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Driving competitive advantage through energy efficiency in Mexican maquiladoras

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ABSTRACT

Energy efficient policies and the appropriate management of energy supplies have become essential in developing and keeping competitiveness across all industries and forms of industrial production. The scientific contribution of this article is the presentation of competitive advantages that can be developed from efficient management of energy resources in two Mexican maquiladoras and that might be replicated in more organizational structures. In order to ascertain how energy efficient Mexican maquiladoras are, several *in situ* visits were carried out; hard data were collected following a proposed energy efficiency program developed by the UNEP, as well as other auditing instruments to acquire first-hand information about the maquiladoras. The results show that the larger maquila tends to have stronger policies in place. The audits were carried out in maquiladoras that focus on the manufacture of electronic and electric goods and whose sole source of energy is electricity. Thus, the practical contribution is that revealing of unexplored opportunities for maquiladora operators and managers alike to build and maintain an edge over competitors through optimized energy use.

1. Introduction

For over half a century, Mexico's economy has largely relied on maquiladoras, usually shortened to maquilas, as a prolific source of job creation and revenue from exports. Maquiladoras were originally set up as industrial plants where simple tasks were performed, such as stitching pieces of fabric together or assembling manufacturing parts before they were exported to the US (The Economist 2013). A lot has changed since and maquiladoras have greatly evolved to specialize in key areas of industrial production, including the manufacture of parts for the aerospace, medical, and automotive industries, among other niches (Sargent and Matthews, 2003).

As competition increases due to globalization, the maquila industry in Mexico is faced with new challenges to maintain its competitiveness, its struggle is not only against the powerful production centers of Southeast Asia and China (Ahmad et al., 2014), but also against domestic players in the race to acquire new markets and retain existing ones (Sargent and Matthews, 2008). It then becomes essential for companies to develop strategic competitive advantages that assure their survival and provide them with tools that help them stand out against other competitors (Hadjimarcou et al., 2013).

The information presented here focuses on examining and exploring the possibilities of two Mexican maquiladoras to draw competitive advantages through the efficient management of energy. The companies are located in Hermosillo, Sonora, and in the US-bordering city of Mexicali, Baja California. For the purpose of this paper, a sustainable competitive advantage is understood as that advantage that a company can sustain over a significant period of time in which it cannot be copied or replicated by the competition, while still generating above-average revenue; furthermore, sustainable competitive advantages typically derive from core competency and are linked to the strategic sustainable growth of the company (Lamb et al., 2008; Kumar 2016). On that note, the

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results of this study will help maquiladora operators and decision-makers align their corporate strategy with sustainable energy measures and have an edge over the competitors by developing a sustainable competitive advantage. It may also serve as an indicator of the appropriateness of investing in energy-efficient technology and implementing energy management systems (EnMS).

Even though the participant companies operate in the same line of business, their size and management styles vary significantly. This can be primarily attributed to the volume of their production, which in turn is reflected on contrasting levels of energy consumption and the energy-saving policies put in place by each company.

A first insight into the energy consumption patterns of the companies was conducted through the analysis of their historical consumption rates, followed by *in situ* visits, walkthroughs and a thermographic diagnosis carried out on energy-intensive processes and machinery. For practical purposes, the study focused on three main areas of the maquiladoras: Heating, ventilation and air conditioning (HVAC) system, lighting, and machinery and equipment.

As previously mentioned, the conditions and settings of the two studied companies are significantly different, and it was only expected that the results for each company would show these discrepancies; therefore, the findings herein must not be seen as indicative of the general situation for the maquiladora industry. However, the implications of the results may be useful for taking the right steps to build sound energy policies, as well as to validate the need of implementing adequate measures for energy conservation, and highlighting the benefits of having an efficient EnMS in place.

The remainder sections of this paper are structured as follows: the next part offers a general glimpse of the situation of Mexican maquiladoras; it exposes major trends about energy management and how competitive advantages may be drawn from it. Section 3 illustrates the methodology followed in the study as well as a full description of the instruments used. It focuses mainly on a model developed by the UNEP for the efficient management of energy and the execution of energy audits in the manufacturing sector. In Section 4, the results of the study are presented. Section 5 discusses the further implications that the findings may have for the industry and, lastly, in the final section closing comments and conclusions are given.

