A KNOWLEDGE-BASED ONLINE WORKFLOW SCHEDULING SYSTEM

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ABSTRACT

Workflow scheduling plays a vital role in advanced manufacturing, and it deserves research efforts to warrant further improvement. This paper proposes an intelligent workflow scheduling system (iWFSS) to integrate information, processes, and knowledge into a unified framework that provides a total solution to online scheduling. The iWFSS consists of an information system, a workflow system, and a scheduling system brought together by an integrated platform for rapid construction of domain-specific workflow scheduling systems. A knowledge representation schema and inference algorithms are designed for scheduling decisions.

Keywords: Workflow scheduling; Knowledge representation; Inference algorithms.

INTRODUCTION

Scheduling is a decision-making procedure to allocate resources to activities over time so that input demands are met in a timely and cost-effective manner (Smith, 2003). Although scheduling is often studied as an isolated optimization problem, it is in practice a complex flow of information and decision-making (Herrmann, 2004). Despite the significant advancement in scheduling in recent years, many challenges remain to be tackled. Some major open topics in scheduling research include (Smith, 2003):

- Generating schedules under complex constraints, objectives and preferences;
- Managing changes;
- Extending scheduling to large-scope problem-solving processes;
- Rapid construction of high performance scheduling services.

With the advent of information technology, there has been rapid development of workflow systems in recent years (Aalst and Hee, 2002; Fletcher, Brahm and Pargmann, 2004). However, the scheduling functions of current workflow systems are often very limited (Aalst and

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Hee, 2002). Although there are many difficulties in workflow scheduling (Baggio, Wainer and Ellis, 2004), it is a potential area of great improvement (Aalst and Hee, 2002; Baggio, Wainer and Ellis, 2004).

This paper therefore proposes an intelligent WorkFlow Scheduling System (iWFSS) with the following objectives:

- To address the complex constraints, objectives, and preferences by exploiting domain knowledge and information in scheduling decisions;
- To address the dynamic changes by combining information, process, and decision-making into an integrated framework, which enables online reactive scheduling;
- To enable rapid construction of domain-specific workflow scheduling systems by providing a flexible and reusable platform.

The reminder of this paper is organized as follows. The next section analyzes the workflow scheduling problem. Section 3 presents the system design of the iWFSS, while Section 4 describes the knowledge representation schema and inference algorithms. Lastly, Section 5 concludes the paper.

PROBLEM ANALYSIS

Due to the dynamic nature of industrial environments, an effective scheduling system should be able to handle changes. Although online reactive scheduling systems are expected in a real-world environment, scheduling research efforts tend to focus on off-line scheduling problems instead (Smith, 2003). Most scheduling systems generate schedules periodically, for example once per week, per day or per shift. Because exceptions may occur in the execution process, the schedules generated by off-line scheduling systems often become invalid and are seldom strictly followed in practice. As a result, the value of off-line schedules is diminished. On the other hand, an online scheduling system maintains an active schedule that can dynamically adapt to changes in real-time. An online schedule is always valid and up-to-date; it is therefore more valuable and can be better followed.

Each production system has its domain-specific constraints, objectives, and preferences. However, most scheduling systems cannot effectively address them. To handle the domain-specific constraints, objectives and preferences, domain knowledge, and information must be effectively utilized and a knowledge-based approach must be adopted.

From the above analysis, we can see that an effective online scheduling system should be able to

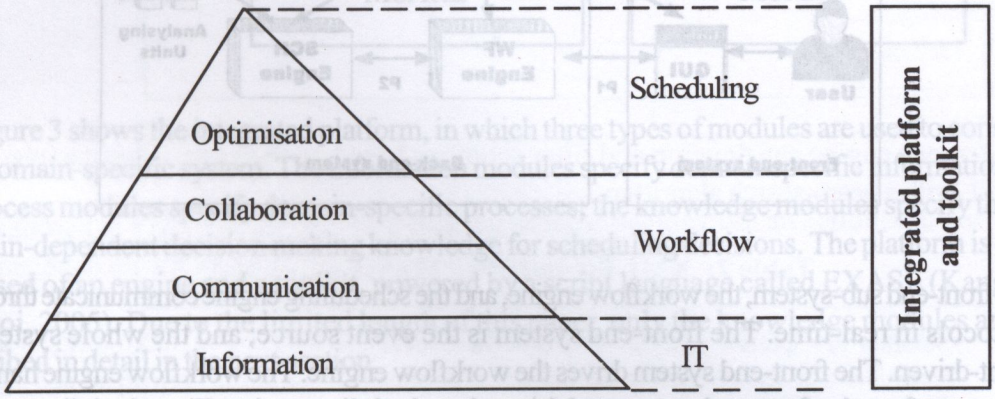
- Access the up-to-date execution state of the system
- Access and make use of domain specific knowledge and information

Hence, an online scheduling system should be connected to an execution system, which can:

- Reflect the up-to-date execution state of the system
- Convey domain-specific information flow

A workflow system is indeed an execution system that can provide all information for scheduling (Aalst and Hee, 2002). Therefore, it is a promising research topic to integrate the information system, the workflow system, and the scheduling system into a total solution. As such, the workflow system is a bridge that connects the information system and the scheduling system, as shown in Figure 1.

