Research Article

The Development of Web-Oriented Decision Support System for Supporting a Single-Level Task Assignment Process

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Abstract

Selecting subordinates for assigning tasks is considered an important process of human resource management and can be found generally in all workplaces. The task assignment must be done based on the concept of "putting the right man on the right job" so that the subordinates who are selected can perform the task to their full potential. This, finally, reflects an effective operation and highly productive results. This research aims to 1) study the process involved and find general criteria that the supervisors use for selecting subordinates for a certain task, 2) develop a Decision Support System (DSS) prototype used for supporting the single-level task assignment, and 3) evaluate the users' opinions on the system prototype. The research was divided into four phases which were 1) asking opinions of three domain experts about the process and the criteria that supervisors used for selecting subordinates for a task 2) analyzing and designing a DSS prototype in order to identify the system scope and the structure of system components 3) constructing a DSS prototype 4) testing and evaluating the DSS prototype with groups of users from five supportive organizations (specifically six supervisors and 31 operative subordinates). After the system testing, focus group interviews were conducted in order to get users' opinions in the areas of the Input Model, the Output Model, and the Process Model of the system. The result shows that the DSS prototype can present practical criteria consistent with employee selection in a real situation. Moreover, the system effectively supports a single-level task assignment process, and also makes the operation of recording, accessing and retrieving the data of the task and the operating employees more systematic, convenient, and reliable.

***Key Words*:** Decision support system; Web-oriented DSS; Task assignment process

Introduction

Selecting subordinates for assigning task is considered as an important process in any workplaces or organizations. After having analyzed the task to specify the task skills and responsibilities of people essential to the task operation, supervisors will select appropriate subordinates to operate the task under their charge. The task assignment process must be based on the concept of putting the right man on the right job. This can be done by considering the efficiency and effectiveness of the work, and the appropriateness of workload distribution in the workplace (Jackson and Schuler, 2003; Snell and Bohlander, 2007).

Although the decision making in a task assignment process happens all the times in all organizations, the criteria that supervisors of each organization use during the process are different. This depends on the types of business, work rules and regulations of the organization and the supervisors' experiences (Sauter, 1997; Turban et al., 2011).

However, there are some criteria which were mentioned in the theory of task analysis (Cascio, 2003; Department of Human Services (State of Michigan), 2011; Ivancevich, 2004; Schneier et al., 1995), for example, required task skills, work duration, work experience and amounts of responsible tasks, and many researchers used those criteria to support the task assignment process. For example, Trivedi and Warners (1976) developed a system called Nursing Allocation System to plan the schedules for the float nurses to work with the nurses in each ward of the hospital. Gopalakrishnan et al. (1993) conducted research on using DSS to help scheduling the work of temporary employees of a local newspaper publisher in Alabama, USA. Juette et al. (2011) developed a DSS for supporting the crew scheduling for operating trains at DB Schenker. Also, Schniederjans and Carpenter (1996) developed a DSS that helped scheduling the work shifts in a factory. The results of their research papers showed that general criteria could help supervisors to select employees and assign tasks more rationally and systematically, which was consistent with the concept of "putting the right man on the right job" although the final decision making depended on the experience and judgment of the supervisors. Moreover, those research papers showed that the DSS enabled supervisors to select, assign or schedule tasks more efficiently, and the organization spent less on operation and employment.

Although many researchers used DSS to support the task assignment process, the DSS which were developed in their research papers did not focus on the activities and processes after the task assignment, for example, the communication between the supervisors and the subordinates involved during the task operation, the task progress report, or the evaluation of the operative subordinates. These processes contributed to the success and effectiveness of the task operation and might affect the next task assignments. Therefore, these were the starting point of this research and development which aimed to develop the DSS that supports the task assignment process and the activities after the task assignment. The research started at studying the task assignment process in order to find out the general criteria that the supervisors in general organizations used for selecting subordinates, and then, to identify the procedural steps or the workflow of task assignment process. The findings will be used as a guideline in developing the single-level task assignment DSS. In a general task assignment process, there are two involved parties, which are "supervisors" who are the ones to select the appropriate subordinates for a task under a certain circumstance and " subordinates" who are the ones to perform the assigned task, report the operating results to their supervisors and inform the supervisors

of their personal data and working abilities so that the supervisors can use the data to consider during the task assignment process. Therefore, using DSS for supporting the task assignment process can help the task assignment to be done systematically and effectively. The recording, accessing and retrieving of data relating to the tasks and the subordinates can be done conveniently. The system also helps to provide appropriate workload distribution in the organization, both in terms of the appropriateness of task skills and the proper workloads assigned. This results in the quality of the task operation and the satisfaction of the employees. Furthermore, the "communicative components" which is integrated to the basic components of the DSS enables the people involved in the task assignment process to communicate more conveniently, resulting in the effectiveness of the employees' future work.

Purposes of the Research

The purposes of this research were as follows:

1. To study the operative process related to the task assignment and find the general criteria that the supervisors used in task assignment process

2. To develop a DSS that supported a single-level task assignment process

3. To evaluate users' opinions on the DSS that supported the task assignment.

The Scope of the Research

- The research population was the supervisors and the operative subordinates in general organizations.

