The 8th

International Conference on Intelligent Manufacturing & Logistics Systems

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Department of Industrial Engineering
Faculty of Engineering
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International Conference on
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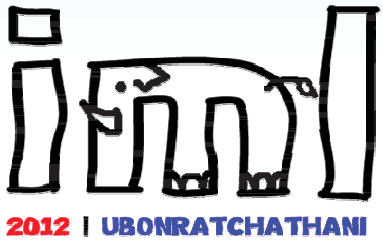

Hosted by:

Department of Industrial Engineering, Ubon Ratchathani University, THAILAND
Department of Industrial and Manufacturing Engineering, Asian Institute of Technology
Thai researchers Consortium of Value chain management and Logistics
Asia Pacific Industrial Engineering & Management Society
Department of Industrial Management Technology, Faculty of Industrial Technology,
Ubon Ratchathani Rajabhat University, THAILAND

Content (CD)

Advance Process Control [APC]

Containers, Seaports and Railways [CSR]

Decision Analysis [DA]

Distributions and Global Logistics [DGL]

Facility Layout Design [FLD]

Fuzzy & Soft Computing [FSC]

Global Logistics & Supply Chain [GSC]

Inventory Management [IM]

Location Allocation Problem [LAP]

Metaheuristics Method [MHM]

Manufacturing Strategy [MS]

Other Related Topic [ORT]

Production Planning [PP]

Reverse Logistics [RL]

Supply Chain & Logistics Management [SCM]

Services Science & Engineering [SSE]

Vehicles Routing & Scheduling [VRP]

Warehouse Management [WM]

WELCOME ADDRESS 1

Dear Participants,
As a president of Ubon Ratchathani University, I would like to officially welcome everyone to Thailand the 8th International Conference on Intelligent Manufacturing & Logistics Systems (IML 2012). We are indeed honored to have you here with us in Ubon Ratchathani – a beautiful province of Thailand. The province combines prehistoric civilization, ancient traditions and customs with natural wonders particularly Pha Taem National Park where pre-historic cave paintings are present; you will be the first person to view the sunrise, before it becomes visible anywhere else in Thailand which is also included in our conference field trip.

Thailand is one of the forefront countries for developing ASEAN Economic Community (AEC) which will establish in the forthcoming years. Because of Ubon Ratchathani's location, it is one of the fastest growing economies in the north eastern Thailand. Well-planned logistic systems are responsible for good economy. That's why we are gathered here to combine our knowledge, to exchange the ideas on the latest developments in the field of intelligent manufacturing and logistics systems among researchers and the practitioners, and to seek opportunities for collaboration among the participants from various countries.

Last but not least, I would like to acknowledge department of Industrial Engineering, faculty of engineering Ubon Ratchathani University for organizing the conference. And I would also like to thank department of Industrial and Manufacturing Engineering, Asian Institute of Technology (AIT), Thai Researchers Consortium of value chain management and logistics, Asia Pacific Industrial Engineering & Management Society (APIEMS), and department of Industrial Management Technology, Faculty of Industrial Technology, Ubon Ratchathani Rajabhat University for their collaboration to bring about such magnificent conference.

In closing, I encourage delegates to participate actively in the interesting discussions. I wish everyone a successful and prolific conference.

Associate Professor Nongnit Teerawatanasuk, PhD
President of Ubon Ratchathani University

WELCOME ADDRESS 2

Dear Participants,

First of all, I would like to thank you for attending this conference in spite of your busy schedules and bid a warm welcome for everyone from all countries to the 8th International Conference on Intelligent Manufacturing & Logistics Systems (IML 2012). As a dean of Faculty of Engineering Ubon Ratchathani University, It is a great pleasure for us to host this conference here in Ubon Ratchathani. This conference will provide a platform to exchange ideas in the field of intelligent manufacturing and logistics systems and a conference field trip to explore the historical and natural essence of Ubon Ratchathani.

ASEAN is becoming one of the most important regions, with more than 590 million people and strong domestic consumption makes ASEAN one of the most promising markets. Total trade within this area is about US$1.7 trillion and gross domestic product is US$1.5 trillion which logistic cost takes up more than 20 % of GDP or US$0.3 trillion. It is undeniably important to bring such topic to the table. We hope this conference will be a great forum for discussing and exchanging information.

