logic. Business service tier is the bridge between user service tier and back end data service tier. In ECAS, the business tier consists of a set of business objects, and both transactional and non-transactional business service components. Components in this layer were developed from VB .NET.

Tier 3 is the data service layer or data access layer, which is responsible for retrieving, saving and manipulating data stored in the SQL Server database. The data service tier of ECAS consists of stored procedures and triggers. The business service components retrieve and manipulate data in the database through these stored procedures. The use of stored procedure to manipulate data will improve the performance of ECAS significantly compared to dynamic Structured Query Language (SQL) statement manipulated from the application. This is because stored procedures have been compiled into the database together with the execution plan of the stored procedures. Moving the data manipulation process from application level to data level will also improve the performance of ECAS because this can reduce the round trips between the client application and the database server. Since only processed information is sent on network, there is less network bandwidth used compared to 2-tier client server model (Vieira, 2000) (Figure 3).

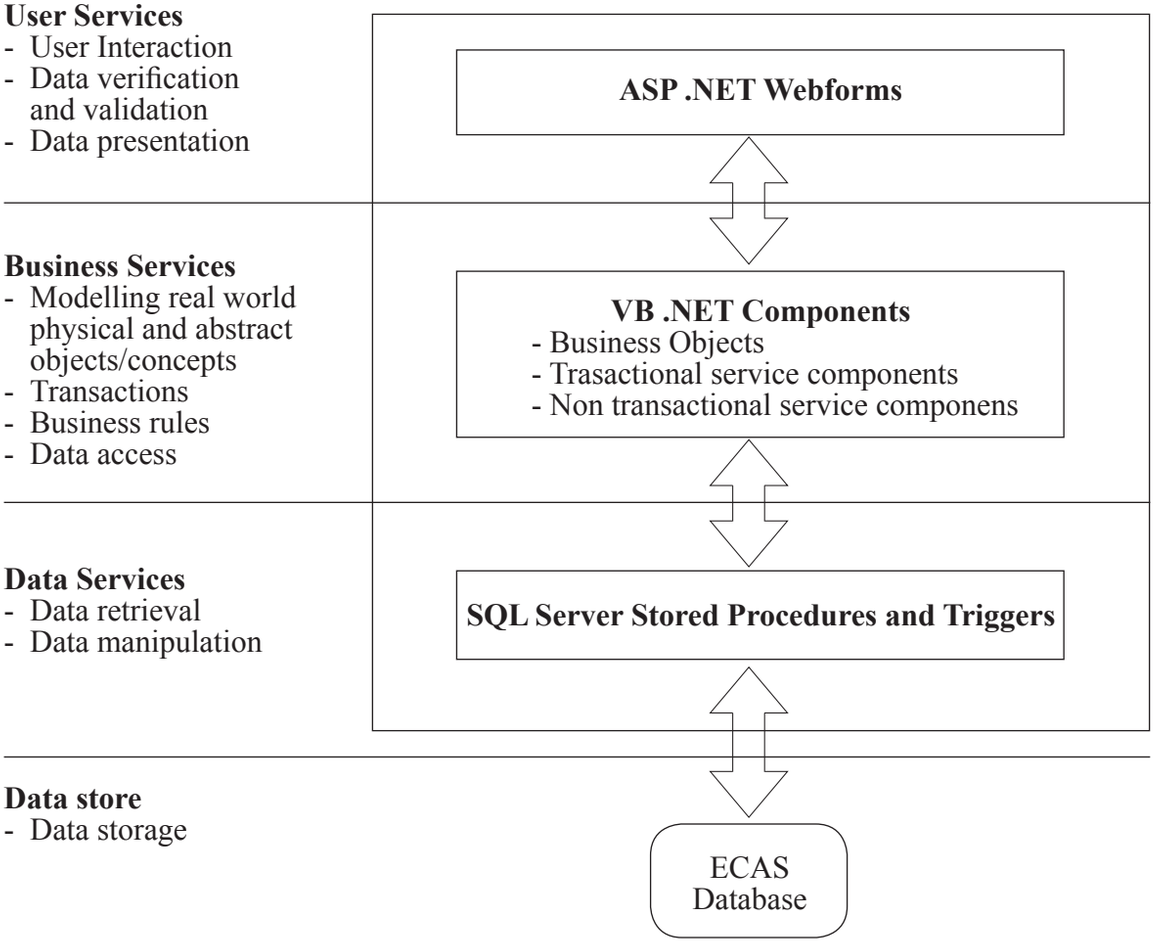

Figure 3. Logical architecture of ECAS

DISCUSSION AND CONCLUSION

Today's software has become more sophisticated and complex to develop due to the more-demanding customers and competition among software developers. Customers want new capabilities as the business grows and the world changes. The success of a company very often depends on how well it manages its software asset. Efficient software truly is a means of competition and has proven to be the reason why some companies succeed, rising to the top of the industries, while others sink into oblivion. Software must be developed quickly, but without loss of quality or excessive cost (McConnell, 1993). In order to achieve this, companies must be able to differentiate between the star employees and the slackers and retain the former. This is because software is developed from the knowledge of employees. People are the most crucial element that determine a successful software outcome (Ow and Yaacob, 1998). While there are various development tools available to speed up the development process, there has been lacking of assessment tools to help in differentiating the star employees and the slackers. ECAS was developed to address this problem by incorporating the computer processing power with the complicated BAM model.

The trend of software development have gone through a tremendous change, from the single tier (host) system in the old mainframe and mini-computer model to the N-tier architecture and distributed computing that make use of both server and client processing. The most sophisticated architecture of today is the 3-tier architecture (Vieira, 2003). For years Microsoft has been investing heavily on the Internet, both in terms of product development technology and consumer marketing (Anderson et al., 2002). Based on this fact, ECAS was developed using Web-based development tools and designed to take advantages of the 3-tier architecture. As a Web-based application, ECAS is Intranet-and-Internet-ready. Any client computer with Web browser can have an access to ECAS from within and outside an organisation. Hence, the performance evaluation of employee can be done anywhere in the world that has Internet access.

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page 242 none