2. Literature review

Part of the success of Mexican maquiladoras can be attributed to their geographic closeness to US markets, a wide and solid network of logistics, and to the ability of Mexican producers to respond swiftly to even minor changes in market demands; however, these and other aspects that have so far allowed Mexico to develop as an important assembly and manufacturing center are no longer a guarantee of its future success (Utar and Ruiz, 2013). The industrialization of Asia and the opening of its economies to global markets, added to the availability of cheap labor in that continent, have become a serious threat to the future success of Mexican industries; yet at the same time, it represents an inflection point to re think the strategies, dynamics and pathways that maquiladoras in Mexico can follow to remain competitive (Sargent and Matthews, 2008).

In the race to industrial competitiveness, the appropriate management of energy has emerged as an important source from which sustainable competitive advantages can be developed (Grant, 2011). The efficient use of energy resources not only contributes to reducing greenhouse gases and costs, but also aids companies in shaping an image of prestige and present themselves as socially responsible businesses in the eye of competitors, clients, and the community at large (Buitelaar and Pérez, 2000; Cartes, 2011). In spite of this, it is still international companies that are more likely to adapt and implement energy-efficiency measures in comparison to domestic players, even if they do so only to mimic similar policies implemented by the corporation in the parent country (Flores et al., 2004).

As has been widely documented, in the manufacturing and maquiladora industries most of the energy losses occur during the transmission of energy from one task to another during production processes, partially as heat losses in poorly insulated facilities and as the result of obsolete technology (Glaser, 1992; DOE, 2015). These aspects have been long identified and a number of procedures and operating standards have been developed to aid maquiladora operators correct them so as to reduce energy waste and consequently decrease the generation of greenhouse gasses (Cancino-Solórzano et al., 2010; Abeelen et al., 2013). Yet, the fact that most of the existing standards on energy efficiency focus on individual parts and components of processes, but not on the system as a whole, remains one of the biggest challenges to achieving industrial competitiveness on energy matters (Bryan and Phelan, 2014; DOE, 2015).

While it is true that implementing energy-efficient technological devices and components is necessary, their implementation *per se* is not a guarantee of good energy management (Glaser, 1992). In fact, the wrong or inappropriate implementation of technology and procedures is a rather common occurrence and one of the main causes for many energy efficiency projects to fail (McKane et al., 2008). It is precisely the poor results achieved after the inappropriate implementation of energy policies that have raised certain reluctance among some decision-makers and maquiladora owners when it comes to funding upgrades in their procedures and acquiring technology for the optimization of their EnMS (DOE, 2011).

Faced against this scenario of intense industrial competition, it is imperative that maquiladoras focus their efforts and resources on developing optimization systems to effectively and efficiently manage their energy use (Sargent and Matthews, 2009). Mexico is an oil-rich country and one of the world's largest oil producers; this apparent reliability and ease of access to fossil fuels must not be seen by maquiladoras as a long-term guarantee of the availability of the cheap energy that will drive their operations (IEA and OECD, 2016). Even when the proponents of the substitution principle claim that natural resources can be exploited to depletion and later substituted by newer technologies and procedures, this approach necessarily calls for a wide timeframe that allows for training, the procurement of the substitution goods and the transition towards newer methods and forms of production; a complex task given the volatility of the markets in which maquiladoras operate (Boos and Holm-Müller, 2012). This is just one of the reasons why natural resources should not be used as competitive advantages; doing so may lead the industry to engage in a race to the bottom and, ultimately, compromise their competitiveness and jeopardize their survival (Sargent and Matthews, 2009; Olney, 2013).

Mexico is in the middle of a historic transition in matters of production, use and disposition of energy resources. The recent reforms on energy legislation will have a deep impact on all sectors of production and will offer maquiladoras a greater choice of energy mix as well as varied ways for their procurement (Alemán-Nava et al., 2014; Olanrewaju and Jimoh, 2014). This opportunity for differentiation and diversification implicitly exposes companies to stronger competition to gain new markets and to the necessity of redesigning and determining new and more efficient processes of production (Wagner et al., 2014).

