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Enhancing Engineering Innovation Towards A Greener Future
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Preface

Welcome Remarks,
Chair of the Steering Committee

It is a great pleasure to welcome all of you to Bali and to the International Conference on Informatics, Technology, and Engineering 2019 (InCITE 2019) held by the Faculty of Engineering, University of Surabaya (UBAYA) in collaboration with The University of Adelaide, Australia and Sirindhorn International Institute of Technology (Thammasat University), Thailand. The first InCITE has been successfully held in Bali, Indonesia in 2017. We are very delighted to host the second InCITE here in Bali, Indonesia again.

There are more than 75 presentations in this conference. We welcome leading experts not only from Indonesia, but also from different parts of the world. The experts will share the knowledge and experiences in the fields of informatics, technology, science, and engineering. The main theme of this conference is **Enhancing Engineering Innovation Towards A Greener Future** in response to several world challenges including sustainable development, global convergence of information and communications technologies, climate change and global warming as well as the depletion of unrenewable natural resources. We hope this conference will provide you a good opportunity to get to know each other better and consolidate bonds of friendship and mutual trust.

We would like to express our sincere gratitude to the Keynote and Plenary speakers, International Scientific Committee, Steering Committee, and Organising Committee for their huge efforts to make this conference successful.

Thank you all for your support and attendance at InCITE 2019. Please enjoy the conference and Bali !

Asst. Prof. Djuwari, Ph.D.

Preface

Welcome Remarks,
Chair of The Organizing Committee

Welcome to Bali, Indonesia to all delegates and presenters. It is my pleasure and privilege to welcome all of you to the 2nd (second) International Conference on Informatics, Technology, and Engineering 2019 (InCITE 2019) held by the Faculty of Engineering, University of Surabaya (UBAYA) in collaboration with The University of Adelaide, Australia and Sirindhorn International Institute of Technology (Thammasat University), Thailand.

InCITE 2019 has received more than 75 papers to be presented in this conference. All papers represent four following parallel clusters: Green Design and Innovation, Green Manufacturing and Green Processes, Power System and Green Energy Management, and The Role of IT in Innovation Enhancement. Each cluster supports the main theme of the conference, which is **Enhancing Engineering Innovation Towards A Greener Future.** The engineering innovation is the key to increase our awareness in maintaining the sustainable growth and development in the world.

The Organising Committee of InCITE 2019 would like to express our sincere gratitude for the tremendous supports and contributions from many parties. The supports from The Faculty of Engineering of UBAYA, keynote and plenary speakers, our International Scientific Committee, the Steering and Organising Committees are really acknowledged.

The last but not the least, thank you for your supports, enjoy the conference and we hope through this meeting all of you can extend your networks and collaborations.

Asst. Prof. Putu Doddy Sutrisna, Ph.D.

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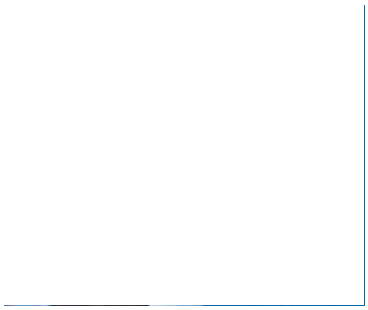

The Role of Ergonomics in Suporting Supply Chain Performance in Manufacturing Companies: a Literature review

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The Role of Ergonomics in Suporting Supply Chain Performance in Manufacturing Companies: a Literature review

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Abstract. Nowadays companies are required to work more productive yet maintain good quality. To increase productivity, company needs a conducive effort to optimize the work system. Supply chain management (SCM) is one form of competitive advantages that is applied to every industrial system. There are many factors which can influence the supply chain performance (SCF).Ergonomics is deemed to be one of significant drivers for SCF. This paper proposes and discusses the concepts related to ergonomics which is considered as macro ergonomics in supply chain system. SCM has been seen as macro ergonomics concerning on organization, people, technology, information and resources. This paper shows the importance of ergonomics at the inbound logistics (includes receiving, storing, inventory control and internal distribution management) and outbound logistics (the activites to get the finished product to customer) which are regarded as the critical supply chain activities. A scientific literature review on ergonomics as a critical determinant for SCF is discussed and provided as a theoretical contribution for further research related to the role of ergonomic to support supply chain performance.