- The research samples were six supervisors and 31 operative subordinates from five supportive organizations. The purposive sampling was used.

Research Tools

According to the four research phases, the tools of this research were as follows:

Phase 1: Asking Opinions from Domain Experts, the tool used was "the interview questions" for asking opinions from domain experts about the task assignment process.

Phase 2: Analyzing and Designing the DSS, the modeling tool used was Microsoft Office XP.

Phase 3: Creating the DSS Prototype, the tools used were Microsoft Visual Studio.NET 2005 (VB.NET), Hypertext Markup Language, Java Script, Microsoft SQL Server 2005 Enterprise Edition, Microsoft Windows Server 2003 Enterprise Edition, and MasterChartDemo (Chart Generator.)

Phase 4: Testing and Evaluating the DSS Prototype, the tool used was "the interview questions" for asking opinions from users about the Input Model, the Output Model, and the Process Model of the prototype.

Process of the Research

The research was divided into four phases as follows:

Phase 1: Asking Opinions from Domain Experts

After studying the theories and reviewing the research papers related to task analysis and factors in the task assignment process, the interview issues and questions were identified. The semi-structured interviews, then, were conducted with three domain experts who were supervisors and had more than five-year experiences in the task assignment. This was to study *"the workflow related to the task assignment process"* and to find out "the criteria that the supervisors used to assign tasks". The interview questions could be categorized into three groups, which were "the subordinates' personal data and the job profiles used for consideration during the task assignment process", "the concerned factors and criteria used in the task assignment process", and "the methodology the supervisors used for selecting subordinates to assign tasks."

Phase 2: Analyzing and Designing the DSS

The operation of the DSS supporting the task assignment was analyzed to identify the target users and necessary functions of the system. After that, the structure of the identified system components was designed.

Phase 3: Constructing the DSS Prototype

❑ The result from phase 2 was used to construct the DSS prototype. The implemented tools were listed as follows:

- Microsoft Visual Studio .NET 2005 (VB. NET), Hypertext Markup Language, Java Script and MasterChartDemo (Chart Generator) for program coding.

- Microsoft SQL Server 2005 Enterprise Edition for managing the system database.

- Microsoft Windows Server 2003 Enterprise Edition as an operation system on the web server.

❑ The prototype was periodically tested and verified by the domain experts in order to ensure the appropriateness of the user interface, the input and output format, and the accuracy of the system operation.

Phase 4: Testing and Evaluating the DSS Prototype

❑ The interview questions for asking users' opinions about the DSS prototype were identified. The interview questions focused on three areas of evaluation, which were the input model, the output model, and the process model of the DSS prototype. Here are some examples of the interview questions.

1. *"The Input Model":* to evaluate the appropriateness of the system input and commands. Some interview questions are listed as follows:

- "Do you think the menu and the commands listed in the DSS prototype are appropriate (in terms of the meaning and the font formatting) and are sufficient to support the task assignment process? Why or why not?"

- "Do you think the stored data are relevant, appropriate, and sufficient to support the task assignment process? Why or why not?"

2. *"The Output Model":* to evaluate the appropriateness of the output represented or generated by the system. Some interview questions are listed as follows:

- "Do you think the output generated by the DSS prototype is intuitive, easy to read, and consistent with your needs? Why or why not?"

- "Do you think the output generated by the DSS prototype completely fulfill your needs in making decisions during the task assignment process? Why or why not?"

3. *"The Process Model":* to evaluate the DSS prototype's efficiency and effectiveness. Some interview questions are listed as follows:

- "Do you think the workflows or the procedural steps of the DSS prototype are consistent with the task assignment process that actually takes place in your organization? Why or why not?"

- "Do you think the DSS prototype provides practical and sufficient criteria used for comparing subordinates in the task assignment process? Are the criteria consistent with the criteria that you (supervisors) use in the real situation? Why or why not?"

- "Do you think the DSS prototype provides good results on the task assignment process? Why or why not?"

❑ The sample users (six supervisors and 31 subordinates) from five supportive organizations were invited to test the DSS prototype. After the prototype testing, the focus group interviews were conducted on sites by using the prepared interview questions.

Research Results

1. Based on the domain experts' interviews, the concerned factors, the comparing criteria, and

the workflows of the task assignment process can be concluded as follows:

❑ **The factors affecting the task assignment process** can be divided into two groups:

- *"Task-related Factors"* refer to the characteristics of the task, which are "skills required by the task", "work duration", "the difficulty level of the task (set by supervisors)", and "the workplace (which affects the physical suitability of the subordinate who is assigned to perform a certain task.)"

- *"Employee-related Factors"* refer to the characteristics of the subordinate, which are "skills occupied by the subordinate", "tasks in responsibility," "work performance," "work experiences," "physical characteristics (e.g., gender, age, status of marriage)" and "work positions."

The factors found will be set as "general criteria" that supervisors can use for considering and comparing subordinates in the task assignment process.