Despite some claims that for the specific case of Mexican maquiladoras, energy management is not and will not be a driver to gain competitive advantages, its mismanagement may well bring companies to their demise (Bryan and Phelan, 2014). However, and in spite of the recent fall in oil prices around the globe, – which would seem to back the notion that savings in energy consumption are not relevant – these claims have found few concurring voices as more and more managers and executives across the board insist that energy efficiency plays a pivotal role in creating and maintaining competitiveness (Grant, 2011; Cui et al., 2014).

A report from McKinsey & Company, Inc. (2009) shows that more than 40% of all the world's revenues are strategically dependent on energy. Furthermore, a recent study by Deloitte Center for Energy Solutions (Motyka and Clinton, 2015) notes that up to 77% of CEOs and top managers in a wide range of business view energy efficiency as an essential means to achieving competitive advantage and 48% of them stated that their companies currently have an energy management system in effect.

Even though cost-cutting remains the number one reason for implementing energy efficiency programs, other factors such as public image and clients' demands keep increasing in significance when it comes to weighing corporate strategy (Di Somma et al., 2015). This is reinforced by the fact that even in the face of dropping oil prices, companies with existing energy efficiency measures have kept or even strengthened them; while companies that had previously not considered energy management, are now adapting energy-saving policies (Motyka and Clinton, 2015).

Decision-making regarding energy management in maquiladoras must not be driven solely by the desire to increase savings. In fact, investing in the implementation of energy-saving equipment and energy efficient measures might initially constitute a net loss for the maquila; this is why the cost-benefit analysis should not focus only on energy use but explore and consider other areas of the maquila that might be equally impacted after the execution of an energy audit (Chai and Yeo, 2012; Van Den Wymelenberg et al., 2013). Savings on energy must be viewed as an integral part of the benefits of carrying out energy audits and not the absolute objective of these (Hadjimarcou et al., 2013; Sudhakara Reddy, 2013). In other words, energy auditing must be an elemental management tool in maquiladoras beyond the inherent economic benefits that it might bring, this is because in general terms the efficient management of energy has impacts also on the work environment, on environmental performance, and on the quality of the work and the product itself; and because its implementation may reveal opportunities for improvement in other areas not directly related to energy use (Water et al., 2008; Tanaka, 2011).

It is pertinent to set a clear distinction between energy conservation and energy use optimization, the two are not mutually exclusive but the existence of one does not necessarily imply the presence of the other. Energy conservation seeks to reduce energy consumption regardless of the effects it might have on product quality or the efficacy of the production processes. Energy optimization, on the other hand, aims at maintaining or increasing product quality through the maximum and optimal use of energy (Sandberg and Söderström, 2003; Van Den Wymelenberg et al., 2013). To this regard, an energy audit must generate recommendations directed at strengthening and promoting energy efficiency over energy conservation. Even when the latter may have a faster effect on return on investment and a direct reduction on production costs, in the long term, and because of its holistic nature, energy optimization is a more solid alternative for the overall performance and sustainable growth of the maquila (Ruiz et al., 2008; Sardianou, 2008).

The decision on which of the two approaches to adopt will depend on the interests and specific market of each company (Tanaka, 2011). Nonetheless, it is worth highlighting that the global electronics industry, as is the case of the studied maquiladoras, is highly competitive, innovative and fast-changing (ILO, 2014), and which market, as electronic components, ranges from medium to high specialization, and therefore is not very price-sensitive or prone to be affected by market fluctuations. A strategy of low-cost production under this scenario is not entirely justifiable, quite the opposite, evidence suggests that maquiladoras with more encompassing and sustainable energy policies show greater growth and industrial performance (Sandberg and Söderström, 2003; Song et al., 2014; Zhao et al., 2014).

3. Materials and methods

The methodological structure of the study is both descriptive and analytical as it attempts to analyze energy use patterns in order to identify opportunities for improvement. To do so, an energy efficiency program was conducted based in a Cleaner Production-Energy Efficiency Manual developed by the United Nations Environment Programme (UNEP, 2004a). This program was adapted for two participant maquiladoras that focus on the manufacture of electronic and electric goods, where Maquiladora 1 refers to the one located in Hermosillo, Sonora, and Maquiladora 2 to the one in Mexicali, Baja California, and whose sole source of energy is electricity.