I would also like to thank department of Industrial and Manufacturing Engineering, Asian Institute of Technology (AIT), Thai Researchers Consortium of value chain management and logistics, Asia Pacific Industrial Engineering & Management Society (APIEMS), and department of Industrial Management Technology, Faculty of Industrial Technology, Ubon Ratchathani Rajabhat University for their support, and most importantly, keynote speakers for their participation in this conference. We have keynote speakers and participants at this conference from many countries including Austria, Thailand, and Korea. It is indeed honored to have all of you here with us.

I hope that over the next two days, we will meet with one another and discuss ideas for moving forward, as we explore the power of partnerships.

Assistant Professor Note Saengtian, PhD
Dean of Faculty of Engineering
Ubon Ratchathani University

WELCOME ADDRESS 3

Dear Participants,

On behalf of Thai Research 's Consortium of Value Chain Management and Logistics (Thai VCML), I feel very delighted and would like to extend our warm welcome to all participants to The 8th International Conference on Intelligent Manufacturing & Logistics System.

The Thai VCML is grateful to support our local host, UBON RATCHATHANI UNIVERSITY, in making this international conference possible. The academic collaborations and network building among researchers in this region are strongly encouraged. This year, we are starting up a forum of Asia-Pacific logistics research network and seek for participants from all over Asia-Pacific Countries. Our initial success is the collaborations among the ASEAN.

A great deal of thanks must be given to all the presenters, delegates, reviewers, committee and local organizing committee in the 8th International Conference on Intelligent Manufacturing & Logistics System.

Associate Professor Duangpun Kritchanchai Singkarin, PhD
Chairman of Thai Research 's Consortium of Value Chain Management and Logistics (Thai VCML)

Dear Participants,

On behalf of Faculty of Industrial Technology, Ubon Ratchathani Rajabhat University and department of Industrial Management Technology, it is a great pleasure for me to welcome you all, especially foreign guests and colleagues, to the 8th International Conference on Intelligent Manufacturing & Logistics Systems (IML2012) at Ubon Ratchathani, THAILAND.

I wish our well-known Thailand hospitality will make you feel comfortable. As host and co-organizer, we will do our best to make this conference productive and successful.

Associate Professor Damrongrit Wiboolkijthanakorn, PhD
Dean of Faculty of Industrial Technology
Ubon Rachathani Rajabhat University

CONGRATULATORY ADDRESS

Professor Mitsuo Gen

Founder of
IML Conference
&
Senior Research Scientist
Fuzzy Logic Systems
Institute, Japan
&
Chair Professor
Dept. of Industrial and
Management Engineering,
Hanyang University, Korea

Welcome to Ubon Ratchathani, Thailand for the 8th International Conference on Intelligent Manufacturing & Logistics Systems (IML 2012) organizing by Dept. of Industrial Engineering, Ubon Ratchathani University in collaboration with Asian Institute of Technology (AIT) and Thai Researchers Consortium of Value Chain Management and Logistics (Thai VCML) in Ubon Ratchathani, Thailand.

The conference of Intelligent Manufacturing & Logistics systems (IML) is to provide a small scale forum for exchanging some of ideas and information about the latest research & developments in the field of Intelligent Manufacturing and Logistics systems among researchers and the practitioners, and to seek opportunities for collaboration among the participants from various countries. Intelligent Manufacturing & Logistics systems based on Artificial Intelligence (AI) is a novel manufacturing environment which has been developed for the next generation of Manufacturing and Logistics system. In the increasingly global communication, Integration of Manufacturing and Logistics systems based on AI and IT has become a necessity brings together different functional areas of an enterprise.

The 1st IML conference in 2005 firstly started as an initiative workshop at Waseda University, Kitakyushu in Kitakyushu Science & Research Park (KSRP) as First Japan-Korea Workshop on Intelligent Logistics Systems and continued at Pusan National University (Prof. Kap Hwan Kim) in Busan, Korea. In 2006 IML conference held Second Japan-Korea Workshop on Intelligent Manufacturing & Logistics at Waseda University, Japan and then authorized them as the 3rd International Conference on Intelligent Manufacturing & Logistics Systems (IML2007) until the 5th IML2009 at Waseda University in Japan. In particularly the IML2009 held together with Symposium on Group Technology and Cellular Manufacturing (GT/CM2009). In 2010 the 6th IML held at National Tsing Hua University in Hsinchu, Taiwan by Dept. of Industrial Engineering and Engineering Management (Prof. Chen-Fu Chien) and in 2011 the 7th IML also held at Yuan Ze University in Chung-Li, Taiwan by Dept. of Information Management (Prof. Pei-Chann Chang).

