# Energy efficiency in production process: A case of footwear trade development

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**Keywords**
*Energy, Efficiency, Footwear, Retail, Production, Warehouse.*

**Abstract**

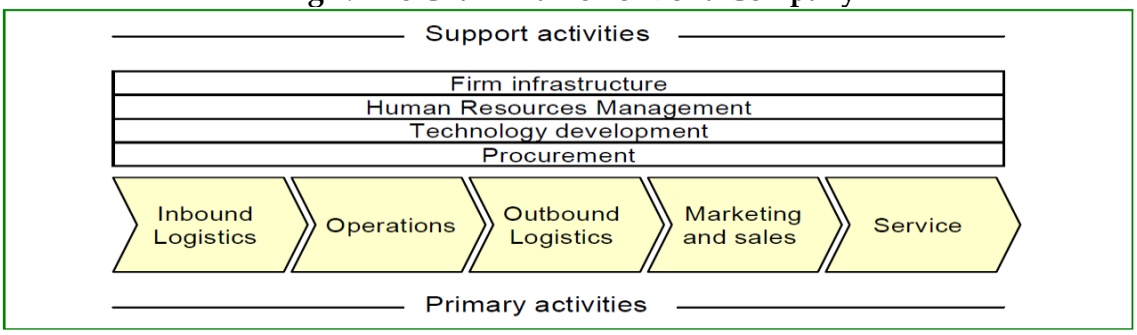
*This paper work explored footwear industrial development. Business activities within time line face on high competitiveness in global supply chain. All companies have been trying to apply specific management strategy in order to maintain sustainability of footwear global business. One of the strategies in their method is how to apply efficiency approach at any level of business activities, precisely the energy efficiency approach. The energy efficiency in footwear industries is an urgent issue to enhance business development, progressively. The actual business at domestic's level and multinational companies' level is to breakdown and to find out the future business opportunity by using appropriate energy efficiency decision. Therefore, it will be significant to deliver technology level of machine, location, and energy type. Based on this phenomenon, the company has kind of decision to relocate their companies, acquisition, and merging (vertical and horizontal). The fashion style, consumer behavior, geographical location is key factors to support powerful supply chain. The meaning of energy efficiency gives influence for profit and competitiveness level to keep sustainable the footwear industrial development.*

## 1. Introduction

The footwear sector intends to increase the energy efficiency in many ways. It is not only for technology of machine but also how the workers become less polluted by products processing. With mean of the energy efficiency, the industrial activities can reach to zero pollutant level or cleanest one. One of the parameters to measure "clean or not clean" is make identification by green factor. The phase of product processing until finishing product, they should use environmental friendly indicators which are significant on persistent of natural resources.

The present situation of footwear industries faces on many challenges. Relocation for newly open companies in many countries has been performed by many companies, especially multinational companies. These companies faced on difficulties such how to solve the problem of unstable of oil and gas prices, environmental issues, global warming and etc.

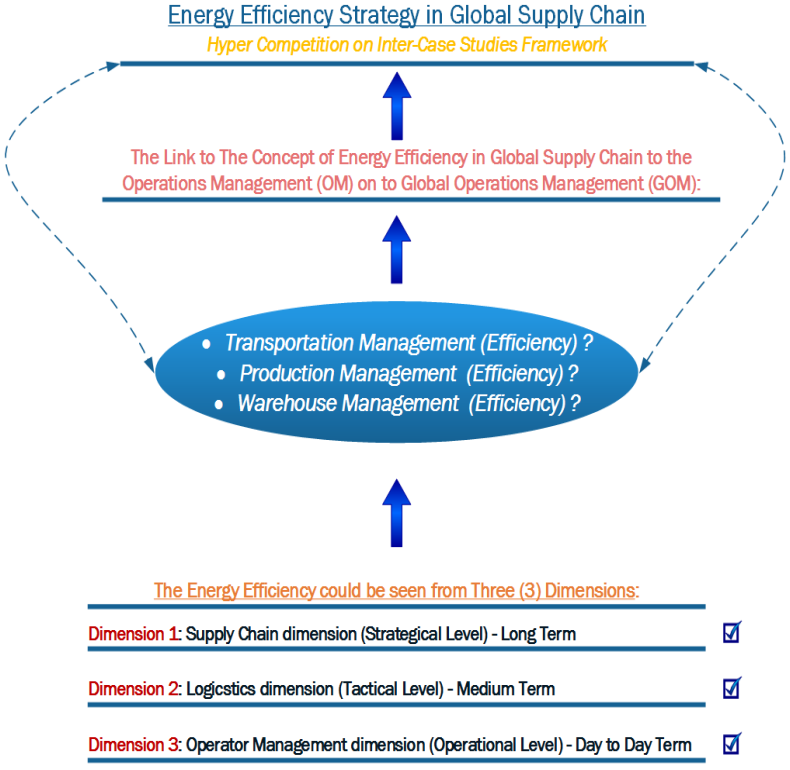
**Fig 1. The Chain Framework of a Company**