1. Introduction

Supply chain management is a form of competitive excellence which is applied in every industrial system. The competitive strength of supply chain is achieved when the operation or act of adding value generates a maximum output. Supply chain is a network of companies that work in harmony to create and deliver product to the hands of end users [6]. In this era, every company is expected not only to work faster, but also to produce more high-quality products; however, there are still a number of businesses that do not consider the affecting factors and their risks. Ergonomics is the affecting factor which maintains the relationship between the company and the environmental aspects [2]. Ergonomics is divided into two sections which are micro- and macroergonomics. The former is the linkage of the workers, machines, methods and materials used, whereas the latter is a top-down

sociotechnical system approach which is applied to an overall work system design of various interaction levels of microergonomics, such as human-job, human-machine, and human-software interface. Macroergonomics is something integrated because it covers knowledge, method, and equipment from sociotechnical system, industrial psychology, system design, physical ergonomics, and theoretical ergonomics. The use of macroergonomics in the supply chain performance evaluation is to analyze the structural work system by evaluating human, environmental, and equipment factors which are the support in production activities. The main purpose of macroergonomics is to harmonize the work system as a whole both in the micro and macro level, to increase the work satisfaction which is committed to the health and safety of the workers, and to increase productivity [12]. The company should build a macroergonomics concept that pays attention to the technical aspects (machines equipped with safety), organization/management, good work environment and competent operators/employees [1].

There are several studies done about the important role of ergonomics that could improve supply chain management performance. Pintelon&Azadeh (2016) stated that a systematic framework is by categorizing human factors in maintenance decision making which are human error, reliable calculation, workplace design/macroergonomics, and human resource management. Whereas Hasle & Jensen (2012) found that the ergonomic means and human factor to create international collaboration could affect global supply chain. Identifying five main challenges from global supply chain, especially the ones related to the sustainable social aspects, are the criteria for social sustainability, the role of key performance indicators in supply chain management, the constant changes in the supply chain, the challenges in building participation, and the agency development and mechanism regulations. The research done by Dewa, et al (2016) produces a model to conduct a sensitivity analysis to the implementation of corrective actions that is generated in the corrective models to reduce errors. According to Hartono (2008), ergonomics does not only focus on human and machine, but also on the interaction between culture and its surroundings. Ergonomic evaluation should also be understood and applied in vendors, suppliers, and all value chain components to achieve high level supply chain performance. This analysis uses Porter's value chain model. Supply chain is considered as value chain which covers supplier, the company itself, distribution and buyer. There are two value chains, which are primary activities and support activities. Primary activities include inbound logistic, operations, outbound logistic, marketing and sales, and services.

Based on several research results that have been conducted, it can be temporarily inferred that ergonomic factor in supply chain holds a vital role to the success of supply chain management itself. On previous studies, mostly ergonomics only focuses on operations, which is the product formation process. Due to this fact, this research discusses the importance of ergonomics on inbound and outbound logistics to improve supply chain performance. Inbound logistic is the role of all processes related to the reception storage, and distribution of internal input. Moreover, outbound logistic is the role of providing the products to the customers, such as inventory control and transportation.

The purpose of this research is to answer the question of how the role and contribution of ergonomic factor in the context of planning and supply chain operation is to inbound and outbound logistic. With many challenges and issues in operational management in supply chain, there is a need for an understanding and ergonomic management in planning and operating supply chain, which becomes a fundamental subject to be studied and managed.

2. Literature Review

2.1. Supply chain management

The term supply chain is defined in various ways. Pujawan (2010) stated that supply chain is the network of companies that work hand-in-hand to create and deliver product to the hands of end users. The purpose of every supply chain is to maximize the supply chain profitability, which is the difference between total revenue obtained from the consumers and the total of overall cost spent on a supply chain. According to Ravindran & Warsing (2013) customer is the single source of profit for every supply chain, which is met on a trade-off between responsiveness and efficiency. Supply chain

responsiveness includes supply chain that is able to respond to the demand in a broad scope, have a short lead time, handle products with wide variation, and have a high service level.

2.2 Key performance indicator of supply chain

According to Miranda and Amin WT (2005), to develop a balanced performance measurement system, the company should consider financial and non-financial aspects. Even though financial performance measurement is vital to strategic decision-making and making external reports, control towards manufacturing operation and distribution is better handled with non-financial measurement. Supply chain performance measurement has an important role in knowing the company condition, whether it experiences decline or incline, and also the improvement as well as what kind of correction that should be conducted to enhance their performance. The measurement of supply chain performance includes company performance measurement of their internal and external process. The internal process happens within the company starting from the production planning to the product delivery to the customers. On the other hand, external process involves the relationship of the company with outside stages, which are supplier and customer. According to Rakhman(2006), performance measurement is important due to the following reasons: performance measurement can control direct and indirect performance;it will maintain the company's track to achieve the purpose of increasing supply chain;and it can be used to increase supply chain performance. Faulty measurement method can cause the decrease in supply chain performance. Supply chain can be directed after performance measurement is conducted.