This model was selected since projects identifying and carrying out energy efficiency improvements have been carried out in several parts of the world as an integral part of cleaner production assessments where energy efficiency has had the potential to reduce the negative impacts of conventional energy options (UNEP, 2004b; UNIDO, 2015). The model works on a sequential and cyclical basis and is comprised of five phases, namely: planning and organization; pre-assessment; assessment; feasibility analysis; and, implementation and continuation. The scope of this paper focuses on the first three phases and allows leeway for other researchers to carry on further analysis.

Particularly, an Energy Management Matrix, from UNEP's manual, was used as a surveying tool that was applied among managers and key personnel to understand the organizational culture and behavior regarding energy management in each maquiladora. The Matrix scale ranges from 0 to 4, where 4 represents the existence of strong energy policies and initiatives embedded in the organizational culture, and 0 denotes the non-existence or unawareness of them. The matrix considers the following six broad categories: *Awareness:* evaluates the extent to which employees are knowledgeable of policies and efforts taken by the company in regards to energy management. *Investment*: denotes the likelihood of the maquiladora to favor energy-related projects and programs over investment in other areas, as well as the rank energy management has when setting priorities in annual budgets. *Motivation*: focuses on the flow of information regarding energy policy in the company and whether both formal and informal channels exist for its divulgation. *Organization*: indicates the level to which energy management is embedded in the corporate strategy of the maquila. *Information Systems:* deals with how systems are set to collect, monitor, or evaluate energy performance. *Policy and Systems:* refers to the existence and progress of an official EnMS within the formal structure of the organization.

Information about energy consumption patterns, energy use awareness and general energy management activities in both maquiladoras was gathered. Officially-issued electricity bills were used to analyze and set energy consumption rates for years 2013 and 2014. Additionally, each maquiladora produced a full list and break-down of their production processes so as to aid the research team in identifying energy-intensive activities. A FLIR-E5 thermographic camera was utilized to detect heat losses on machinery, load centers and in the insulation of the building. A Klein electronic voltage tester model ET200 was used to determine the voltage of highly energy intensive machinery during normal working conditions. For the qualitative part of the research, a series of interviews with open-ended questions were held with the board of managers and supervisors at the two studied facilities.

For identifying energy inefficiency causes, a cause-and-effect diagram was used. It is also known as Ishikawa diagram, after its author Kaoru Ishikawa, or Fishbone diagram, due to its shape, where the "head" of the fish represents the problem, usually located at the right of the diagram, and the "fish bones" represent the causes, usually located at the left, by grouping similar causes into categories (Galley, 2007). Thus, by reading it from left to right, this diagram helps to understand the many causes that may contribute to an effect or problem, it graphically displays the relationship of the causes to the effect and to each other, and it helps to identify areas for improvement (Institute for Healthcare Improvement, 2004).

Finally, the period of the study lasted from November 2014 to April 2016. After the study, recommendations were issued with the purpose of increasing energy efficiency and improving the general performance of maquiladoras.

4. Results

4.1. Planning and organization

During the initial visits, it was found that neither of the maquiladoras had energy management integrated in their vision or mission statements, or as part of their strategic growth plan; however, in both cases, energy conservation existed as a separate policy. Table 1 shows the general background information of the maquiladoras at the time when the study was conducted.

During the walkthroughs, it was noticed that in the larger company, maquiladora 2, efforts were made to reach energy efficiency objectives, albeit these were not apparently communicated to all departments. In contrast, the smaller company, maquiladora 1, showed no formal structure regarding energy management with no official appointee and no clear energy conservation goals. The different amounts of electricity used in each maquiladora might respond mostly to their respective volume of production rather than a poor energy management. In this sense, with the intention of having a general overview on how energy efficiency is approached in the participant companies, one of the first steps was to conduct the survey previously described based on UNEP's Energy Management Matrix among managers.