Source: M.E. Porter (1985) – Modified & simplified figure

Porter (1985), said: "the value of chain framework within company should be established, strongly. There are kind of activities which support each other. The process is coming from inbound logistics, operations, outbound logistics, marketing and sales, the finally delivery service up to the customer in hand. These activities called primary activities. To support all those activities is important one to build up firm infrastructure, human resource management, technology development, then a good procurement."

**Fig. 2. The Dimension of Global Supply Chain**




*Source: Aminata, J., Sbihi, A., & Grandval, S. (2013).PhD Thesis*

The framework of description style on this research work: How to link the concept of energy efficiency with efficiency strategy in global supply chain with regards to the operations management (OM) or global operations management (GOM). The operation management consists of efficiency production management, efficiency transportation management, and efficiency warehousing management. From the paragraph above, it can be derived the dimension of energy efficiency.

## Dimension of Energy Efficiency

The energy efficiency could be seen from 3 (three) dimensions: Supply chain dimension (*Strategic level*), especially in long term. Logistics dimension (*tactical level*) is in Medium term. Operations management dimension (*day to day term*). The research work detailed on the supply chain from top to bottom contains: (I) Efficiency production management, (II) Efficiency transportation management and (III) Efficiency warehousing management. The figure above shows that the energy efficiency strategy above can be derived to understand the global supply chain whole agenda and issues. Basically by better knowledge in dimensions I, II, and III.

**Table 1. Top Footwear Retailers in Europe turnover in Europe 2011 in Billion €**

| Rank | Retailer | Turnover | outlets |
|---|---|---|---|
| 1 | Deichmann | 4.1 | 3200 |
| 2 | Vivarte | 3.0** | 4500 |
| 3 | Eram | 1.8** | 1755 |
| 4 | Foot Locker | 1.2e | 2167 |
| 5 | Garant | 0.8 | 5360 |
| 6 | Bata | n/a | 5000 |
| 7 | ANWR Schuhe | 0.8 | 3100 |
| 8 | Macintosch | 0.7 | 873 |
| 9 | Leder & Schuh | 0.5 | 355 |
| 10 | Shoezone | 0.3 | 570 |

Note: **= 2010 and e=estimate2011 data are the latest available data for comparisons, Source: Compiled from http://www.retail-index.com, retrieved 01/02/2914

The table above shows, there top 10 footwear retailers in Europe as in 2011 in billion Euros. The first rank is Deichmann, and statistics above shows the turnover 4.1 as the highest one. Then, following by Vivarte, Eram and Footlocker. The lowest number of outlets is Leder & Schuh 355 outlets only. Shoezone reached 570 outlets but the turnover is smaller one, 0.3 billion Euros, only.

**Fig. 3. Typical Model of modern Footwear Machines**

We found that the main problem in footwear industries is:

1. Low labor cost compared to European Countries, mainly with China.
2. High level of globalized and trend fashion competition.
3. EU in the process of restructuration and relocation of the companies through the world within three decades.
4. The energy efficiency matter; level of unstable/high volatility energy prices, unstable demands, and corporate social responsibility, its means that corporate or company gives contribution to the environment, for example pollutant or emission. Therefore, the company should take care of environmental impact.

Sample of Footwear Machine: "Energy in footwear Industries: At its heart, physics is the study of the interaction between matter, everything possessing mass, and energy, the capacity to perform work. One of the more interesting forms that energy can take is that of potential energy. Essentially, an object can store energy based upon its position".