A great deal of thanks must be given to Dept. of Industrial Engineering, Ubon Ratchathani University for the support to the IML2012 and Dept. of Industrial and Manufacturing Engineering, AIT. Finally, I would like to express my gratitude to members of the organising committee and sponsors who so generously gave their support to the 8th International Conference IML2012 in Ubon Ratchathani,Thailand,in particular, Prof. Voratas Kachitvichyanukul at AIT, Asst. Prof. Dr. Rapeepan Pitakaso, Asst. Prof. Dr. Sombat Sindhuchao and Dr. Natthapong Nanthasamroeng at Ubon Ratchathani University.

Human Aspects in Supply Chain Planning and Operations

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Abstract
Supply chain planning and operations is deeply dependent on human despite the increasing use of automation in various supply chain activities. Human has played roles in managing day-to-day transaction recording, data analysis, quality inspection, materials movement, as well as making decisions on various aspects of supply chain planning, including setting inventory parameters, capacity flexibility level and various other decisions. Despite the critical roles of human in supply chain planning and operations, there is a limited literature that comprehensively addresses this issue. Supported by literature review in the field, we discuss human roles in supply chain planning and operations. We use the business process models and then we attempt to identify critical roles of human in each key process of supply chain planning and operations. This early research is expected to set the stage for the follow up empirical research.

Keywords: human aspect, supply chain planning and operations, business process

1. Introduction

Supply chain management has received attention from academic as well as practitioners since the early 1980s. A supply chain may be defined as an integrated process wherein a number of various business entities (i.e., suppliers, manufacturers, distributors, and retailers) work together in an effort to: (1) acquire raw materials, (2) convert these raw materials into specified final products, and (3) deliver these final products to retailers[1]. Supply chain management (SCM) crystallizes concepts about integrated Changes in consumer demand for new products will affect the level of human complexity in the supply chain business planning and at the core of SCM are a variety of production planning and scheduling systems that optimize the operations of the supply chain network[2]. A supply chain is a system of people/human, activities , information, and resources involved in creating a product and then moving it to the customer[3]. Supply chain planning and operations is deeply dependent on human despite the increasing use of automation in various supply chain activities. Human has played roles in managing day-to-day transaction recording, data analysis, quality inspection, materials movement, as well as making decisions on various aspects of supply chain planning, including setting inventory parameters, capacity flexibility level and various other decisions.

Despite the critical roles of human in supply chain planning and operations, there is a limited literature that comprehensively addresses this issue. One of literatures argued that global competitiveness is constrained by the mindsets that supply chain personnel operate under, as well as the degree of analytical and social capital possessed. The individual is the importance key to effective supply chain operations. There is any interaction between mindset, human capital and global competitiveness in an increasingly competitive global marketplace[4]. There is evidence to the human dimension that 80 percent of supply chain problems occur due to the people[5]. Human limitations become one of big problems on strategic level for supply chain [6]. Five critical performance levers have the greatest impact on supply chain performance: (1) configuration,(2) management practices, (3) external relationships, (4) organization; and (5) systems[7]. Human capability become important entity for management practices, external relationships, and organization. Optimizations and integration on supply chain cannot be done without people [8] .

Supported by literature review in the field, we present a discussion on human roles in supply chain planning and operations. We used the business process models and then we attempt to identify critical roles of human in each key process of supply chain planning and operations. This paper is expected to set the stage for the follow up empirical research.

2. Literature review

This section will examine the shortcoming in the supply chain literature dealing with the human role in the supply chain planning and operation. We analyze the literature dealing with human capabilities and supply chain. This literature review can improved our understanding of human role characteristic in supply chain planning and operation.