2.3 Macroergonomics

Macroergonomics is a sub discipline of ergonomics which focuses on studying work system design [12]. A work system is comprised of a mutual interaction between personnel with hard and soft wares. A work system includes two or more individuals who cooperate to achieve a general purpose in an organization. Macroergonomics is known as an ergonomics sub discipline related to the correlation between humans, organizations and technology. Macroergonomics is an integrated discipline because it covers knowledge, methods, and equipment from sociotechnical system, industrial psychology, system engineering, physical ergonomics, and theoretical ergonomics. In its application, macroergonomics presents a valuable niche that none of these areas are overlooked. As science, macroergonomics directs to develop an understanding of a work system, behavior, or personnel that interact with hard or soft wares in an internal physical environment, external surroundings, and organizational structure as well as process to improve. Macroergonomics also studies profession, but it examines jobs and work system in a wider scope. Several points that are discussed in macroergonomics are organizational structure, interaction between people in an organization, and workers' motivation aspect. On the other hand, microergonomics only observes from occupational level, but macroergonomics views from both occupational and organizational levels. The table below states the differences between micro- and macroergonomics:

Table 1. Differences micro- and macroergonomics [12]

Characteristics	Microergonomics	Macroergonomics
Level of discussion	Micro	Macro
Work unit	Task, sub task	Work division, group
Purpose	Optimize work	Optimize work system
Focus	Detailing	Extensive review
Measurement tools	Generally measure physically, such as area, i-lumination, decibel, and time	Generally organizational and measure subjectively, such as the number of people, range of control, behavior, and moral.
Expertise application	Anatomy, psychology, psychology of perception	Organizational behavior, industrial psychology and organization

2.4 Porter's value chain

Value Chain Analysis is a strategy used to analyze the company's internal activities. It is a process where a company identifies the primary activity and support that increase the value of the product, then analyzes it to reduce cost or increase differentiation. Value Chain Analysis that is extensively used by companies is Porter's Value Chain Model which is introduced by Michael Porter in the year 1985. The said model is pictured below.

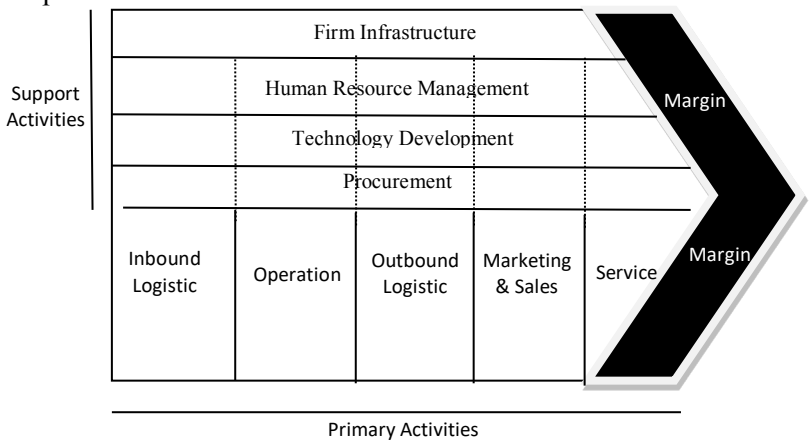

Figure 1. Porter's Value Chain [2]

Porter's Value Chain is divided into two categories, which are primary activities and support activities. The explanation of Porter's Value Chain category is as follows.

- Primary Activities
  The main activity is directly related to physical creation, sales, maintenance, and support from a product or service. Several components that support primary activities are:
  1. Inbound Logistic
     All process related to receiving, storing, and distributing internal input.
  2. Operations
     The action of transformation that changes the input to be the output, which will be sold to the customers.
  3. Outbound Logistic
     Give the customers their product or service. Outboung logistic is the activities to get finished product including warehousing, order fulfillment, transportation and distribution management.
  4. Marketing & Sales
     A process used to persuade the customers to buy the sold products.
  5. Service
     The action related to maintaining product value or services for the customers after the purchase.