Table 2. Real fact and List of Current Footwear Technology Development

| Products List | Main Products | Enterprise Business Development |
|---|---|---|
| 1. *Shoe Machine*<br>2. Folding Machine<br>3. Splitting Machine<br>4. Insole Machine | 1. *Pressing Machine*<br>2. Riveting Machines, *Automatic Riveting Machines*<br>3. *Automatic Drilling Machine*<br>4. Trimming Machine, Automatic Trimming Machine<br>5. Shoe Polishing Machine Cementing Machines<br>6. Covering Machine<br>7. Skiving Machine<br>8. Pounding Machine | 1. Footwear enterprises in several places shows that Shoe Machine *does not share huge amounts of money* for installation<br>2. Production capacity of domestic enterprises is under capacity.<br>3. R & D<br>4. *Focusing in Energy efficiency market* |

Source: http://www.eyelet-machine.com retrieved and update by Authors per 08/02/14

The update outputs from real business are shown in the table above. The idea is divided by three categories; product list, main products, enterprise business development. Referring to the energy consumption in reality, each machine stand alone is not consuming a lot of energy. But, when the job order is up to thousands tones, it will needs energy management.

Pressing machine, automatic riveting machines and automatic drilling machines in certain condition need non strop available energy to create massive products. The limit in footwear industries is fashion style. It proves that's not all manufacture or company can provide well both in price offer and quality level.

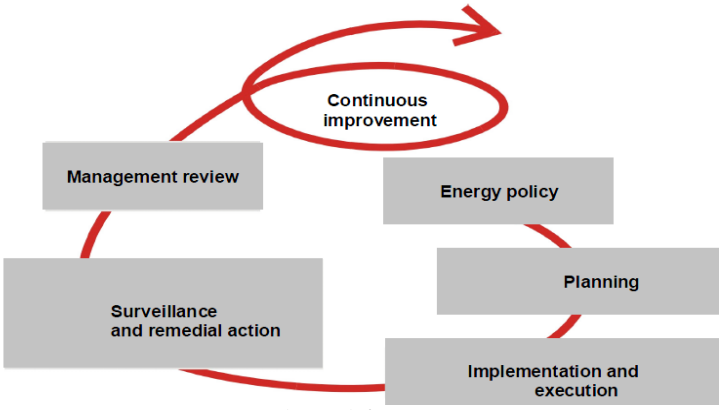
In the categories of enterprise development, initial cost for investment is noted low. But, energy efficiency market orientation and R&D development are role playing to promote footwear industries to be sustainable.

The footwear industry is tending to be slow growth in many aspects. The strategy of supply chain method should perform well. For instance, how to fulfill the demand, rapidly? In reality, comparing to the modern type of retail management somehow there are extreme fragmentation and diversification of purchasing method, the elasticity of the price that all this items relative to traditional retail. An increasing method of supply chain or distribution method especially in new location or store and single brand outlet is really interesting facing current competition.

## 2. Literature Review

Mohd Nor Azman et al., (2011); Salvi et al., (2013) Saidura et al., (2007); explained the exploration of current condition in global network and framework. All companies have to promote the better machine by modern equipment, and modern components assembling. Factory layout and internal management problems are key factors to reach energy efficiency, by direct or indirect impact.

**Fig. 4. The Continuous Development in the Energy Efficiency System**




*Source: Diagram adapted from ISO 14001*

For continuing energy policy step by step, one should use a stable execution plan. Energy policy can be implemented by planning and execution. Following this phenomenon, it is urgent to use surveillance (control) and remedial action to get a good perspective in management review.

Well organized and well information systems are really needed to back up resistant problem in company and related stake holder. The customer satisfaction is number one to get as many clients and captive market share increasing, and yearly.

## Footwear Industries

Joseph Sarkis et all (2010), green (global) supply chain management has been increasing both industrial sector and academic field. The future direction, using organizational theories provide some opportunity to make an objective and special target, clearly. By making a good understand the available field and identify all opportunities to collaborate, closely.