2.1. Human Capabilities in Supply Chain

Human capital in a company will provide a competitive advantage. The mindset of the supply chain personnel plays an important role in the decision making process. Another important aspect of human in its global supply chain are analytical capital and social capital [4]. The key to managing risks in the supply chain is the human being involved in the supply chain [9]. Human resources are one of the factors that shape the construction supply chain [10]. Human perceptions affect the dynamics of the system [11]. At the operational level, the first key determinant of success is the humans [12]. A survey showed that 80 percent of the problems in the supply chain occur due to the human [13]. The human factor remains a critical issue in business process changes [14]. Humans as an asset to reduce cycle time in relation entities in the supply chain [15]. Types of skills needed in the supply chain personnel are: technical, interpersonal, internal enterprise, external enterprise, and strategic business skills [16]. Human factors that affect the successful implementation of information technology in supply chain are: behavioral attitude, level of education, knowledge in computer, international exposure, training and education, reward and employee empowerment and incentive scheme [17]. Production capacity should be designed as efficiently as possible in the use of natural and

human resources to improve environmental and social development [18]. Changes in consumer demand for new products will affect the level of human complexity in the supply chain [19]. Human factors like, ignorance, indifference, and arrogance are contributing to the bullwhip effect [14]. The performance of supply chain is more sensitive to variations in human skill, knowledge and attitudes, and mental effort [20]. The dominant culture in the organization will influence the decision process in making supply chain partnership work [21]. The roles of people in supply chain need to be explicitly addressed [22]. The use of technology will provide accurate and reduces human error [23]. A harmonized relationship between people, organization, information, activities and resources will support the supply network performance [24].

Based on the information described above, then the human aspects can be classified into: (1) mindsets; (2) technical skill; and (3) managerial capabilities.

Mindset refers to opinion, believes, intentions or perceptions which affect a person's attitudes [25]. Technical skill refers to knowledge and skill of person's to fulfill specific operations. A managerial capability refers to knowledge, skills, and mental effort that support person's made decision and management activity. This classification determine existing dimension of human capability to fulfill requirement in supply chain operations. Based on literature there are intersections (minimum one intersection) between three dimensions that human capability required to fulfill supply chain activity. Detail classification for this literature review illustrated on Venn diagram below (figure 1). This diagram shows the authors and position subject of human capability. The proportions for each intersection based on number of literature are: 44% for intersection between mindsets, technical skill and managerial capabilities; 32% for intersection between mindsets and managerial capabilities; and 24% for intersection between technical skill and managerial capabilities. There was no intersection between mindsets and technical skills.

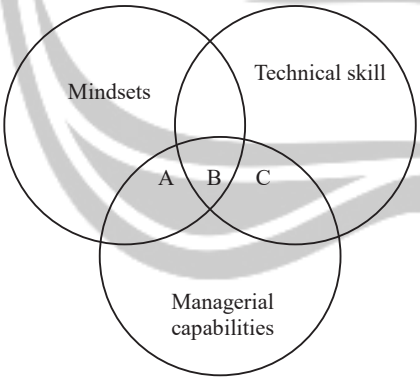

Figure 1. Van Diagram of Human Capability

Table 1 List of author and area position.

Area	Reference
A	[11, 13, 17, 20, 21, 26-29]
B	[4, 9, 10, 14, 16, 22, 24, 30-32]
C	[12, 15, 18, 19, 23, 33]

2.2. Supply Chain Planning and Operation

A supply chain consists of all parties involved, directly or indirectly, in fulfilling a customer request. The supply chain includes not only the manufacturer and suppliers, but also transporters, warehouses, retailers, and even customers themselves[34]. Human capital is a part of manufacturer, suppliers, transporters, warehouses, retailers, and even customers. Figure 2 shows the model of activities and firms in a supply chain. It start with the extraction of raw materials or minerals from the earth, through the manufacturers, wholesalers, retailers, and the final users[35].