❑ **Criterion Scoring Methodology**

The criterion scoring methodology that the supervisors use in comparing subordinates can be divided into two modes:

- *"Manual Criterion Scoring"* refers to the way in which the supervisors analyze the data of both the task and the subordinate by using their experiences and attitudes. Then, the supervisors will score each selected criterion (e.g. work experience, work positions, or physical characteristics of the subordinates) by themselves.

- *"Automatic Criterion Scoring"* refers to the way in which the system analyzes the quantitative data stored in the system, and then, uses the proper *"Quantitative Model"* to calculate scores for the selected criteria (e.g. the percentage of skill matching, the percentage of the work success, the work performance of the subordinates.)

❑ **The workflow of the task assignment process**

Figure 1 shows the workflow of the task assignment process. Before the task assignment, the supervisor will create a profile for each new task by identifying the task details, required skills, and the work rules, while the subordinates have to inform their supervisor of their characteristics, occupied skills, and report the outcome or the progress of the task in responsibility.

At the initial step of the task assignment process, the supervisor initiates the screening process by comparing the skills required by the task and the skills occupied by the subordinates **(A)**. The initial screening process helps supervisors to eliminate the unqualified subordinates and to reduce the scope of possible alternatives' determination. After that, the subordinates in the list of possible alternatives (or the suitable candidates) will be compared in terms of appropriateness of task skills (or the percentage of skill matching) **(B)** and the criteria identified by supervisors **(C)**. Finally, the supervisor selects the most appropriate subordinate to perform the concerned task **(E)**, based on the evaluation of appropriateness from all aspects (i.e. task-related factors, and employee-related factors) **(D)**.

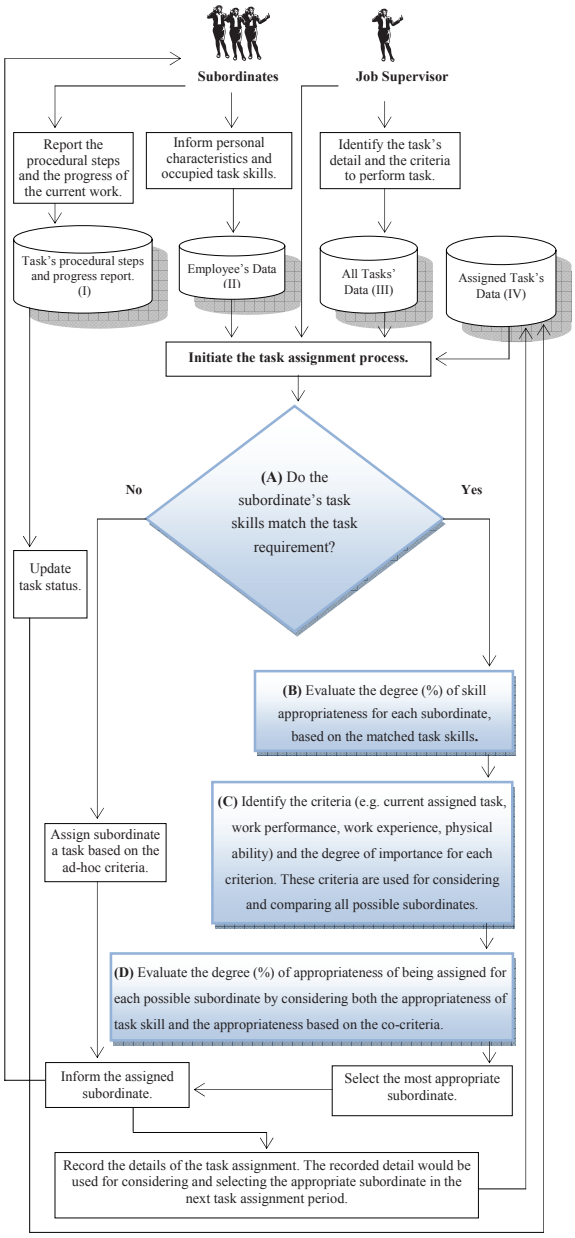

Figure 1 The Workflow of the Task Assignment Process ***(Remark:** In step **(A)-(D)**, the factors related to both the task and the subordinate are considered and calculated.)*

While considering the identified factors **(C)**, different supervisors may select different factors to compare subordinates, depending on the type of business, work rules of the organization and the experience of the supervisors. After the supervisor decide to choose the most appropriate employee to be responsible for the task, the supervisor will inform the subordinate of the task details and record all information that derives during the process as an evidence to use in the next task assignment period.

2. The DSS prototype supporting a single-level task assignment was developed using Microsoft Visual Studio .NET 2005 (VB.NET), Hypertext Markup Language, Java Script and MasterChartDemo (Chart Generator). When the development was finished, it was installed on the server which was operated using the Microsoft Windows Server 2003 Enterprise Edition. The DSS prototype relates to the target users and the components as follows:

❑ **Target Users**, which can be divided into two groups.

- *"Supervisors"* can use the following system functions.

1. Creating and recording the task profile, such as the start date, work duration, required task skills, and the difficulty level of the task, etc.
2. Selecting subordinates for a certain task.
3. Checking or following the task progress after the task assignment in order to use data in the next task assignment period.
4. Approving the submitted task which causes the task status to change.
5. Communicating with the people involved in the task operation.