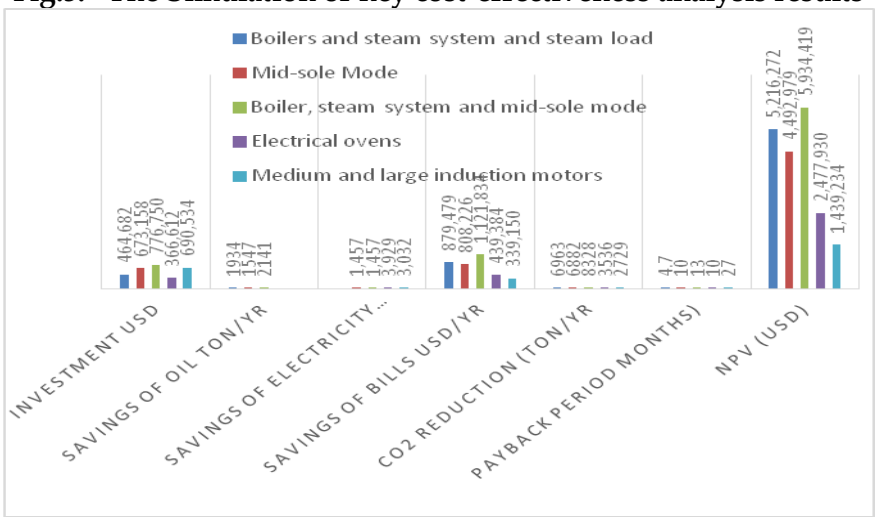
Sudheer Gupta, Omkar D., and Palsule-Desai (2011); according to mitigation, environmental quality level being considered for producing, distributing products in global markets act a central role.

Mohd Nor Azman et al. (2011); Salvi et al. (2013), and Saidura et al. (2007); "the exploration of current condition in global framework; first, the cross linking of the machines network is one of the obstacles to promote certain enterprises move up better. Second, the complexity of component and how to fulfill the fashion trends. Third, the diversity of factory layout. Fourth, the internal management problem".

Ming Yang (2009); "Energy consumption and energy intensity reduction opportunities are quite different from one enterprise to another. It is necessary to understand how much energy is used at individual enterprise, where the most energy is consumed and what the best opportunities are to invest in energy efficiency. Auditing energy efficiency was recently undertaken in one of the top 1000 largest Chinese enterprises."

Energy efficiency is as a corporate social responsibility (CSR) which company has responsibility for sustainable of environmental quality improvement; *see Fabio Musso and Mario Risso (2006).*

**Fig.5. The Simulation of key cost-effectiveness analysis results**




Ming Yang (2009): updated, Energy efficiency improving opportunities in a large Chinese shoe-making enterprise

The paper work that has been done previously showed that CO2 reduction in ton/year is the suitable one by using boiler, steam and mid sole mode. The technology system by using medium and large induction motors showed the lowest one in term of CO2 reduction. However boiler, steam system and mid sole mode was the highest one in investment $ US.

**Table 3. EU 27 Structural Data**

| Number of Firms | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|
| Turnover (Million Euros) | 26100 | 24000 | 21700 | 21100 | 18900 | 17170 |
| Production Value (Million Euros) | 30296 | 26515 | 21977 | 24000 | 19841 | 17498 |
| Added Value at factor Cost (Million Euro | 28927 | 25351 | 20000 | 15832 | 11369 | 6905 |
| Direct Employment | 7631 | 6873 | 5589 | 4656 | 3635 | 2614 |
| | 368600 | 325700 | 291000 | 250833 | 212033 | 173233 |

Source: Eurostat-updated

The table above shows EU 27 in structural data, from year to year the number of firms decreasing. However, all variables; turnover, production value, value added and direct employment showed that have decreased during duration of 6 years.

**Table 4. Production, Consumption and External Trade**

| 1000 Pairs | 2008 | 2009 | 2010 | 2011 | % of Growth 2008-2011 |
|---|---|---|---|---|---|
| Production | 560231 | 470551 | 491006 | 505304 | -10 |
| Exports | 172369 | 153292 | 168402 | 191500 | 11,1 |
| Imports | 2428402 | 2247836 | 2521994 | 2550505 | 5,0 |
| Apparent Consumptio | 2816264 | 2565095 | 2844597 | 2864309 | 1,7 |

Source: Eurostat-updated

Apparent Consumption=Production + Import – Export

The table 4 shows production, consumption, and external trade in 1000 pairs with variables; production, exports, imports and apparent consumption. Regarding to percentage of growth 2008-2011 the export value was the highest one, 11.1 %.