Figure1: An integrated total solution



Traditionally, the information system, the workflow system, and the scheduling system are separate research topics. To build them into an integral system, it is of vital importance to simplify the system complexity such that practicable solutions will become achievable.

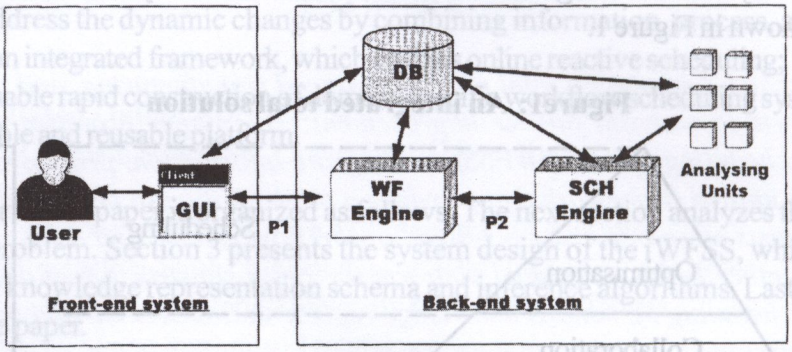
In this paper, three strategies are devised to tackle the system complexity. The first strategy is to decompose a complex system into several simple sub-systems. The sub-systems communicate and collaborate through protocols and they share data and information through a central database. The second strategy is to develop a flexible and reusable platform, which can hide technical details and can greatly reduce system development effort. The third strategy is to seek feasible and good solutions, instead of optimal ones that are often impractical for real-world problems.

SYSTEM DESIGN OF THE iWFSS

Figure 2 shows the system design of the iWFSS. The system can be divided into two sub-systems, namely the front-end sub-system and the back-end sub-system. The former provides GUI for user interaction; it accepts input and presents information to the user. The latter

is composed of a workflow engine, a scheduling engine, and a central database. The workflow engine manages the tasks and work items in the system and drives the workflow system according to process definitions. The scheduling engine maintains an online schedule for the work items in the system dynamically. The database system stores all sorts of information, which can be accessed by the GUI system, the workflow engine, and the scheduling engine.

Figure 2: The architecture of the iWFSS



The front-end sub-system, the workflow engine, and the scheduling engine communicate through protocols in real-time. The front-end system is the event source; and the whole system is event-driven. The front-end system drives the workflow engine. The workflow engine handles the events from the front-end system and drives the scheduling engine. The scheduling engine handles the events from the workflow engine and maintains the schedule by knowledge and information; it may utilize several parallel computation units to improve real-time performance.

When a new task enters the system, the workflow engine will generate corresponding work items for the task according to its process definition, and the scheduling engine will determine the start time and the end time for each work item. Thus, a feasible schedule is constructed. The user of the system will fulfil the work items according to the schedule and keep the system state up-to-date. When deviations from the schedule are detected, the scheduling engine will revise the schedule to keep it consistent with the current system state and to maintain good system performance.

In the iWFSS, information, process, and knowledge are brought into a unified framework. Since information, processes, and knowledge are all domain-dependent and liable to changes, it is impractical to design a general-purpose workflow scheduling system. Instead, a flexible and reusable platform has to be developed to support rapid construction of domain-specific systems.