- *"Subordinates"* can use the following system functions:

1. Informing the supervisor of their personal data and task skills.
2. Recording task operation details.
3. Reporting the outcome, task progress or problems occurring during the operation to the supervisor
4. Submitting the completed task to the supervisor

5. Communicating with the people involved in the task operation.

❑ **DSS Prototype's Components**

Based on the architecture of the DSS (Dong and Loo, 2001; Sauter, 1997; Sprague, 1980; Turban et al, 2011; Vongsumedh, 2007), the DSS prototype is composed of four components, which are "Data Component", "Model Component", "User Interface", and "Communicative Component", (as shown in Figure 2). Each component has a role in the system operation as follows:

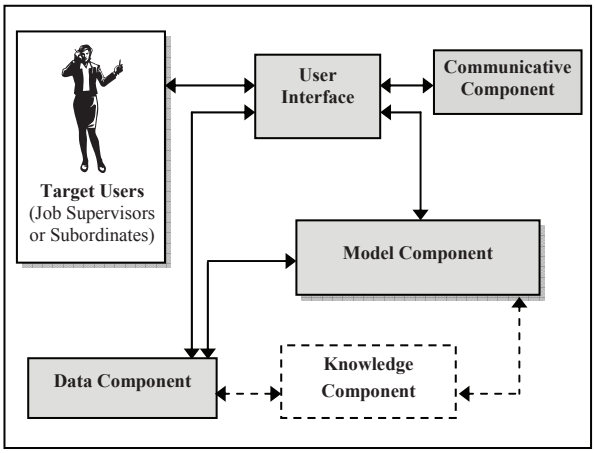

Figure 2 Components of the DSS Prototype

Component 1: "Data Component"

The component deals with the data used for supporting the workflow of the task assignment process (Figure 1). These data are classified and stored in four data repositories as follows:

I. The Task Operation Details and Progress: The data stored in the first repository are composed of the on-going task's status, task's progress, and procedural steps of any task. While the subordinates are being assigned tasks, they can report these data back to the job director. Therefore, the job supervisor can check the progress of any task, and keep tracks of events occurred during task's working duration.

II. The Employee Profiles: The second data repository stores characteristics and capabilities of all subordinates in a specific business unit, such as, age, gender, job positions, task skills occupied by subordinates, work-starting dates, and so on.

III. The Task Profiles: The third data repository stores characteristics of all tasks in a specific business unit, such as, task skills required by any task, task's working duration, task's started dates, task's submitted dates, task's status, and so on.

IV. The Task in Responsibility: The last data repository stores all assigned task's data. It plays an important role in identifying tasks undertaken by a particular subordinate at any given time. These data show the relationship between the task and the subordinate. Moreover, the given data are necessary for the task assignment process, since the job supervisor must take them into account in the next task assignment.

Component 2: "Model Component"

The component provides the analysis capability for the DSS in order to compare the possible alternatives (or subordinates) in steps A to D. Based on the theory of job analysis and information gathered from the experts, the quantitative models used for comparing and considering the alternatives are created. These models generate the mathematic results by analyzing the related quantitative data stored in the data repositories. The general results are in the form of scores so that the job supervisor can use them in comparing and selecting the appropriate employee. The examples of the model used during the system operation are as follows:

- *Skill Matching Score (S)*: The model helps job supervisor to identify the subordinate who has the required task skills by considering the connection between "the task skills of the employee comparing to the task skills required for the task." This is given by:

$$S_i = \left(\frac{Os}{Bs}\right) \times 100 \qquad (1)$$

i: The employee's number, when i = 1, 2, 3, ...

Os: The number of task skills that the employee has corresponding to the requirement, when Os = 1, 2, 3, ...

Bs: The number of all task skills that the task requires, when Bs = 1, 2, 3, ...

*(*Note*) This model is automatically activated and used in step (B) of the workflow shown in Figure 1.*

- The Percentage of Success in Task Operation (Psuc): The percentage of success in task operation is considered by the ratio between "the number of accomplished tasks performed by specific employee" and "the number of all tasks assigned to a specific employee." This is given by:

$$\boldsymbol{Psuc_i} = (\frac{A}{B}) \times 100 \qquad (2)$$

i: The employee's number, when i = 1, 2, 3, ...

A: The number of accomplished tasks performed by an employee$_i$, when A = 1, 2, 3 …

B: The number of all tasks assigned to the employee$_i$, both the finished and the on-going tasks, when B = 1, 2, 3 …

$A \leq B$

- Task Performance (Tp): The efficiency of task operation by considering "the number of tasks that the employee can complete and submit on time" comparing to "the standard number of tasks that the employee must be able to finish within the timeframe. This is given by:

$$\boldsymbol{Tp_i} = \frac{Ts_i}{Tst} \qquad (3)$$

Ts: The number of tasks that the employee$_i$ can complete and submit on time.

Tst: The standard number of tasks that the employee must be able to finish within the timeframe.

i: The employee's number, when i = 1, 2, 3, ...

The value of Tp_i is beween 0 - 1.