2.5 The relation between supply chain performance and ergonomics

Not only does ergonomics focus on humans and machines, it also focuses on the interaction between culture and its surroundings. If a company is not supported by good ergonomics, supply chain performance will not run well. Ergonomics affects the accuracy and rate of a production process tremendously. The initial step to establish the right ergonomics to supply chain is by recognizing the ergonomic standard used. For instance, the product and design process standard that should be ergonomic and safe. Macroergonomics is a concerned with a broad view of ergonomics which is

called technical system. Since supply chain management us regarded asa system of organization, there will be a closer relantionship between macroergonomics and supply chain management. The concern of how to maintain comfortable work station, flow of material, safety, team work and other. In today's competitive business world, employees are expected to work faster with more qualified result to meet customer needs. The biggest issue of ergonomic is how to maintain the employees or operators in appropriate way when they are working. All the workstation available should fits to the body dimension of operators, so they can work safely, comfortably and more productively [2]. Ergonomic can also be viewed in inbound and outbound logistic. Inbound logistic is from the suppliers to point of storage or use. The engineering ergonomist may have to work with supplier, providing specifications related to the material management. Other objectives for the procurement, transportation, warehousing must also be included in the ergonomics process. If the inbound logistic are not going well, it will hinder the production process such as inventory can not meet the demand. Outbound logistic is the activity to get finished product including distribution. If the distribution isnot going well, it will result in a late delivery product and thus, also failure to meet customer satisfaction.

3. Research Methodology

This research is theoretical; hence, the output produced is a study of literature, and data collection is yet to be done. This research focuses on the role of ergonomics in supply chain performance. The first step is collecting some journals which have a similar topic to this research. Material collection is an important stage. The database selection istaken through Emerald, Science Direct and Scholar.google.com. with keywords "macroergonomics", "supply chain". Criteria for journal selection is published from 2008-2018 (the last ten years). This stage is conducted by entering the title, abstract and conclusion which is similar to this research.

4. Analysis

The study related to the role of ergonomics in supply chain performance has been conducted by Hartono (2008). This research used Porter's Value Chain model with several additional variables to create the current complex field of ergonomics. Hartono (2008) stated that it is important to highlight ergonomics determinants such as employees' physical capability, safety, task requirements, equipment requirements, and policy or procedure in work system. These should be accounted for in every part of the company's supply chain. This research has not discussed further about the involvement of ergonomics in primary activities and support activities as one of the supporters for supply chain performance. Another study is by Hasle & Jensen (2012) which found the ergonomic means and human factor to create an international collaboration which could affect the global supply chain. Hasle & Jensen (2012) identify five main challenges of global supply chain, especially the ones related to the sustainable social aspects, which are the criteria for social sustainability, the role of key performance indicators in supply chain management, the constant changes in the supply chain, the challenges in building participation, and the agency development and mechanism regulations. The research done by Dewa, et al (2016) produces a model to conduct a sensitivity analysis to the implementation of corrective actions that is generated in the corrective models to reduce errors. Sensitivity analysis model is built by using Monte Carlo simulation. This model is equipped with human aspect that tends to be unclear, which uses the fuzzy concept. This model is capable of recommending cost effective corrective actions. However, this study has yet to consider the mental and inherent behavior aspects that are attached to human individuals. The summary of this study's differences with the previous one and the research position is as follows.

Table 2. Research position table

Characteristics	Hartono (2008)	Hasle & Jensen(2012)	Dewa, et al (2016)	This research (2019)
The scope of research	-	Operations (machine,	Operations (machine,	Inbound logistic (Inventory

Characteristics	Hartono (2008)	Hasle & Jensen(2012)	Dewa, et al (2016)	This research (2019)
		assembly)	assembly)	control & transportation) and outbound logistic distribution
Method	Porter's Value Chain	General ergonomics	Monte Carlo simulation	Porter's Value Chain
Performance measurement used	Did not measure performance	Occupational accident levels and attendance	Human error in carrying out the production process	Delivery time, number of complaints

Based on the table, this research focused on inbound and outbound logistic with the Porter's value chain method. Key performance indicator of this researh is delivery time and number of complainys. This research is expected to be a literature review for further reseacrh related to the role of ergonomics in supply chain performance.

5. Conclusion

After conducting reviews of several journals related, it can be concluded that macroergonomics has a vital role in a company's internal and external process. This will provide a considerable impact towards every process, supply chain included. Research results show that there are not many journals that discuss the effects of macroergonomics in supply chain on inbound and outbound logistics. To date, most of the discussions focus mainly on management from the company, and non-value-added activity on the production floor in the form of defects found. This becomes one of the considerations that could be used to conduct further research.

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