In maquiladora 1, the general manager, as well as six department managers and one line supervisor answered the survey, while in maquiladora 2, four members of upper management and two key supervisors participated in the same activity. The results, as shown in Fig. 1, evidence that organizational culture in respect to energy use varies greatly between both companies. This is also apparent in most other aspects of energy management and might be linked to

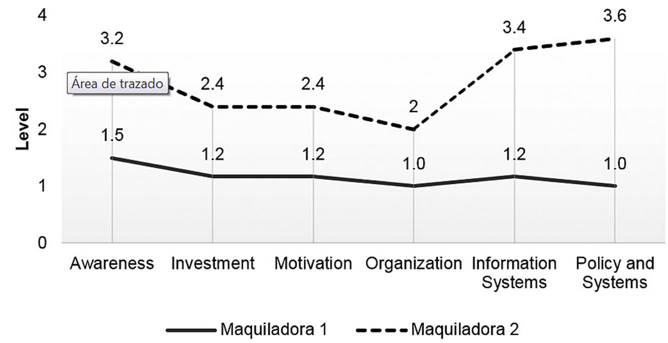

Fig. 1. Organizational Culture in Energy Management.

the size, structure and availability of the maquiladora to effectively develop and implement policies.

4.2. Pre-assessment

In addition to the survey, a pre-assessment was conducted to have a general overview of the energy consumption patterns in the maquiladoras. To accomplish this aim, the study addressed three focus areas: HVAC, lighting, and equipment and machinery. Table 2 shows a summary of the energy consumption by area.

The potential savings were estimated based on the time that all three areas are powered by electricity versus the actual time effectively demanded by production; e.g. the time that a molding machine remains powered on or on stand-by mode, versus the effective time in which the machine is needed to complete a task in production. A summary of potential savings is shown in Table 3.

4.2.1. Thermographic analysis

In energy audits, thermal imaging is used for predictive maintenance as it reveals "hot spots" where invisible heat sources can be detected by identifying differences in temperature to fractions of a degree (ATN Corporation, 2017; Flir, 2014). Heating and cooling systems can be analyzed locating problems on, for instance, duct disconnects, mechanical wear, and refrigerant issues as well as energy waste and moisture intrusion (Flir, 2017).

Using a thermographic camera to spot heat radiation in strategic points in the maquiladoras revealed significant heat losses, especially in the areas of production and molding. It also helped to back up observations that were evident to the naked-eye, such as rundown load centers or the lack of proper insulation in areas where machinery works at high temperatures.

The disparity in the operating standards and production of the maquiladoras is also reflected on the set-up and construction of

Table 1
Background information of maquiladoras.

	Maquiladora 1	Maquiladora 2
Location	Hermosillo	Mexicali
Number of employees	139	1947
Area in square meters	2358	16,770 m^2
Number of work shifts	1	3
EnMS in place	No	Yes
Energy management appointee	N/A	N/A
Total annual electricity consumption (kWh) for 2014	765,621	8,884,503

Table 2
Electricity consumption by area (kWh).

	HVAC	Lighting	Machinery and equipment
Maquiladora 1	351	204	4614
Maquiladora 2	11,071	763	16,961

Table 3
Summary of Potential Savings by area (kWh).

	HVAC	Lighting	Machinery and equipment	Total (kWh)
Maquiladora 1	64	118	543	726
Maquiladora 2	1603	23	2329	3955

their facilities. Maquiladora 1 runs all its operations in a single production unit where some machinery may operate with temperatures up to 350 °C, sharing space with equipment and personnel who require air-conditioned environments. This drawback alone compromises the efficiency of all HVAC systems. In contrast, Maquiladora 2 is located in modern and well-maintained facilities where areas of production are clearly defined and separate production units exist for different tasks. Proper insulation is found throughout.

To illustrate the situation previously described thermographic images have been included where brighter areas represent a higher heat loss, *i.e.*, the higher the luminosity, the greater the loss of heat. In maquiladora 1, it was found that sometimes machinery and equipment were powered on even during downtime in production. Added to this, some of the machinery worked at very high temperatures but had poor insulation and was kept in cooled areas. For instance, Fig. 2 indicates that at the center of the molding machine, where a lighter color can be perceived, there is a temperature over 260 °C while darker areas indicate lesser temperatures. Additionally, Fig. 3 shows an oven where the door edge reach a temperature around 44 °C which clearly reflects a heat loss into the working place. The facilities of Maquiladora 2 generally are well-kept and have regular maintenance. The maquiladora also has energy policies in place with strict controls for recording temperature and drying times. However, the same phenomenon as the previous figure is illustrated in Fig. 4 where temperatures from ovens' door edges reach around 81 °C as indicative of heat loss.