*(*Note*) In case of converting and displaying the value of Tp_i in the form of task performance score, the value of Tp_i is multiplied by 100.*

However, though the supervisor in each organization will choose the same criteria in considering and selecting the subordinates during the task assignment, the model that each organization has created to analyze the data can be different. This depends on the work policies, regulations or the work procedures within the organization. Therefore, the DSS developers also need to consider these differences and provide the tailor-made models according to the user's needs and the requirements of the organization.

Component 3: "User Interface"

Both supervisors and employees operate the system using the Menu-oriented Format so that both groups of user can scope out the system functions. Moreover, the Input-Output Structure Format is provided in order to allow the users to fill in the data necessary for the system operation and the task assignment process, as shown in Figure 3-5.

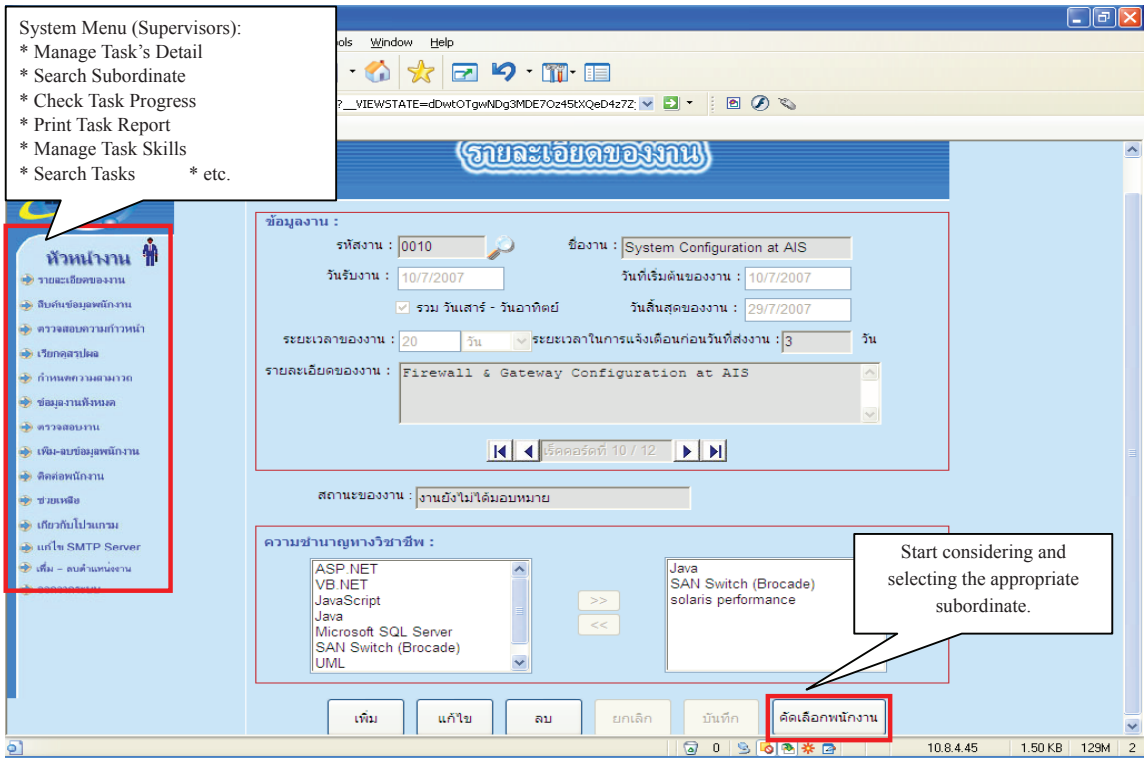

Figure 3 Input-Output Structure Format for Recording Task's Detail
*(**Remark:** This screen supports the step (A) of the workflow shown in Figure 1.)*