Figure 3: The integrated platform

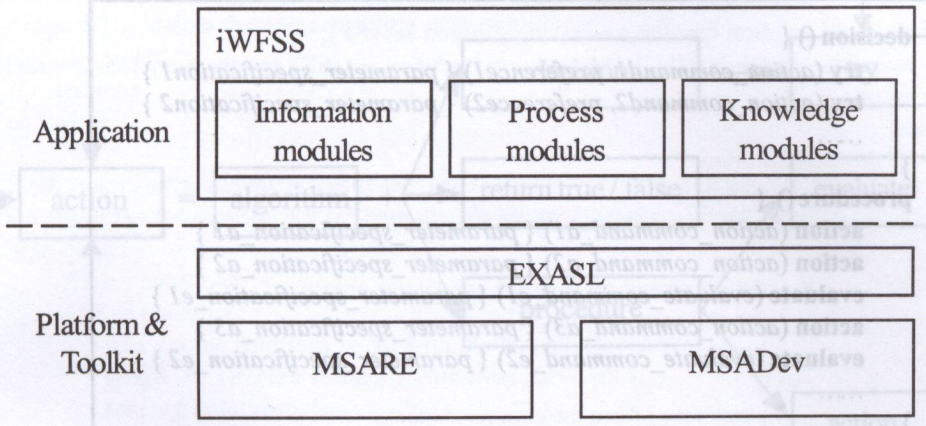


Figure 3 shows the integrated platform, in which three types of modules are used to construct a domain-specific system. The information modules specify domain-specific information; the process modules specify domain-specific processes; the knowledge modules specify the domain-dependent decision making knowledge for scheduling decisions. The platform is composed of an engine and a toolkit, powered by a script language called EXASL (Kang and Choi, 2005). Due to the limited length of this paper, only the knowledge modules are described in detail in the next section.

KNOWLEDGE REPRESENTATION SCHEMAAND INFERENCE ALGORITHM

In schedule construction and revision, a set of decisions has to be made according to the current system state, constraints, objectives and preferences. To exploit domain knowledge and information in decision-making, knowledge modules are introduced to manage the decision making knowledge based on a decision-making framework, the Multi-Stage Multi-Scenario Analysis (MSMSA) model.

A knowledge representation language, Embedded eXtensible Application-oriented Script Language (EXASL), is developed based on the MSMSA model. With EXASL, decision-making knowledge can be specified in a straightforward way by the five commands below:

- decision -- to enumerate alternative actions, each of which may lead to a different solution;
- try -- to specify an alternative action;
- procedure -- to specify a sequence of commands;
- action -- to specify an action to be executed on a solution;
- evaluate -- to specify the evaluate command, which can evaluate and filter solutions.

Table 1: Synopsis of the decision commands

```
decision () {
    try (action_command1, preference1) { parameter_specification1 }
    try (action_command2, preference2) { parameter_specification2 }
    .....
}
procedure () {
    action (action_command_a1) { parameter_specification_a1 }
    action (action_command_a2) { parameter_specification_a2 }
    evaluate (evaluate_command_e1) { parameter_specification_e1 }
    action (action_command_a3) { parameter_specification_a3 }
    evaluate (evaluate_command_e2) { parameter_specification_e2 }
    .....
}
```

An inference engine can develop and filter solutions based on the knowledge encoded in EXASL with a beam-search algorithm.

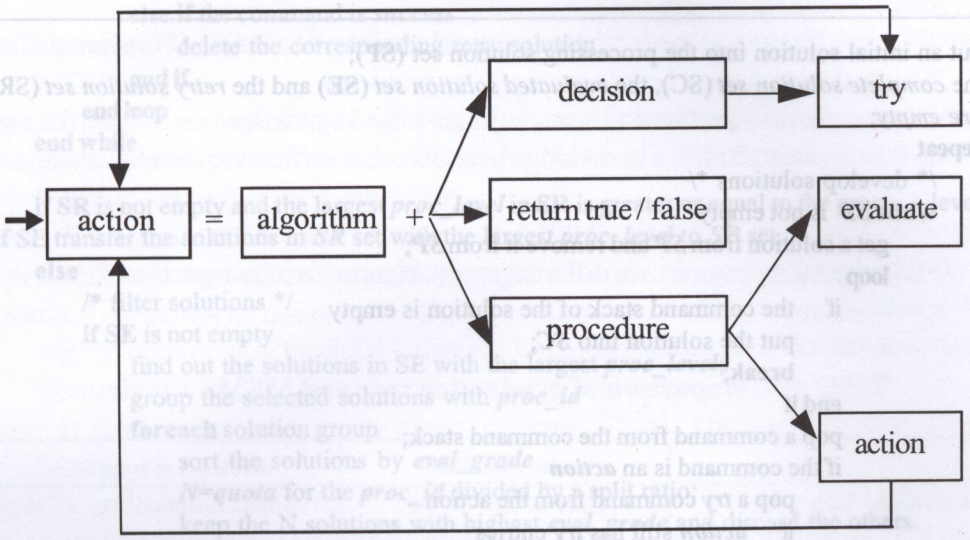
Table 2: XML format of an MSMSA solution

```
<Solution id=" quota=" proc_level="" proc_id="" eval_grade="">
<Data>
</Data>
<CommandStack>
    <Action agent=" module=" agent_class=" interface=" cmd="">
        <param name=" value="/>
    </Action>
    <Success id="">
    <Evaluate agent=" module=" agent_class=" interface=" cmd="/>
    <EndProc parent_id="/>
</CommandStack>
</Solution>
```

To facilitate implementation, each solution is encoded into XML as shown in Table 2. In a solution, the Data section records solution specific data (the work memory) in XML; the CommandStack section lists the commands to be executed upon this solution.