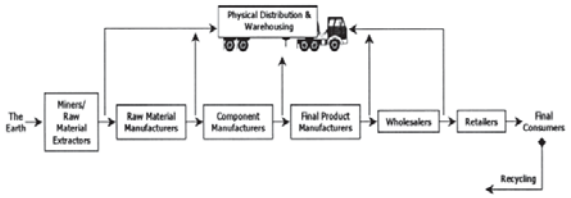

Fig 2. Activities and firms in a supply chain (New and Payne, 1995)

Decision phases in a supply chain are supply chain strategy or design, supply chain planning, and supply chain operation[34]. Supply chain planning is concerned with the coordination and integration of key business activities, from the procurement of raw material to the distribution of final product to the end customers [36]. Supply chain planning deal with the management of customer orders through the supply chain. Decision about quantities to produce, production and delivery dates, distribution modes, and allocate resources to each product needed must be made from each partner involved[37]. Scope of supply chain planning [34]: Companies start the planning phase with a forecast for the coming year of demand in different market. Planning includes making decisions regarding which markets will be supplied from which locations, the subcontracting of manufacturing, the inventory policies to be followed, and the timing and size of marketing and price promotions. The result is that companies define a set of operating policies that govern short-term operations.

The time period used in supply chain planning could be weekly or daily. During this phase, firms allocate inventory or production to individual orders, set a date that an order is to be filled, generate pick lists at a warehouse, allocate an order to a particular shipping mode and shipment, set delivery schedules of trucks, and place replenishment orders. [34]. Operations are process of transformation, whereby people and physical resources are combined into productive system to provide goods and/or services. Operations activities consists of process and product design, job design and measurement, distribution planning, planning and scheduling, inventory management, capacity planning [38, 39] .

2.3. Business Process

Process of the supply chain can be identified using the business process. Business process refers to sets the relations between task, order, activity and actors to achieve a goal of business. The scope of supply chain activities include forecasting, production and delivery strategy, inventory and enterprise software, as well as integration aspects related to interaction and communications with customers and suppliers. Operation is the way the activity is carried out. The operation areas include manufacturing technology and systems variables along with human resources issues [40]. There are trade-off decision areas in manufacturing activity [41].

Here is the explanation of one example of a production and procurement process contained in the supply chain. Operational planning as an initialization process, begin with forecasting in generic product units. While customer orders are received, the generic planning units are changed to specific end item and assigned shipping dated. The process

of production and assembly in bill of material (BOM) implemented. Once an order passes this stage, quantity and due date are locked-in the production schedule. A master production schedule drive assembly operation and MRP [42]. Another process that became a key process in managing the supply chain are:

- Procurement process
- Order fulfillment process
- Production planning process
- Product design process and
- Products return process.

Customer satisfaction in supply chain met through order fulfillment process. Order fulfillment can be defined as the activities that take place from/ start at a buyer places an order until that order has been delivered in to the buyer. Order fulfillment involves generating filling, delivering and servicing customer orders [43]. Business process for order fulfillment can be simplified as:

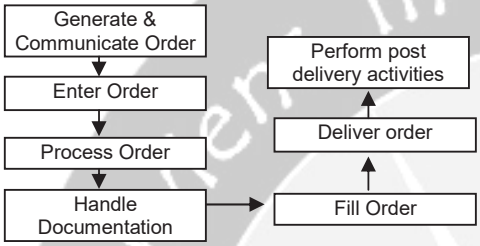

Fig 3. The Operational Order Fulfillment Process (Croxton,2003)

2.4. Human factors/capabilities.

Human factors can be positioned at research focus on relation between human-equipment, human-computer, human-system, human-environment and human-interaction [44]. These relations be present in supply chain and the goal of humans factors is to account human aspect in systems design [45]. Human in operations fields act as actors. In this section we study the human roles on order fulfillment process. First, identify activities requirement for each step on order fulfillment process. Second, identify possibility of human errors to happen. Finally, identify human capabilities requirement to fulfill each activities. Data process and activities are taken form Croxton (2003).

Table 2. Preliminary identification activities and human error

Process	Activities	Human error
Generate & communicate order	* Generate order * Transmit order	Customer fail to receive accurate information
Enter order	* Receive order * Enter order * Edit order	Misinformation of order collection
Process order	* Check credit * Check inventory * Plan order flow and transportation	Planning error and loss of opportunity
Handle documentation	*Acknowledge order *Prepare bill of lading, picking instruction and packing slips * Generate invoice	Misinformation of bill, picking instruction and invoice
Fill order	* Pick product * Pack Product * Stage for loading * Prepare load confirmation	Error in pick and pack of product. Wrong placement of product
Deliver order	* Prepare shipping documents * Transmit delivery confirmation * Audit and pay freight bill	Wrong delivery order and freight bill
Perform post deliver activities	* Receive and post payment * Record bad debt expense * Measure process performance	Misinformation of process performance.