**Table 5. Top 10 EU 27 Supplier in Million (Euro)**

| | 2008 | 2009 | 2010 | 2011 | 2012 | Share of 2012 Imports | % Growth 2011-2012 | % Growth 2008-2012 |
|---|---|---|---|---|---|---|---|---|
| Extra-Eur | 12483 | 12059 | 14108 | 14562 | 14922 | 100,0 | 2.5 | 19.5 |
| China | 5768 | 5941 | 7177 | 7447 | 7643 | 51.2 | 2.6 | 32.5 |
| Vietnam | 2163 | 1696 | 1872 | 1704 | 1963 | 13.2 | 15.2 | -9.3 |
| Indonesia | 698 | 780 | 928 | 129 | 1221 | 8.2 | 18.7 | 75 |
| India | 962 | 936 | 1139 | 1233 | 1089 | 7.3 | -11.7 | 13.2 |
| Tunisia | 453 | 411 | 473 | 456 | 409 | 2.7 | -10.3 | -9.7 |
| Cambodia | 111 | 138 | 206 | 269 | 298 | 2 | 10.6 | 167.1 |
| Morocco | 219 | 247 | 280 | 294 | 272 | 1.8 | -7.5 | 24.2 |
| Switzerland | 190 | 177 | 172 | 208 | 260 | 1.7 | 25.3 | 36.8 |
| Brazil | 457 | 368 | 394 | 304 | 235 | 1.6 | -22.9 | -48.6 |
| Bosnia and Herz. | 155 | 147 | 172 | 187 | 189 | 1.3 | 1 | 22.2 |

Source: Eurostat-updated

The amazing recorded in Cambodia's in percentage growth, and then followed by Indonesia, Switzerland, and then China. However, China holds the strong position during 2012.

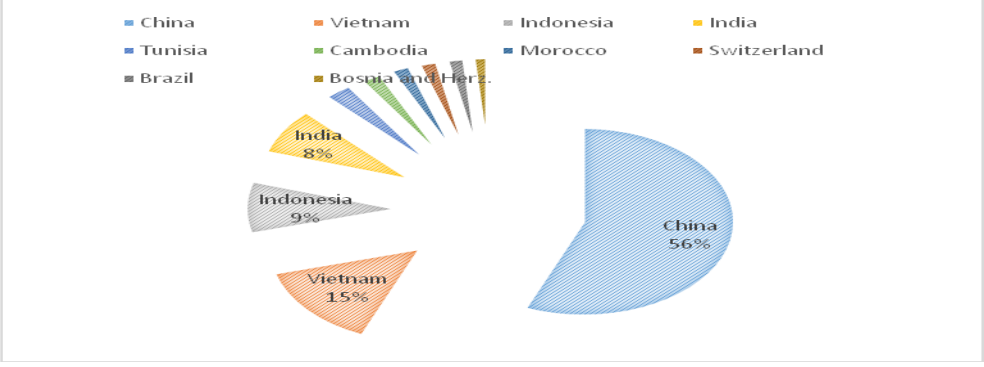
**Table 6.Top EU Supplier as Share of 2012 Imports in Million**

| Countries | Share of 2012 Imports |
|---|---|
| China | 51.2 |
| Vietnam | 13.2 |
| Indonesia | 8.2 |
| India | 7.3 |
| Tunisia | 2.7 |
| Cambodia | 2 |
| Morocco | 1.8 |
| Switzerland | 1.7 |
| Brazil | 1.6 |
| Bosnia and Herz. | 1.3 |

Source: Eurostat-Update by Authors

The China, Vietnam, Indonesia, and India are the most significance countries which act exporter or EU supplier as share 2012 import.

**Fig.6. Top EU Supplier as Share of 2012 Imports in Million**




Source: Eurostat - Update by Authors

China, Vietnam, Indonesia and India are the main player was declared clearly in figure above.

**Table 7. Top EU Supplier as % Growth 2008-2012 in Million**

| | % Growth 2008-2012 |
|---|---|
| China | 32.5 |
| Vietnam | -9.3 |
| Indonesia | 75 |
| India | 13.2 |
| Tunisia | -9.7 |
| Cambodia | 167.1 |
| Morocco | 24.2 |
| Switzerland | 36.8 |
| Brazil | -48.6 |
| Bosnia and Herz. | 22.2 |

Source: Eurostat-Update by Authors

Cambodia, Indonesia, Switzerland, china, Morocco are quite important supplier as EU supplier.

