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## Petra Engineering Industries Co., Jordan

**Country:** Jordan

**ISO member body:** Jordan Standards and Metrology Organization (JSMO)

**Project team:**

**Project leader:** Ms. Rula Madanat, Assistant Director General for Technical Affairs, Director of Knowledge Management Department (JSMO)

**Member:** Ms. Zainab Khaleel, Head of TBT Enquiry Point Division, Knowledge Management Department (JSMO)

**Member:** Ms. Dima Jalal, Head of Planning Division, Organizational Performance Management Department (JSMO)

**ISO Central Secretariat advisor:** Reinhard Weissinger, Manager, Research, Education & Strategy

**Duration of the study:** June 2011 – April 2012

## **4.1 Objectives and organization of the pilot project**

The main objective of this pilot project was to determine in a quantitative manner the economic benefits of the use of standards for the company assessed. The findings can be applied to promote the use of standards based on evidence that they can improve the financial results of companies through savings and increases in revenue.

The ISO pilot project in Jordan was conducted from June 2011 to April 2012 and was led by the Jordan Standards and Metrology Organization (JSMO), with the participation of MBA students from the University of Jordan under the guidance of ISO.

## **4.2 Introduction to the selected company**

Petra Engineering Industries Co. was selected for this pilot study since it is a leading engineering company in the Heating, Ventilation and Air Conditioning (HVAC) industry in Jordan, committed to achieving a competitive advantage in providing high quality products that meet and exceed customer's needs and expectations. Petra is committed to adopting and implementing standards for design, production and compliance purposes. It seeks to achieve world-class performance and excellence by adopting TQM principles, and has obtained many certifications from established bodies for its compliance with well-known international standards.

Petra was founded in 1987 with a vision to produce a wide range of heating, ventilation, and air conditioning equipment meeting the diverse application requirements of major markets worldwide. The implementation of successful corporate and business strategies has taken Petra to a high level, and has enabled the company to compete with well-established, high-end companies from other countries.

Petra has expanded significantly throughout the years and continues to grow. The company is currently building a new facility in Mafraq, Jordan, that will cover an area of over 200 000 m<sup>2</sup> and be equipped with technically advanced production lines. At present, Petra has a 300 000+ m<sup>2</sup> production facility in Muwaqar, about 70 km south of the Jordanian capital, Amman, with more than 1 500 employees, including highly competent technical and managerial staff, and over 300 engineers.

In 1994, Petra extended its line of HVAC equipment, utilizing some of the industry's most advanced machinery and raw materials to achieve the highest quality standards. Petra's equipment has rapidly gained recognition in over 20 countries worldwide. After 2000, Petra's products entered the USA – a major milestone in its success, particularly in view of the strong competition in this market. Petra continues to export to the US and to over 50 other countries including Saudi Arabia, Qatar, the United Arab Emirates (UAE), Egypt, and Palestine. According to figures for 2010, the following ten markets represent nearly 95% of Petra's sales :

	Key markets for Petra	% of total sales
1.	Saudi Arabia	29.37 %
2.	Jordan	26.89 %
3.	Qatar	9.86 %
4.	USA	8.88 %
5.	UAE	8.81 %
6.	Egypt	3.21 %
7.	Iraq	2.41 %
8.	Palestine	2.09 %
9.	Kuwait	1.64 %
10.	Sudan	1.51 %
	<b>Total:</b>	<b>94.67 %</b>
	Rest of the world:	5.33 %

**Table 1** – Key markets of Petra

As Petra is targeting global markets, it is competing with large multinational companies. Its main competitors are :

- Hitachi (Japan)
- LG (Korea)
- Samsung (Korea)
- Al Zamil (Saudi Arabia)
- York (USA)
- Carrier (USA)
- Train (USA)

Petra's production facilities include :

- Automatic coil brazing line condensing units
- Production plant large capacity chiller units
- Production plant packaged units
- Assembly plant sound testing room small chillers
- Production plant roof top packaged units
- Production plant sheet metal forming
- Plant pipe bending mini split units
- Production plant lab control room fin presses
- Production press heat exchanger fan coil units
- Production plant CNC sheet metal forming
- Unit air handling units

In order to meet customer requirements, Petra provides customized designs manufactured to specific customer needs. The company has a highly competent and dedicated design staff to ensure that all products incorporate state of the art technology in accordance with many internationally established HVAC standards.