Table 3. Preliminary identification activities and human capabilities

Activities	Human capabilities
* Generate order * Transmit order	The ability to read, record, process and to interpret data. (technical skill)
* Receive order * Enter order * Edit order	The ability to read and record data. (technical skill)
* Check credit * Check inventory * Plan order flow and transportation	The ability to read, record, process and to interpret data. The ability to make decision. (technical skill & managerial capabilities).
*Acknowledge order *Prepare bill of lading, picking instruction and packing slips * Generate invoice	The ability to read, record, process and to interpret data. The ability to make decision. (technical skill & managerial capabilities).
* Pick product * Pack Product * Stage for loading * Prepare load confirmation	The ability to read, record, process and to interpret data. (technical skill).
* Prepare shipping documents * Transmit delivery confirmation * Audit and pay freight bill	The ability to read, record, process and to interpret data. The ability to make decision. (technical skill & managerial capabilities).
* Receive and post payment * Record bad debt expense * Measure process performance	The ability to read, record, process and to interpret data. The ability to make decision. (technical skill & managerial capabilities).

3. Classification of Competencies

As discussed above, human has played critical roles in planning and executing supply chain processes. There are an array of competencies needed to arrive at an excellent planning and operations of a supply chain. Bearing in mind that supply chain manages the flow of physical products with a heavy reliance on information, below are the six categories of competency needed for successfully planning supply chain operations and executing it:

1. Data management is the ability to obtain / prepare data input required for making various supply chain decisions.
2. Skills to operate tools such as software and hardware as well as to use various methods such as forecasting techniques, methods to determine inventory parameters, etc.
3. Analytical skills such as those related to analyzing data, doing what if analysis on parameters, simulating scenarios related to supply chain plans, etc.

4. Ability to react / adapt to new information / situation such as adjusting production plan, handling urgent orders, changing modes of delivery, and handling last minutes requests from customers.
5. Ability to work in a team especially in coordinating sales and production plan, synchronizing production plan with purchasing plan, coordinating new product development with marketing plan, etc.
6. Ability to collaborate with business partners such as involving suppliers in developing new product, obtaining sales data from distributors, making sure that suppliers provide order status timely, etc.

The above six categories may be further elaborated with respect to more specific business processes. We will give elaborated competencies for three processes related to supply chain planning and operations, i.e., forecasting, production planning, and inventory control.

3.1 Human Competencies for Demand Forecasting

When developing the demand forecast, people involved should have sufficient and reliable input and thus, it is important for those people to have an ability to provide timely and accurate sales data. This requires skills in data recording, data compilation, and data storage. Demand forecaster should also have skills to operate pertinent software and use methods suitable for developing sales forecast for a specific product line, for a specific market region, or for a group of items or aggregated regions. Analytical skills would be required to obtain better understanding on the data pattern and relationships between variables that may have effect on sales. This should be supported by a good knowledge of sophisticated statistical analysis, including for example, data mining techniques. When time proceeds, very often forecasters have to make adjustment due to changes in market situation. Demand maybe significantly lower or higher than those previously predicted, so adjustment for the future periods may be necessary. Ability to react appropriately with the current situation is very important to have a sufficient level of responsiveness to the market without introducing too much instability to the planning system.

Apart from the above hard skills, demand forecaster also requires soft skills, in particular to work with a team from different function within the organization. An accurate demand forecast is of interest for all parties, especially people working in the area of sales & marketing, production planning, production, purchasing, and distribution. It is important for demand forecaster to work with people in those functions. In addition, demand forecast should also take into account information from outside of the organization, in particular from the customer. The concept of collaborative forecasting is very much putting reliance on cross-organization collaboration in developing demand forecast. People have always been a core factor in making cross-functional as well as cross-organization collaboration to work.