For each solution, the inference engine pops a command from its CommandStack each time and executes it until there is no command in the CommandStack. In executing a command, new commands may be pushed into the CommandStack, and the solution may be split into multiple copies.

Figure 4: The knowledge representation schema



As shown in Figure 4, the decision-making process begins from an action, each of which contains an algorithm followed by four possible results.

The algorithm can modify a solution by domain-specific heuristic logic, in which domain knowledge can be programmed and domain information can be accessed. In such a way, domain specific constraints, objectives and preferences can be specified in the decision-making process.

The four possible results of an action are:

- return *true*. The inference process will continue on the current solution.
- return *false*. The solution is infeasible and will be discarded.
- end with a *decision*. The solution will be split into several alternative solutions and different actions will be pushed into their *CommandStack*.
- end with a *procedure*. A sequence of commands will be pushed into the CommandStack of the current solution.

While a decision may result in multiple alternative solutions (Multi-Scenario), the procedure can segment the decision process into multiple 'develop-filter' cycles (Multi-Stage). Therefore the decision-making model is called Multi-Stage Multi-Scenario Analysis (MSMSA).

To avoid combinatorial explosion, a quota management mechanism is designed. The quota management can ensure a constant computation overload by focusing on the most promising solutions and prune away inferior ones. The search method is a beam-search by nature. The detailed inference algorithm is specified in Table 3.

Table 3: The inference algorithm

```
put an initial solution into the processing solution set (SP);
the complete solution set (SC), the evaluated solution set (SE) and the retry solution set (SR)
are empty;
repeat
    /* develop solutions */
    while SP is not empty
        get a solution from SP and remove it from SP;
        loop
            if   the command stack of the solution is empty
                 put the solution into SC;
                 break;
            end if
            pop a command from the command stack;
            if the command is an action
                 pop a try command from the action
                 if   action still has try entries
                      copy current solution as s_copy;
                      push action to the action stack of s_copy
                      put s_copy to SR
                      push a success to the action stack of current solution
                 end if
                 execute the try command;
                 if the result is true continue;
                 else if the result if false
                      discard this solution;
                      break;
                 else if the result is decision
                      split the solution into alternative solutions;
                      distribute quota to alternative solutions according to their preference value;
                      put the alternative solutions into SP;
                      break;
                 else if the result is a procedure
                      increase the proc_level of the solution by one;
                      assign a new proc_id to the solution;
                      push an EndProc command (parent_id=original proc_id)
                           into the command stack;
                      push a sequence of commands into the command stack;
                      continue;
                 end if
            else if the command is an evaluate command
                 calculate the eval_grade value of the solution by the evaluate command;
                 put the solution into SE;
                 break;
            else if the command is an EndProc command
                 decrease the proc_level of the solution by one;
                 restore the proc_id to the parent_id of the EndProc command;
```

```
                continue;
            else if the command is success
                delete the corresponding retry solution
            end if
        end loop
    end while

    if SR is not empty and the largest proc_level in SR is greater or equal to the proc_  level
of SE transfer the solutions in SR set with the largest proc_level to SP set
    else
        /* filter solutions */
        if SE is not empty
            find out the solutions in SE with the largest proc_level;
            group the selected solutions with proc_id
            foreach solution group
                sort the solutions by eval_grade
                N=quota for the proc_id divided by a split ratio;
                keep the N solutions with highest eval_grade and discard the others.
                distribute the quota to the N solutions according the their eval_grade;
                transfer the N solutions to SP
            end foreach
        end if
    end if
until (SP is empty) or time out
select the best solution in SC as the final solution;
```

Based on the above knowledge representation schema and inference algorithm, the iWFSS scheduling engine is developed. The major advantages of the iWFSS scheduling engine include:

- It provides a straightforward approach for representing decision making knowledge, which can be used by the inference engine to search for the best solution by a build-in beam search algorithm;
- It can address the complex constraints, objectives and preferences in scheduling by EXASL (Embedded extensible application-oriented script language);
- It can greatly decrease the development effort of a scheduling system by integrating many related techniques and methodologies into a unified solution;
- It facilitates the construction of large-scale knowledge bases by organizing the knowledge base with object-oriented methodology;
- It supports XML and database for information access and process.
- It supports online scheduling by improving real-time performance through parallel computation.

Although production rules are the most commonly adopted knowledge representation method in expert systems, rule-based expert systems often cannot yield good scheduling solutions due to the following limitations (Jackson, 1998; Smith, 1992):

- It makes myopic and arbitrary decisions; as a result, good potential solutions may be discarded in early stage.
- It lacks effective procedural control mechanisms; as a result, it is often difficult to handle the complex schedule construction problems.
- It lacks effective methods to manage large-scale knowledge bases. With the increase in the number of rules, a knowledge base becomes difficult to develop and maintain.