4.3. Assessment

After a full inventory of the equipment, tools and systems used in production or as support for production was obtained, the auditing team took on the task of estimating the daily electric consumption of the focus areas. The contribution of CO_2 to the environment was calculated based on the latest Electricity Emission Factor for Mexico, which was set to 0.454 T/MWh of CO_2 at the time that the study was conducted (SEMARNAT, 2015). The results are presented in Tables 4 and 5 for maquiladoras 1 and 2, respectively.

The extent to which the savings are significant for the companies was estimated based on their potential savings in respect to their total annual expenditure on electricity within the savings

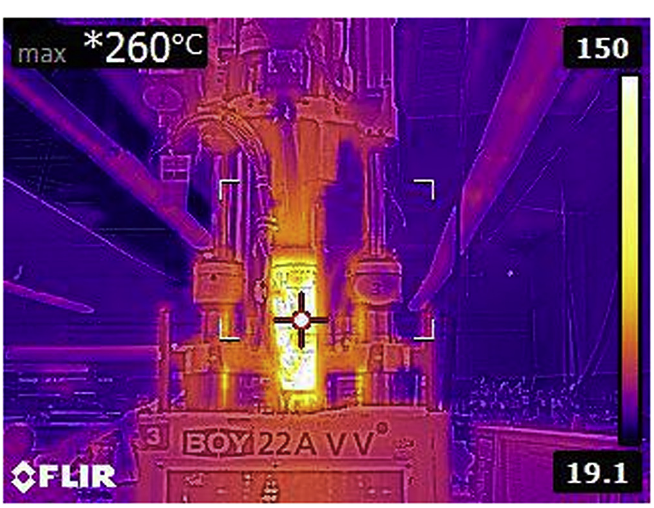

Fig. 2. Severe heat loss in a molding machine inMaquiladora 1.

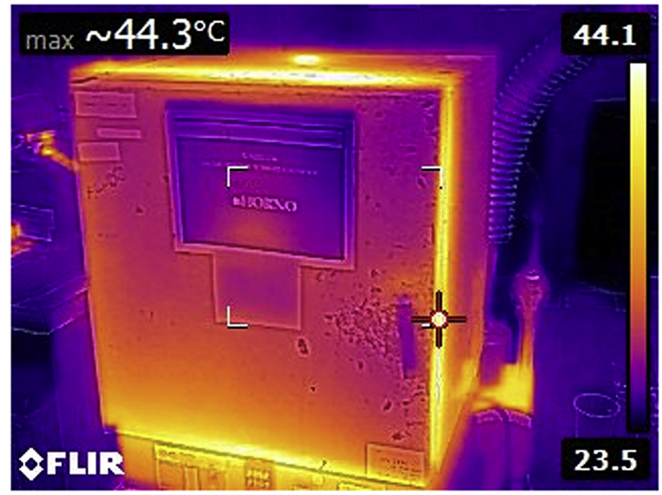

Fig. 3. Ovens turned on during production downtime and with poor sealing in Maquiladora 1.

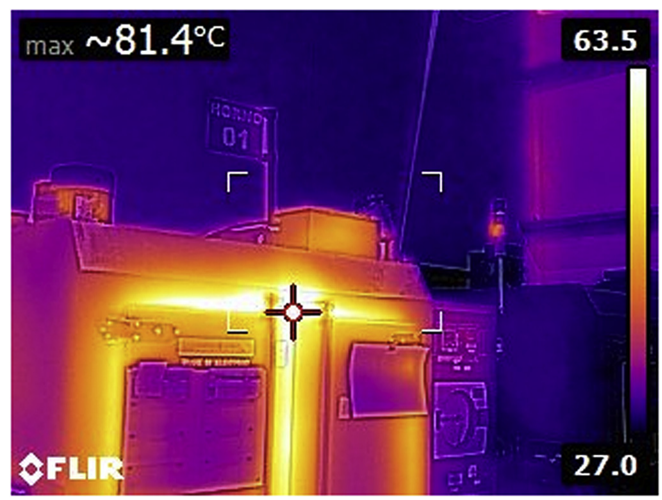

Fig. 4. Heat loss in drying ovens because of inappropriate door insulation in Maquiladora 2.