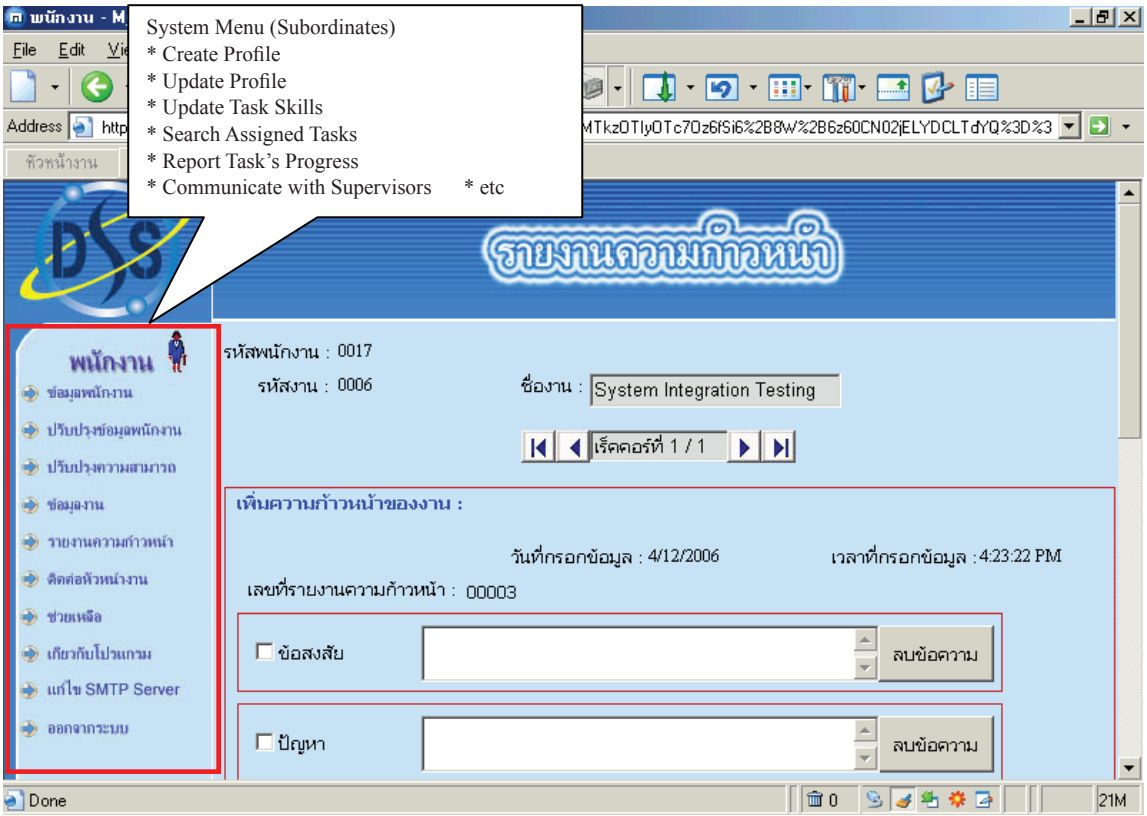

Figure 4 Input-Output Structure Format for Task's Progress Report

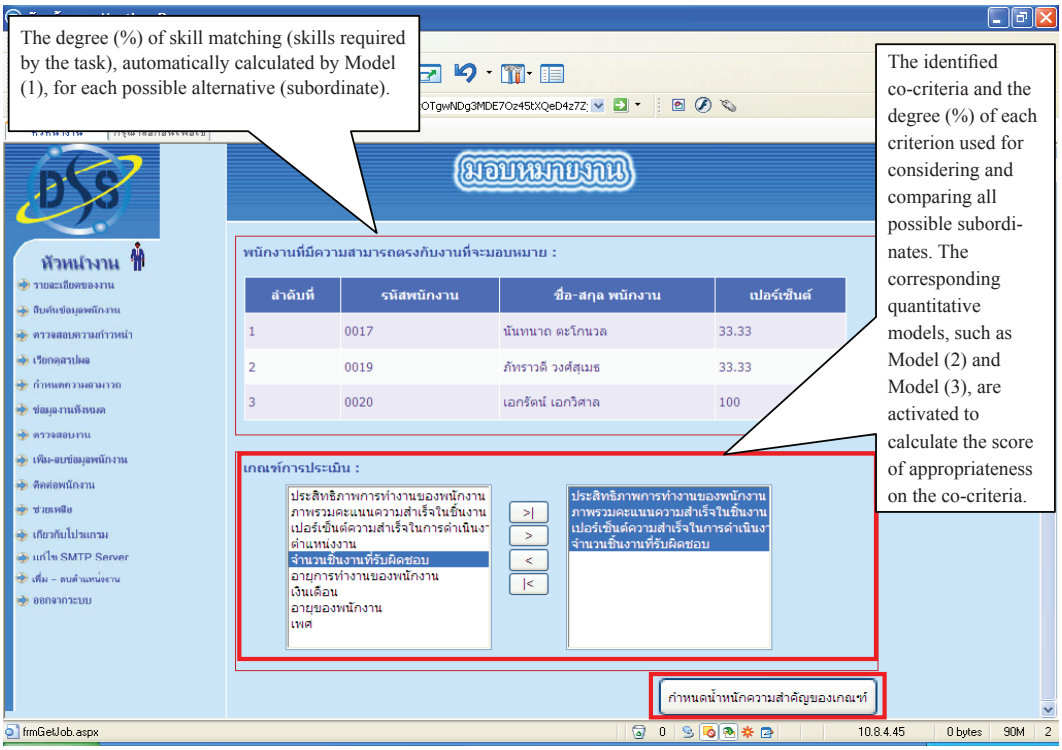

Figure 5 Steps for Identifying the Co-Criteria Used for Alternatives/Subordinates Comparison
*(**Remark:** This screen supports the step (B) and (C) of the workflow shown in Figure 1.)*

The system output will be presented in the form of a graphical format (Figure 6) together with a conclusion table (Figure 7) to facilitate the comparison of appropriate employees.