The iWFSS scheduling engine uses different approaches in various aspects as shown in Table 4.

Table 4: Comparison of production rule and MSMSA system

	Production Rule	*MSMSA system*
Knowledge base	Rule sets	Object oriented (Agent, interface, inheritance)
Work memory	Single	Multiple
Procedural control	Difficult	By procedure command
Conflict resolution	Meta rules	Multiple scenario analysis
Inference mechanism	Forward chaining Backward chaining	Forward chaining Simulate & test. Beam search engine
Parallel	No	Yes

With the above improvements, the iWFSS scheduling engine provides a promising solution to knowledge-based online scheduling.

CONCLUSION

Workflow scheduling is potential area of great improvement. This paper proposes an integrated intelligent workflow scheduling system (iWFSS) to combine information, process and knowledge into a unified framework for intelligent online scheduling of workflow systems. The system design of iWFSS is described; knowledge representation schema and inference algorithm of the iWFSS scheduling engine are developed. A prototype system is now under-construction and will be evaluated in a real industrial environment.

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A CASE STUDY FOR GLOBAL SUPPLY CHAIN MANAGEMENT IN VIETNAM

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ABSTRACT

Global Supply Chain Management (GSCM) has become an important strategy to assist businesses improve their competitiveness. A global supply chain not only needs to face the problems of information flow, but also needs to face problems of products flow. More and more businesses are considering using an integrated concept for improving processes of information and materials from the upstream and downstream of business and between different countries or areas. In this paper, a study of global supply chain, the authors went to Ho Chi Minh City in Vietnam to visit a company, to interview its president and observe the warehouse of products. The results of the interview revealed many problems within the company and also in its upstream and downstream. The problems of upstream are about the products flow of suppliers, because different suppliers use different ordering processes, and thus the company is controlling its processes of export and quality by different systems. Therefore, the challenge for the company is how to manage the flow of products from different manufacturers at the same time.

Keywords: Global supply chain management; Small and medium enterprise; Vietnam, and international cooperation of industry and university.

INTRODUCTION

Global Supply Chain Management (GSCM) has been became an important strategy to assist business in thinking how to quickly improve their competitiveness. In a global supply chain, a business not only needs to face problems of information flow, but also needs to face problems

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of products flow. More and more businesses are considering using an integrated concept for improving processes of information and materials from the upstream and downstream of business between different countries or areas.

The problem of global supply chain management is very difficult to understand and management, because the processes of information and materials in a global supply chain of business are very complex: they include the scope of business to business and business to customers. Therefore how to assist a business to define the problems of global supply chain management is an important task.

To understand how a real company manages ity global supply chain, we had an opportunity to contact a small and medium enterprise in Vietnam, the company belonging to a Taiwanese owner, located in Ho Chi Minh City since 2001. The company focuses on international import trading in motors and other products. These products are from Taiwan and other countries. For example, the company buys motors from the TECO group in Taiwan, and buys motors from Siemens in Germany. The company, as an agency, sells these products in Ho Chi Minh City and other cities in Vietnam.

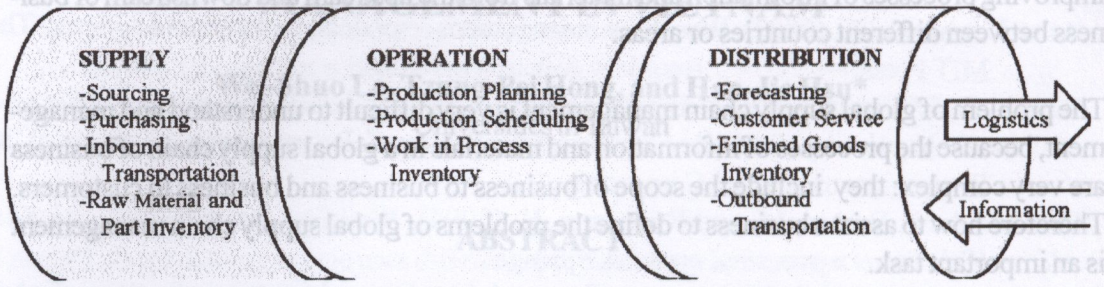
The interview revealed many problems, not only within the company itself, but also in its upstream and downstream. The problems of upstream are about the products flow of suppliers, because different suppliers have different order submitting processes. Thus, the company is controlling its processes of export and quality through different systems. Therefore, the challenge for the company is how to manage the flow of products from different manufacturers at the same time.

The purpose of this research is to understand the problems of global supply chain management in a real small and medium enterprise in Vietnam, and through interview to identify problems in its operations processes. The contributions of this research is that it can be seen as an international cooperation model between industry and university. It can also assist this Taiwanese company in Vietnam to use the concept of global supply chain to improve its competitiveness.