Table 4
Electricity use and CO_2 load by area in Maquiladora 1 (kWh).

	Daily consumption (kWh)	Daily contribution CO_2 (t)	Potential savings (High/moderate/low)
HVAC	11,071	5036	Low
Lighting	763	347	Low
Machinery and Equipment	16,961	7716	Moderate
Total	28,795	13,099	

Table 5
Electricity use and CO_2 load by area in Maquiladora 2 (kWh).

	Daily consumption (kWh)	Daily contribution CO_2 (t)	Potential savings (high/moderate/low)
HVAC	351	159.48	Low
Lighting	204	92.99	Low
Machinery and Equipment	4164	2098.83	Moderate
Total	4719	2351	

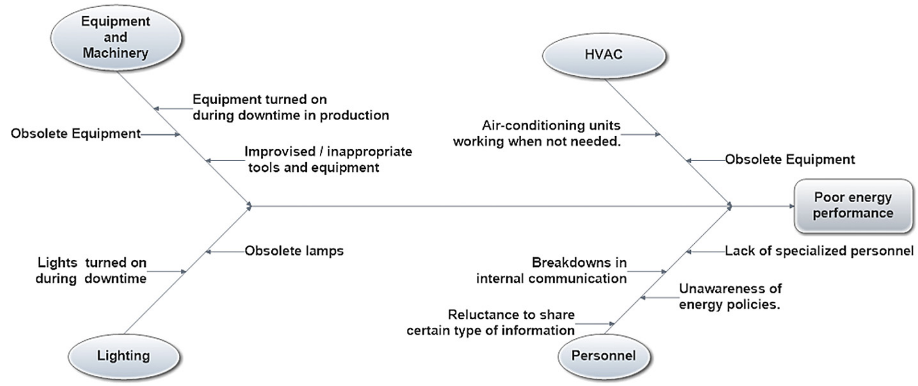

Fig. 5. General causes that hinder energy performance in maquiladoras.

frame found in the literature review. Potential for saving levels were set as in consensus of the auditing team along with key personnel within the company, where “high” indicates that doing changes are relatively easy and/or may have a fast impact in general savings, “moderate” indicates that doing changes is more complex and/or the impact in general savings is seen at middle term, and “low” indicates that doing changes is relatively difficult and/or may have a slow impact in general savings.

- General causes that hinder energy performance in maquiladoras

In both maquiladoras, an analysis was carried out to determine the possible causes that hinder energy performance. The Ishikawa diagram was used for this purpose, as shown in Fig. 5. In addition to the three focus areas, the analysis also included attitudinal aspects of the personnel in regards to the implementation of internal policies for the conservation of energy, their perspectives, knowledge and willingness to adopt and comply with them. These additional data were collected using the energy management matrix mentioned before, as well as through direct observation. Following are the main root causes by category:

- **HVAC:** Air-conditioning units working during production downtime, obsolete equipment.
- **Lighting:** Lamps are switched on during periods of inactivity in production, obsolete lighting, unevenness in the quality and quantity of lamps installed. Process of lamp replacement stalled or irregular.
- **Equipment and machinery:** Equipment powered on during downtime in production, out of order equipment, obsolete equipment, improvised equipment
- **Personnel:** Lack of internal communication, lack of specialized personnel, reluctance to share key information, breakdowns in communication.

- Possible alternatives to improve energy performance

Each one of the maquiladoras was served with customized alternatives for their specific needs, but in all cases these potential solutions stem from common causes and shared problems. The main options to improve their energy performance are summarized next:

- **HVAC:** Acquisition of mini-split units or independent air-conditioning units, replacement of obsolete air-conditioners, installation of WI-FI or automatically-managed air-conditioning equipment.
- **Lighting:** Replacement of obsolete luminaries with more efficient ones, such as LED or T5 technology; lighting must be sectioned by area; lighting must be switched-off when not needed.
- **Equipment and machinery**: Preventive maintenance, substitution of obsolete equipment for energy-efficient technology, implementation of time controls for equipment turned on during downtime periods, well-delineated and physically separated production units, proper insulation on machinery and facilities.
- **Personnel:** training personnel about energy awareness, implementation of a permanent energy-conservation team, hold ongoing workshops for energy conservation, appointment of an energy manager.
- **Organizational recommendations:** to incorporate energy management into the organizational culture; to formally establish a permanent energy management system; to highlight the long-term non-monetized benefits of the EnMS for investors and stakeholders; and to involve decision-makers in all strategic matters relating to energy management.