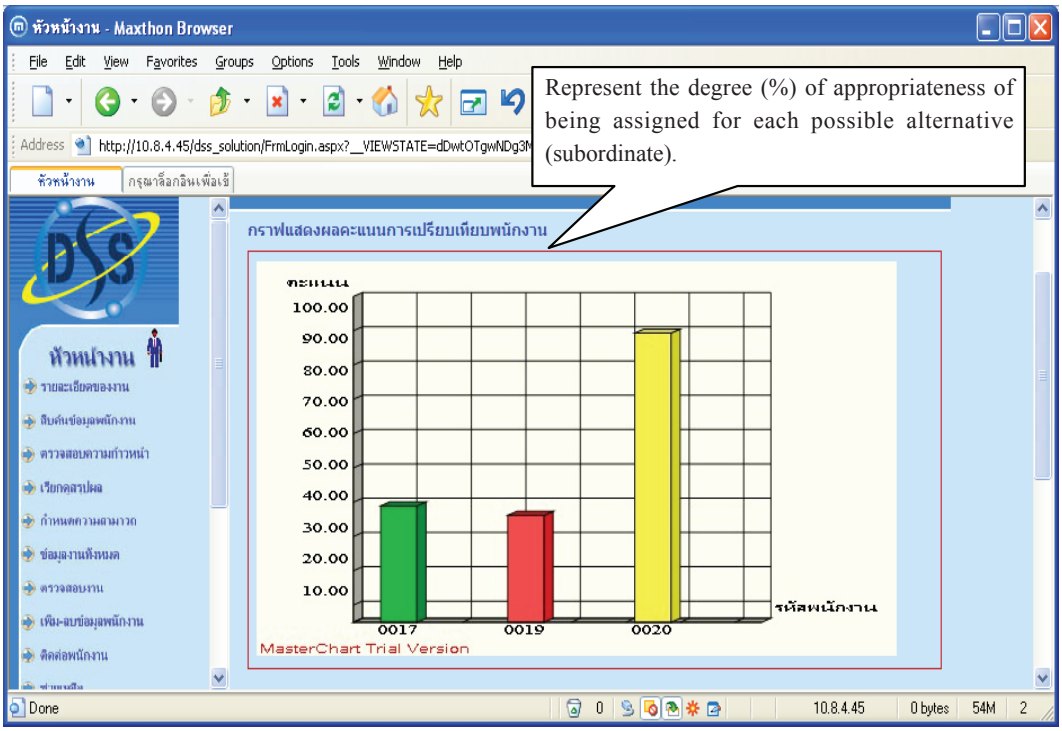

Figure 6 Result of Alternative Comparison (Graph)

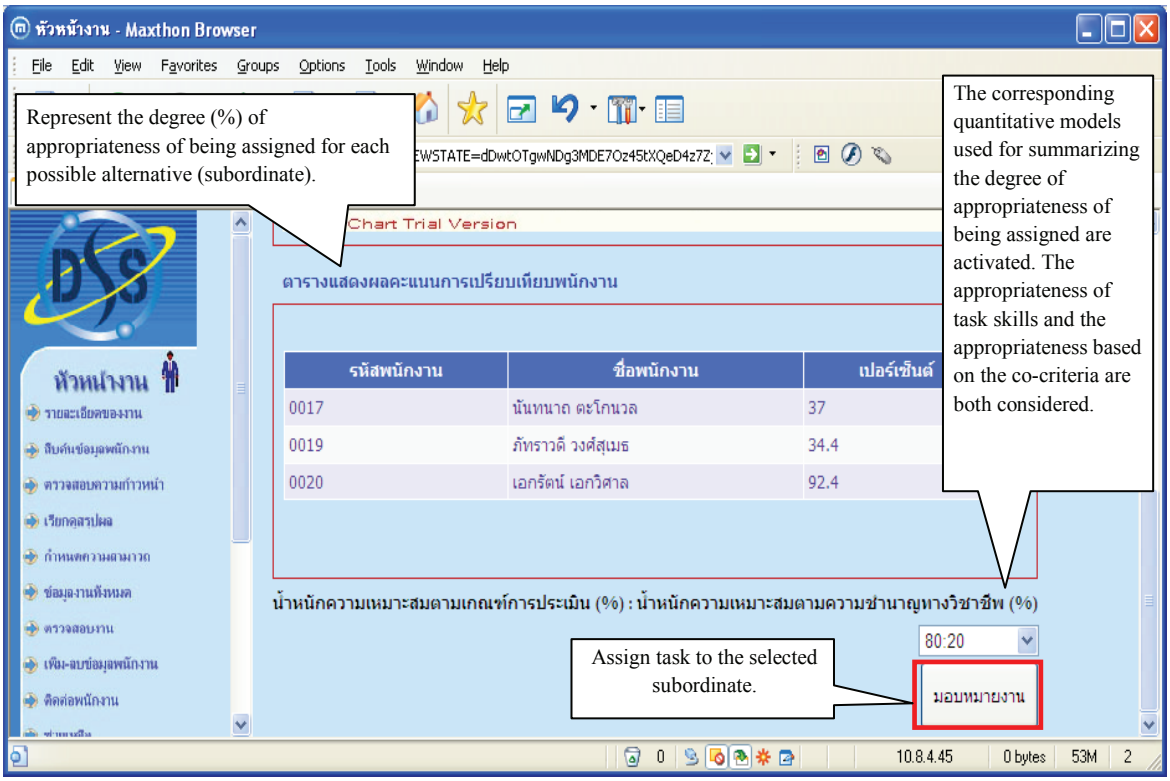

Figure 7 Result of Alternative Comparison (Table)
*(**Remark:** This screen supports the step (D) of the workflow shown in Figure 1.)*

Component 4: "Communicative Component"

The DSS prototype supporting the single-level task assignment process was designed and developed as a web-based application so that the users can conveniently and flexibly use this system anywhere anytime. In addition, both groups of user can send emails and personal messages to one another during the assignment process, the task operation, and the task progress report.