PROBLEMS OF A SUPPLY CHAIN

Logistics usually play an important role in a supply chain. Logistics can be divided into two types: inbound logistics and outbound. Inbound logistic represents a purchase process for a company's raw material,, and outbound logistic represents a distribution process of products. Copacino defined the problems appearing in logistics as an integrated pipeline [4], which is shown in Figure 1.

Figure 1: The problems appearing in logistics as an integrated pipeline



In Figure 1, there are three main activities - supply, operation, and distribution. They are described as follows.

- Supply: It includes the tasks of sourcing, purchasing, inbound-transportation, raw material and past inventory.
- Operation: It is the business processes themselves, and includes production planning, production scheduling, and work in process inventory.
- Distribution: It focuses on satisfying the requirements of customers. The tasks include forecasting, customer service, finished goods inventory, warehousing, and outbound transportation.

Information flows in the direction of distribution to operation and then supply. Logistics flows in the direction of supply to operation and then distribution. These three activities form an integrated architecture for a supply chain, and should be considered together.

Electronic processing is a key factor in a business. Business processes include much information, which should be efficiently and effectively delivered to managers. Managers can then use the information to help make decisions. If the information cannot be quickly delivered, the managers may not make a decision in time and may cause a great loss of business.

Therefore, a small and medium enterprise needs to know how to use an information system to contact their suppliers upstream and their customers downstream. It is an important issue, because thecompany will deal with suppliers or customers from different countries, and information and logistics will be across different nations became of multiple and complex international networks.

QUESTIONS FOR INTERVIEW

In this section we consider some questions which will assist us to understand which problems are important in a business for managing its global supply chain:

- The supply chain. To understand the supply chain can help us to know the network of a global supply chain, and progress to draw a picture of global supply chain as soon as possible.
- Problems of global supply chain. We use the three areas of supply chain from Figure 1 as a check list to identify problems in the supply chain, so that the business can then learn how to solve these problems and improve their capability in the globalization context.

a. SUPPLY
   - Sourcing: which source can be used?
   - Purchasing: which products will be purchased?
   - Inbound Transportation: which method will be used for inbound transportation?
   - Raw Martial and Part Inventory: how to conduct these?

b. OPERATION
   - Production Planning: how to plan for production?
   - Production Scheduling: how to schedule for production?
   - Work in Process Inventory: how to manage this ?

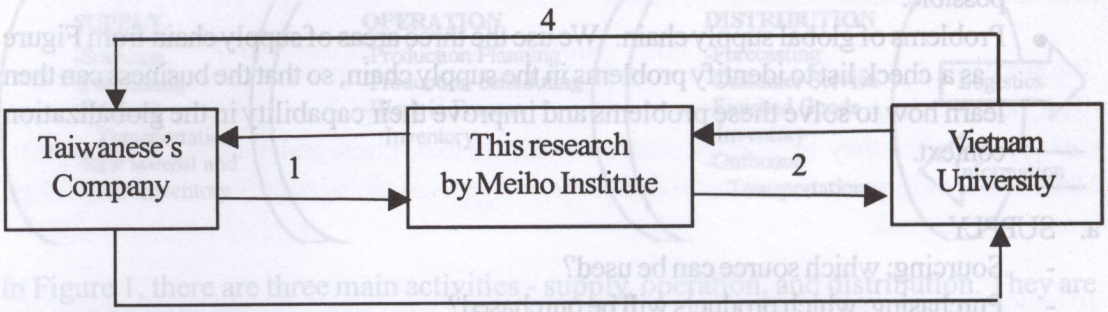
c. DISTRIBUTION
   - Forecasting: how to forecast, and which method or system will be used?
   - Customer Service: how to do this well?
   - Finished Goods Inventory: how to manage this?
   - Outbound Transportation: which method will be used for outbound transportation?

CASE STUDY

Motivation

To understand how a business faces the problems of a global supply chain, we had an opportunity for an international cooperation project between industry and university. When we visited Vietnam we were able to contact a local Vietnamese university and a Taiwanese company. The Vietnamese university could provide input to the company's experience of business administration, technologies, and new management knowledge. Additionally, the Taiwanese company hopes the interview will enable us to understand the state of its business administration in Vietnam, and to assist them in improving their capability. We could also tell the Taiwanese company in Vietnam where to find good local employees with technical capability. The relationships and processes we shown below (Figure 2):

Figure 2: The relationships and processes in this international cooperation project by Meiho Institute