5. Discussion

There are many companies endorsing energy efficiency as a one of the factors that triggers competitive advantage within this competitive world (3M, 2004; ERM Power, 2016; Ferrovial, 2013; BetterBricks, 2015). Energy has evolved towards a massive opportunity for companies to create value establishing a competitive advantage over their peers (Neagle, 2016). Among the several reasons for companies to adopt an energy management systems (EnMS) are the increasing profits, reducing costs and improving public image. Nevertheless, there are equally a considerable number of circumstances that deter companies from investing in, or transiting towards, more energy-efficient forms of production; these are mostly related to lack of knowledge or competency, lack of involvement of directives or budgetary constraints.

As mentioned previously, the findings in this paper are specific to the audited companies and may not be used to make sweeping generalizations. However, the potential savings on electricity estimated after the audit strongly agree with savings percentages quoted in literature of up to 12% for maquiladora 1 and approximately 7% for maquiladora 2 (Bryan and Phelan, 2014; Di Somma et al., 2015). It was also quite noticeable that maquiladora 2, where an EnMS was in place, showed considerable more employee and managerial awareness regarding energy use and that the company's efforts in these regards seemed to be replicated in other areas such as production. On the other hand, maquiladora 1, where no EnMS existed, showed wider areas for improvement. Both companies are part of international manufacturing corporations, but while maquiladora 1 is small and highly specialized, maquiladora 2 is large and has a more varied range of customers and manufacturing products.

From talking to managers and from mere observation in the plants, it seemed that maquiladora 2 had a more direct corporate presence in the form of visiting managers and auditors from headquarters. Thus, company mandates and policies are more apparent, as well as energy information more readily available, unlike maquiladora 1, where corporate policy seemed to be centralized but not very locally enforced or there was general unawareness of it. This can be supported by the results of the UNEP's Energy Management Matrix (Fig. 1), where the categories of “Awareness,” “Information Systems” and “Policy and Systems” have a bigger gap between the two maquiladoras, particularly the last one, than the other categories.

The strategic growth plans of maquiladoras must embrace developing and maintaining competitive advantages to exceed existing competitors and newcomers. The optimization of energy use may be the foundation where these advantages may be drawn from and developed, since, as noted by Grant (2011), energy costs may account for as much as a fifth of business expenditure. Several tasks may help achieve this goal such as building on the energy performance gains of previous or current energy projects, responding appropriately to increasing energy costs, strengthening their reputation and corporate social responsibility (CSR) image, overcoming budgetary constraints for energy investment, and getting the active involvement of top management.

As a final remark, Birol (2015) states that energy efficiency is crucial in order to reach a sustainable energy future through minimizing the consequences of high energy costs and increasing competitiveness while at the same time addressing security of supply and environmental concerns.

6. Conclusions

The scientific contribution of this article is the presentation of competitive advantages that can be developed from efficient management of energy resources in two Mexican maquiladoras and that might be replicate in more organizational structures. The inclusion of energy audits must be an indispensable tool in the management of maquiladoras to the point where energy efficiency and energy conservation become part of the corporate vision and are present in the structural foundations of companies. Maquiladoras must look at implementing permanent energy policies directed at the optimization of the use of energy resources, the promotion of sustainable practices among employees, the inclusion of the communities' needs in the decision-making process, and at adopting and pushing for energy measures that aid in reducing CO_2 and that promote the sustained and sustainable economic growth of maquiladoras. It is noteworthy that these effects are inclusive of economic benefits that may not be tangibly observed at first but which will become more visible in the long run and where other non-easily monetized elements are also factored in, such as public image, customer engagement, or a more solid net of stakeholders. A true competitive advantage will only be acquired as the result of on-going efforts to meter, collect, report and manage energy data appropriately. The implementation of an EnMS is a permanent commitment where technical, intellectual and economic capitals must be harmonized towards the same goal, only then will the atmosphere be set to further develop a competitive advantage that is truly sustainable and long-lasting.

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