**Table 8. Top 10 EU 27 Market in Million (Euro)**

| | 2008 | 2009 | 2010 | 2011 | 2012 | Share od 2012 Imports | % Growth 2011-2012 | % Growth 2008-2012 |
|---|---|---|---|---|---|---|---|---|
| Extra-Eur | 5692 | 4756 | 5387 | 6478 | 7305 | 100 | 12.8 | 28.3 |
| USA | 1017 | 772 | 942 | 1077 | 1187 | 16.3 | 10.2 | 16.7 |
| Russia | 1012 | 671 | 753 | 927 | 1126 | 15.4 | 21.4 | 11.2 |
| Switzerland | 764 | 722 | 807 | 931 | 1063 | 14.6 | 14.2 | 39.2 |
| Japan | 296 | 275 | 295 | 354 | 414 | 5.7 | 16.8 | 39.5 |
| Hongkong | 188 | 171 | 235 | 335 | 398 | 5.5 | 19.1 | 111.8 |
| Turkey | 229 | 261 | 256 | 338 | 361 | 4.9 | 6.9 | 57.6 |
| China | 75 | 79 | 111 | 191 | 254 | 3.5 | 33.1 | 240.6 |
| Norway | 212 | 180 | 202 | 230 | 248 | 3.4 | 7.7 | 16.9 |
| Ukraine | 195 | 124 | 135 | 168 | 175 | 2.4 | 4.1 | -10.2 |
| Canada | 152 | 119 | 146 | 178 | 174 | 2.4 | -2.1 | 14.9 |

Source: Eurostat-updated

Share of 2012 import; USA, Russia, and Switzerland taken important position. In percentage of growth during 2011-2012 China, Russia, Japan and Hongkong. In percentage of growth China, Hong Kong, Turkey, Japan and Switzerland have significance percentage growth.

## 3. Global Supply Chain in Footwear Industries

On product quality alone, domestic and imported shoes have been little difference between shoes, but the lack of capacity of independent innovation, to imitate the situation is still prevalent. But in terms of price, domestic equipment is still much lower than imports, not to mention Italy German products, the Korean product, and the price at least higher than the domestic unit more than doubled. Moreover; one, digital: Digital is the future development trend of the manufacturing sector, it convenient, fast,

Second, the intelligent: more and more shoe shoes want to have the intelligent features of equipment, Third, the Automation: In order to save on labor costs, more and more shoe will use automated equipment and many are also applying machine shoes machine factory hand,

"Environmental protection, energy saving, efficient and safe" is basically a shoe machine industry, the eternal topic, but also the demand for shoe, shoe-making in many areas, we can still much room for improvement.

- **Basic Formula in Efficiency**

**Equation 1. The general efficiency formula**

$$Efficiency = \frac{Output}{Input}$$

Relative efficiency measurement The measurement of relative efficiency where there are multiple possibly incommensurate inputs and outputs was addressed by Farrell and developed by Farrell and Fieldhouse(2), focusing on the construction of a hypothetical efficient unit, as a weighted average of efficient units, to act as a comparator for an inefficient unit. A common measure for relative efficiency is