3.2 Human Competencies for Production Planning

Production planning is a process of establishing an efficient and executable production plan that delivers high customer service. An executable production plan requires understanding on available resources. A good production plan has been always dependent on the people behind the planning process. Planners are responsible to prepare appropriate input data such as demand forecast, customer orders, available inventory, production capacities, and other related input. Data management is thus an important competency a planner should posses. A good data do not automatically transfer to a good plan. Planners should be capable of using various tools, including the planning software and conversant with models or methods that can be used to establish the plan. A good planner should be able to establish alternative scenarios and simulate those scenarios to obtain information on which alternative works best under a certain situation.

It is also important to note that in any situation, a plan should be flexible in absorbing changes. Various changes could happen in business environment and as well as internal to production system, including urgent orders from customers, sudden machine breakdown, late deliveries of materials from suppliers, natural disasters in any part of the supply chain that should be reflected in the production plan, etc. A good planner should be able to wisely adjust the plan to accommodate necessary changes. On the other hand, planners should always keep a balanced consideration of responsiveness and efficiency when trying to adjust the plan. Sufficient attention should also be given to the differing (and conflicting objectives) among stakeholders. Planners should lead the formation and operations of a solid cross-functional team to ensure that customer responsiveness (representing the interest of marketing & sales department) is taken care of, while also ensuring a good level of efficiency (representing the interest of operations people). The last is the ability to work with business partners to develop plan that reflect the needs of customers and commitment of suppliers to supply materials and other inputs. To achieve this, planners should have the capability to work with people across different organization within the supply chain, including persuading customers and suppliers to provide necessary information to develop a collaborative plan.

3.3 Human Competencies for Inventory Control

The objective of inventory control in any organization is to ensure availability of materials to support production plan or availability of products to supply customer demand, while keeping inventory cost low. In many organizations, inventory controllers are managing thousands of stock keeping units (SKU) with varying characteristics: demand pattern could be smooth or erratic, value per unit may be low or high, lead time maybe long or short, impact of shortage maybe critical or negligible. Facing with those different characteristics, inventory controllers should have ability to:

- collect data needed to determine inventory control parameters such as lead time, demand, price, and various cost parameters. Today, with sophisticated ERP systems, organizations are very much assisted in data management. However, this does not mean that human intervention is no longer critical. There are many evidences showing that data related to inventory record is inaccurate due to lack of commitment and discipline in recording inventory transaction or carelessness in inputting transaction data leading in data errors.
- analyze data, use methods and tools to control inventory. With so many variations in demand pattern, value, and criticality, inventory controllers should have adequate ability to do inventory classification, select appropriate method based on item characteristics, and use transaction history (and predicted future events) to set inventory policies, such as reorder point, order frequency, maximum inventory, etc.
- adjust materials plan to reflect changes in supply chain environment. Good knowledge of uncertainty is a very important element of effective inventory

control. Inventory controllers set the level of safety stock to guard against uncertainty in demand during the lead time. If they do not really know the level of uncertainty, safety stock could be too high leading to excess in inventory or too low leading to shortages before the next shipment from a supplier arrives. Material plans may have to be quickly adjusted when there is an indication that demand is suddenly slowing down or uprising or when there is an indication that supply availability is decreasing.

- build a solid cross-functional team especially among sales & marketing, production planning, and procurement functions. Inventory policy should take into account conflicting objectives of different functions. Marketing and production are normally interested in keeping higher level of inventory, while accounting and warehousing people would tend to drive the inventory level down. While analytical skills of inventory controllers are important, it is equally important for them to have team-working skills.
- work with business partners to establish better control over materials availability and visibility across the supply chain. Inventory is a result of upstream and downstream processes in a supply chain. Ability of inventory controllers to obtain such information as inventory level and demand from supply chain partners (rather than estimating them) is critical to the effectiveness of inventory decisions.

4. Summary and Conclusion

We present a discussion on human roles in supply chain planning and operations in this paper, an important topic that has not received much attention from the academics. We have used a process oriented model to show the activities in some supply chain processes and then human aspects in each activity has been outlined. We also present the six distinct competencies needed to perform supply chain planning and operations. How those six competencies work for the three core processes in supply chain planning and operations, i.e., demand forecasting, production planning, and inventory control has been discussed. This paper is expected to set the stage for the follow up empirical research.

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