(*Note*) The new trend of DSS development is trying to converge with the concept of Knowledge Management (KM) that enables the organization to transmit personal knowledge to organizational knowledge. The given convergence brings out the new DSS component called "Knowledge Component". This component may facilitate the knowledge capturing, knowledge organizing, knowledge refinement, and knowledge sharing which come up with the useful knowledge for the decision making process. However, this component and the KM concept were excluded from this research and development.

3. The opinions of the users both supervisors and subordinates on the DSS prototype were concluded in two points.

❑ ***Strength of the System***

- "Supervisors" commented that the system enabled them to access and retrieve subordinates' data easily and conveniently. With the support of the retrieved data (e.g. employee's task skills, details of the assigned task), the job supervisors could assign the task to the subordinates properly.

- "Supervisors" commented that the system enabled them to check the task progress report (or operation report) conveniently. Therefore, they

could make a decision in the next task assignment quickly, based on these data.

- "Supervisors" commented that the system could provide various criteria that were relevant to the task assignment process. The supervisors in each organization, who might concern on different criteria, could select the criteria that were consistent with their task assignment process and regulations.

- "Supervisors" commented that the system enabled the task assignment process to be more systematic and more reliable since the employees who were evaluated at the same time would be evaluated using the same criteria.

- "Supervisors" commented that the system could help assuring that the selected employees were the ones who had knowledge and skills that matched the task.

- "Supervisors" and "subordinates" commented that the web-based DSS enabled them to flexibly and conveniently perform all activities related to the task assignment process (e.g. assigning task, keeping track of the assigned task, reporting and communicating to stakeholders).

- "Supervisors" and "subordinates" commented that the communicative component allowed them to communicate with each other easily.

❑ ***Weakness of the System***

- "Supervisors" commented that the system could not support "the multi-leveled job assignment process", which was normally found in the project-based workflow. Moreover, the system did not allow supervisors to identify the level of complexity for each task. Therefore, the current system could work well in the situation that all assigned tasks had the same level of complexity.

- "Supervisors" in the field of engineering and science commented that in some cases, the system could not compare the employee's occupied task skills properly since the system did not categorize the skill levels or the competency level for each skill occupied by the employee (for example, Very Poor, Poor, Satisfactory, Good, Very Good). Therefore, there was no difference in skill capability between the two (or more) employees who had the same skills.

- "Supervisors" commented that the system did not give the supervisor a chance to set up the scores or clarify the level of the task quality after submission. Task quality scores might be used to support the next task assignment.

- "Supervisors" and "Subordinates" commented that the system did not give employees a chance to access the details of the task procedural steps or the solutions of the previous tasks that were similar to the ones they were working on. Therefore, the knowledge sharing was still not supported by the current DSS prototype.

Conclusion and Discussion

The result from studying the task assignment process and the general criteria used during then shows that the factors used for considering and comparing subordinates during the task assignment process can be divided into two categories (i.e. task-related factors and employee-related factors.) During the task assignment process, both categories will be considered in order to compare and select the appropriate employee to perform the task. In order to make a decision during the task assignment process, the supervisors will combine the consideration on work regulations and the recorded quantitative data of the task performance together with their experience and attitudes. This is consistent with the research of Trivedi and Warner (1976) and the research of Kaixuan (1994) which found that the basic criteria to select an appropriate person to do a certain task (for example, task skills, work experience or physical suitability of the employee) made the basic task assignment process more

appropriate and systematic. However, the final decision would depend on the experience and consideration of the supervisor.

After implementing the DSS prototype, the prototype was tested by the users, which were 6 supervisors, and 31 subordinates, from 5 supportive organizations. The focus-group interviews were, then, set up to ask users' opinions on the areas of the Input Model, the Output Model, and the Process Model of the system. The interview's result shows that the web-based feature of the prototype enables both groups of user to access the system and perform task-related activities easily and conveniently. In addition, both supervisors and subordinates found that the communicative component of the system allowed them to easily communicate with the people involved. This is consistent with Turban et al. (2011) and the findings of Dong and Loo (2001), and Gudigantala et al. (2011). Moreover, the supervisors expressed that the provided system functions allowed the task assignment process to be performed conveniently, reliably, and systematically. This finding is consistent with the works of Basnet and Ellison (1998), and also consistent with Juette et al. (2011).

Future Work

To improve the task assignment capability, the supervisors should be able to perform the multi-leveled task assignment process which is found in the project workflow. In addition, to clearly and precisely identify the appropriate subordinates during the task assignment process, the level of the employee's task skills (or the degree of work competency) and the quality of task operation should be set by the supervisors. Moreover, the system should enable supervisors to identify the task's levels of complexity, which affects the determination of task operation's quality after task submission.

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