**Equation 2. Efficiency Calculation:**

$$Efficiency = \frac{Weighted\ sum\ of\ Output}{Weighted\ sum\ of\ Input}$$

**Table 9. Energy savings and emission reductions**

| | Boiler 1 | Boiler 2 | Boiler 3 | % Total Used |
|---|---|---|---|---|
| Boiler production capacity (ton of steam/unit/hr) | 4 | 10 | 4 | 66.67 |
| Number of boilers in operation | 4 | 2 | 3 | 44.44 |
| Hourly fuel oil consumption rate (ton/unit/hr) | 0.25 | 0.5 | 0.25 | 80.65 |
| Number of hours of operation per day (hrs/day) | 24 | 24 | 24 | 100.00 |
| Number of days of operation in a year (days/yr) | 302 | 302 | 302 | 100.00 |
| Load factor (%) | 20 | 42.7 | 15 | 85.47 |
| Annual consumption of heavy oil (ton/yr) | 1449.6 | 3094.9 | 815.4 | 27.04 |
| Hourly production capacity (ton of steam/hr) | 3.2 | 8.5 | 1.8 | 22.86 |
| Daily production of steam (ton of steam/day) | 76.8 | 205 | 43.2 | 23.63 |
| Annual production of steams (ton/yr) | 23194 | 61898 | 13046 | 23.63 |
| Daily lost seam & water at the open outlet (ton/day) | 76.8 | 41 | 43.2 | 47.70 |
| Annual lost steam & hot water (ton/yr) | 23193.6 | 12379.6 | 13046.4 | 47.70 |
| Temperature of steam at the outlet of the boiler (1C) | 194 | 194 | 194 | 100.00 |
| Temperature of steam & hot water at the condenser (1C) | 98 | 98 | 98 | 100.00 |
| Total share of energy savings by closing the steam system (%) | 41.5 | 26 | 41.5 | 130.91 |
| Savings of heavy oil per year (ton/yr) | 601.1 | 803.6 | 338.1 | 34.49 |
| Savings of diesel per year (ton/yr) | 0 | 191.6 | 0 | 0.00 |
| Total savings of oil and diesel (ton/yr) | 601.1 | 995.2 | 338.1 | 31.08 |
| CO2 emission reduction (ton/yr) | 2163.8 | 3582.6 | 1217.1 | 31.07 |

Source: adapted from Ming Yang (2009)

**Table 10. Cost effectiveness analysis**

| | Boiler 1 | Boiler 2 | Boiler 3 | % Total Used |
|---|---|---|---|---|
| Average price of heavy oil in 2006 constant price (USD/ton) | 417 | 417 | 417 | 100.00 |
| Cost of high pressure steam pump (USD/unit) | 5263.2 | 5263.2 | 5263.2 | 100.00 |
| Number of units needed (units) | 4 | 8 | 4 | 25.00 |
| Cost of total steam pumps (USD) | 21052.6 | 42105.3 | 21052.6 | 25.00 |
| Cost of higher pressure steam transmission pipe (USD/m) | 20 | 20 | 20 | 100.00 |
| Length of the steam system and boilers (m) | 100 | 600 | 100 | 12.50 |
| Capital cost for high pressure pipes (USD) | 2000 | 12000 | 2000 | 12.50 |
| Total equipment investment costs (USD) | 23052.6 | 311342.1 | 23052.6 | 6.45 |
| Equipment installation costs | 6915.8 | 93402.6 | 6915.8 | 6.45 |
| Grand total of investment and installation fees (USD) | 29968 | 404744.7 | 29968.4 | 6.45 |
| Saved value of salt (USD/yr) | 762 | 2033 | 429 | 23.64 |
| Saved value of water (USD/yr) | 3525 | 1882 | 1983 | 47.70 |
| Saved value of fuels (USD/yr) | 250639 | 477241 | 140985 | 28.85 |
| Total saving values (USD/yr) | 254927 | 481156 | 143396 | 28.99 |
| Payback period (Months) | 1.4 | 10.1 | 2.5 | 29.79 |
| Life time of the new technology (yrs) | 20 | 20 | 20 | 100.00 |

Source: adapted from Ming Yang (2009)

## Conclusion

There are a small numbers of researchers who are working in energy matter particularly in footwear industry. However, energy availability will be key factor when discussing industrial location (the location of companies) that energy is under construction or still in difficulty for price and resource feasibilities and availability. For example, most of companies are always looking for industrial location to get the best industrial location based on global market demand.

Especially for the European market, most suppliers are coming from non EU 27. The market is dealing with a very recent trend style. It gives impact to keep the enterprise giving quickly feedback to the market. Moreover, the labor cost gives uncertain condition for footwear sustainability, mainly the enterprise based in the region with unstable energy prices.

The future solution for energy matter is to construct relative less expensive energy price for promoting footwear industries. Internal organization within footwear industries should maintain, carefully. To avoid the worst of labor wage problem in certain position or level at company.

Energy efficiency that shows an amount of saving, total emission reduction and cost effectiveness will take important role in global supply chain that stimulates trade structure and international trade flows.

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