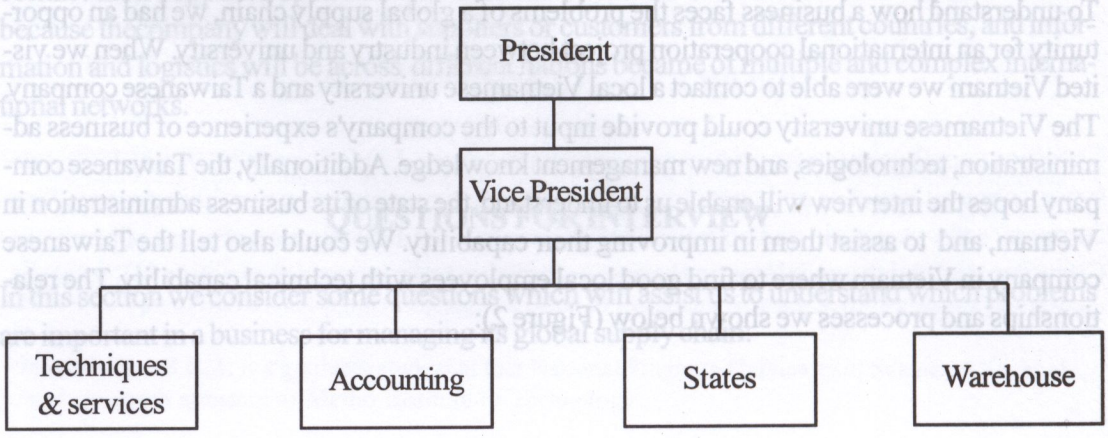


Step 1. Research created by Meiho Institute through contact with a Taiwanese Company in Vietnam (interview)
Step 2. Contact with a University in Vietnam (with technology capability)
Step 3. The Taiwanese Company contacts the Vietnam University directly
Step 4. The Vietnam University's response to the Taiwanese Company's requirements

Introduction to the Taiwanese's Company

Fan-Sun international Company is a trading company, located in Ho Chi Minh City in Vietnam since 2001. It belongs to the industry of commerce and electronics. Their main products for sale are motors and pumps, and they have 50 ~ 80 employees who are almost all Vietnamese except the president and vice president who are Taiwanese. Although, the president of company is Taiwanese, he has been living and working in Ho Chi Minh City for 20 years. He hopes that the Vietnamese employees can be trained in professional technologies, customer management, and languages, and continue their education.. The Organization Structure for Fan-Sun international Company is shown below in Figure3:

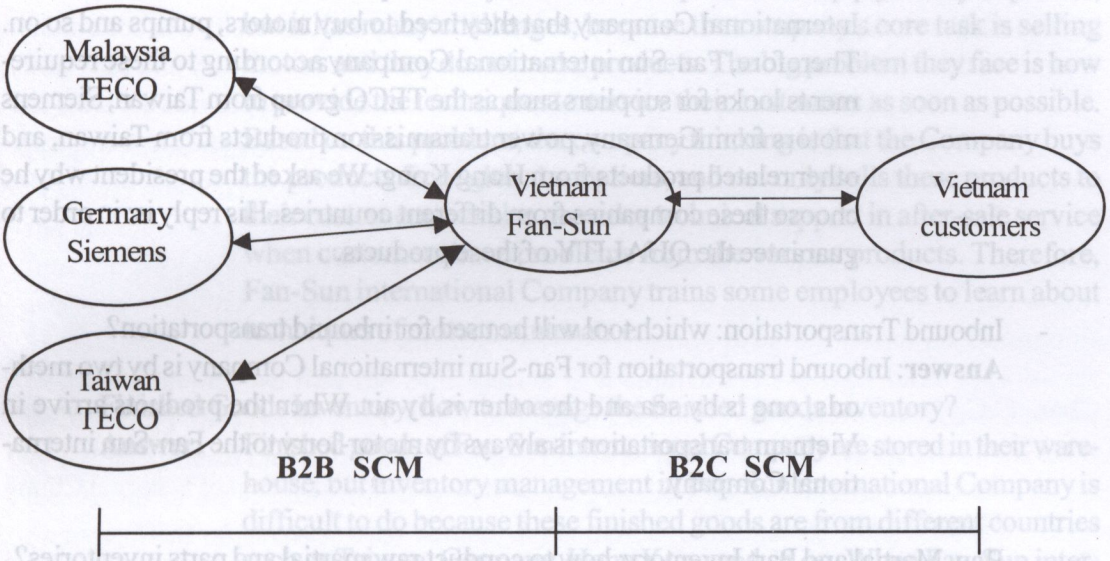
Figure 3: Organization framework for Fan-Sun international Company



The Supply Chain

Fan-Sun international Company buys motors from the TECO group from Taiwan, and buys motors from Siemens from Germany, and then Fan-Sun international company, as an agency, sells these products to Ho Chi Minh City and other cities in Vietnam. Their supply chain is shown below:

Figure 3: The Supply Chain



PROBLEMS OF GLOBAL SUPPLY CHAIN

We use three areas of supply chain as a checklist to identify problems in the supply chain. Then the business can learn how to solve these problems and improve their globalization capability. The Interview with Fan-Sun international Company is described below:

a. SUPPLY

- Sourcing: which source can be used?

Answer: The strategy for supplier management in Fan-Sun international Company is only a buy-sell relationships. Suppliers provide their products for Fan-Sun international Company to choose, the Company decides which products it would like to buy. The company submits its orders to suppliers, who thenl deliver Fan-Sun's products to Fan-Sun of Vietnam. Therefore, the president of Fan-Sun international Company says that they do not use any sources from each supplier, but they really learn something from these

international suppliers such as management's methods or how to use information systems to improve their competitiveness.

- Purchasing: which products will be purchased?

  Answer: Vietnam is a very special country, because the requirements of goods are from customers, who then push the stores or agency to purchase these goods. The agency according to these requirements of suppliers, then buy these goods. Fan-Sun international Company also follows this model to purchase their products when local companies or customers tell Fan-Sun International Company that they need to buy motors, pumps and so on. Therefore, Fan-Sun international Company according to these requirements looks for suppliers such as the TECO group from Taiwan, Siemens motors from Germany, power transmission products from Taiwan, and other related products from Hong Kong. We asked the president why he choose these companies from different countries. His reply is: in order to guarantee the QUALITY of these products.

- Inbound Transportation: which tool will be used for inbound transportation?

  Answer: Inbound transportation for Fan-Sun international Company is by two methods, one is by sea and the other is by air. When the products arrive in Vietnam transportation is always by motor-lorry to the Fan-Sun international Company.

- Raw Martial and Part Inventory: how to conduct raw martial and parts inventories?

  Answer: Fan-Sun international Company does not need any raw martial, but in their warehouse are some inventories of parts, these inventories being used for after-service parts as a service for their customers. However, to maintain this service Fan-Sun international Company has to spend more money to store these parts and to manage them.

b. OPERATION

- Production Planning: how to planning for production?

  Answer: Fan-Sun international Company is a sales company, therefore there is no need for production planning. Fan-Sun international Company outsource to manufacturers of upstream.

- Production Scheduling: how to schedule for production?

  Answer: Same as above.

- Work in Process Inventory: how to manage the work in process inventory?

  Answer: There is no work in process inventory.

c. DISTRIBUTION

- Forecasting: how to forecast and which method or system will be used?

Answer: The Fan-Sun International Company has no information system or method to forecast their market. This is very difficult to do, the main reason being that the company is a small / medium enterprise, they do not employ an information manager to assist the company to do this task.

- Customer Service: how to do customer service?

Answer: Customers service by Fan-Sun international Company is very important, but it has many challenges, because the company's core task is selling motors and they do not make products. The big problem they face is how to provide the techniques to service their customers as soon as possible. Based on this problem, the company thinking is that the Company buys the products from global suppliers, and not only sells these products to their customers, but also provides technical support in after-sale service when customers have problems from the various products. Therefore, Fan-Sun international Company trains some employees to learn about techniques of motor maintenance.

- Finished Goods Inventory: how to manage the finished goods inventory?

Answer: Finished goods of Fan-Sun international Company are stored in their warehouse, but inventory management in Fan-Sun international Company is difficult to do because these finished goods are from different countries such as Taiwan, Germany, Hong Kong and so on. When Fan-Sun international Company receives these products from each international supplier, these products are all put into the same area for storage (one warehouse), and only paper records are used to record what is there. If the company wants update these records it has to do it on paper.

- Outbound Transportation: which methods will be used for outbound transportation

Answer: Outbound transportation for Fan-Sun international Company uses only one method, that is to use vehicles to deliver their products to each customer. Sometime, some customers will go to Fan-Sun international Company directly by motorcycle, as these customers find them readily available.

CONCLUSIONS

From the interview we can draw some conclusions.

- The Order process is not clear for each supplier. Suppliers provide different ordering

systems. This situation means that although each order process is different for Fan-Sun international Company to follow, but Fan-Sun international Company can use these opportunities for contacting them and learning how to develop order systems so that it can more easily manage these global suppliers.

- There is no production-sales information system to connect the Departments of accounting, inventory management and sales. The employees use traditional method to record, manage, and control, and therefore their data is always kept on paper. This data usually cannot be effectively analyzed automatically, and it is also difficult to check for errors.
- Opportunities for international cooperation of industry and university Our contribution to this study is also related to international cooperation of industry and university, especially for the concept of global supply chain management, provide the local university with techniques and support on information system design and electronic engineering, and recruit employees with technical skills from Ho Chi Minh University of Industry.

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