### **4.3 Attitude of the company towards standardization**

Petra believes that the road to success is achieved by providing competitive, high quality products and customer service at competitive prices, and by delivering reliable after sales-service in order to meet customer needs and expectations, and enhance their satisfaction. The company is confident that its success in supplying a large variety of high quality equipment is the result of working in accordance with international standards. It has adopted many standards, including those for energy efficiency, and has earned the following management system certifications :

ISO 9001, *Quality management systems – Requirements*: Petra has been certified to ISO 9001 since 1996, and the certification was renewed to reflect the current 2008 version of the International Standard.

ISO 14001, *Environmental management systems – Requirements with guidance for use*: Petra has been certified to ISO 14001 since 1999, and is currently applying ISO 14001:2004.

Both standards are generic and therefore applicable to all company operations, including design, manufacture and service of heating, ventilation, air conditioning and refrigeration equipment.

Based on European and US standards, Petra is entitled to use the following certifications for its products:

CE Marking (European Conformity): By applying the CE mark, Petra assures that its products comply with all applicable EU Directives, and have been subject to the appropriate conformity assessment procedures. Petra products comply with Machinery, Low Voltage, Energy Efficiency and Electromagnetic Compatibility Directives.

This certification has been achieved by a testing and conformity assessment which emphasizes product properties such as safety, quality, durability, environmental compatibility, and conformity to standards.

- UL (Underwriter’s Laboratories): According to the 1995 heating and cooling equipment standards, Petra’s products are UL listed, since it has complied with the relevant safety and high quality requirements.
- ETL Listing (Intertek Testing Services): The ETL Listed Mark is proof of product compliance (electrical, gas and other safety standards) to North American safety standards. Authorities Having Jurisdiction (AHJs) and retailers in 50 states and Canada accept the ETL Listed Mark as proof of product safety. According to the 1995 heating and cooling equipment standards, Petra’s products are ETL listed, since its testing laboratories conform to UL 1995, second

edition ; CAN/CSA C22.2, No. 236,, which are standards for heating and cooling equipment and Gas Unit Heater and Gas-Fired Duct Furnaces (ANSI Z83.8B; CGA 2.6b-M00).

- ARI Certifications: AHRI Certified™ is the trusted mark of performance assurance for heating, ventilation, air conditioning and commercial refrigeration equipment, issued by the *Air-Conditioning, Heating, and Refrigeration Institute* (AHRI). Products earning this mark undergo rigorous independent annual evaluation to ensure that their performance complies with AHRI standards. The certification of HVAC equipment and components allows consumers to compare products independently on the basis of verified performance ratings.
- Eurovent Certification: This certifies the performance ratings of air-conditioning and refrigeration products according to European and international standards. Petra AHU products are certified and published on the Eurovent Certification website.

Petra is also a member of the national IEC technical committee, and is involved in the standardization technical committee for energy efficiency.

At the national level, Petra has been awarded the “King Abdullah II Award for Excellence” based on TQM principles (ISO 9004) and has been made a member of the Golden List Programme for the export model managed by the Jordan Customs Department. Such recognition has given the company competitive advantages enabling it to successfully penetrate new markets and expand in existing ones.

## 4.4 Analysis of the value chain

### 4.4.1 Industry value chain

Figure 1 gives an overview of the value chain of the HVAC industry:

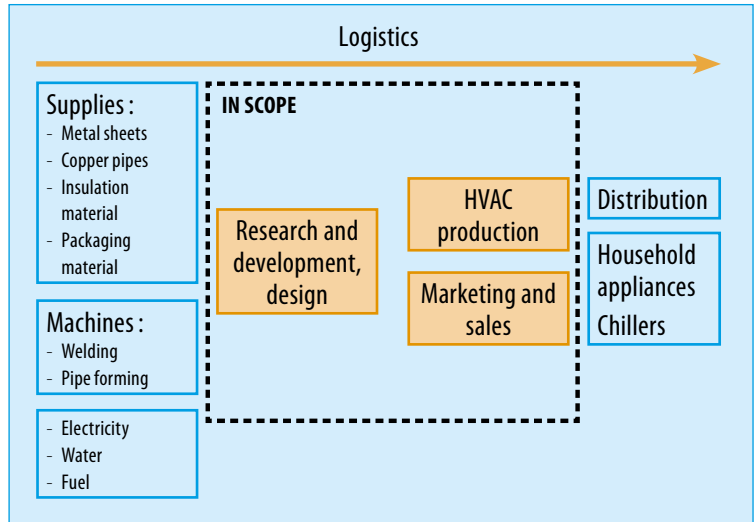


Figure 1 – Value chain of the HVAC industry

### 4.4.2 Company value chain

Figure 2 shows Petra's internal value chain:

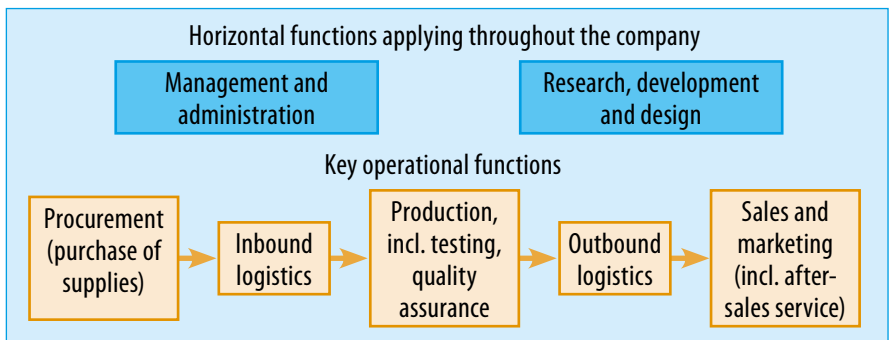


Figure 2 – Company internal value chain



### 4.4.3 Key value drivers

The key operations and business functions that contribute to the success of the company are research and development, procurement, production and marketing. We can identify the value drivers in each business function as follows :

	Business function	Activities	Value driver
1	Management and administration	Management systems Quality planning HR management Correction, prevention and innovation	Better quality management Better environmental management Reduced liability cost
2	Research, development and design	Applied research, and product development	Clearer product specification Variety reduction Customized and high quality products
3	Procurement	Screening of suppliers Selection of suppliers Contracting suppliers	Partnership with suppliers More efficient receipt of supplies Better product availability Variety reduction Better information transfer Reduced storage cost
4	Production	Production planning Order processing Quality assurance	Operational efficiency Compliance with safety and energy efficiency requirements
5	Marketing and sales	Market planning Client acquisition Contracting	Customer trust Better customer communication

**Table 2** – Key value drivers

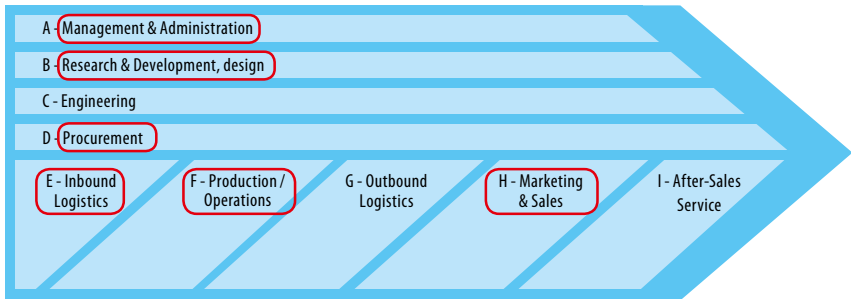
### 4.5 Scope of the pilot project assessment

The scope of the assessment was determined after interviews with Petra management. The business functions were selected based on the significant use of technical standards with high correlation to

the company's value drivers, in addition to some other factors such as availability of resources for the assessment project, and the ease of access to key information.

The business functions included in this study, and for which the impacts of standards are assumed to be the highest, are the following:

1. Management and administration
2. Research, development and design
3. Procurement and inbound logistics
4. Production
5. Marketing and sales



**Figure 3** – Business functions selected for the assessment

## 4.6 Use of standards in the company value chain

The following table illustrates the main business functions in the scope of the project, and the standards used in each function:

	Business function	Edition of the standard currently used by Petra	First introduced in	Edition of the standard initially used
1	Management and administration	ISO 9001:2008	1996	ISO 9001:1994
		ISO 14001:2004	1999	ISO 14001:1996
2	Research, development and design	ISO 9001:2008	1996	ISO 9001:1994
		ISO 14001:2004	1999	ISO 14001:1996
		UL-2005	2000	UL – 1995
		AHRI 430	2007	---
		AHRI 440	2002	
		ANSI/ASHRAE 30-1995	2007	AHRI 550/590
3&4	Procurement and inbound logistics	ISO 9001:2008	1996	ISO 9001:1994
		ISO 14001:2004	1999	ISO 14001:1996
		UL-2005	2000	UL-1995
	Production, testing and quality assurance	AHRI 430	2007	---
		AHRI 440	2002	
		ANSI/ASHRAE 30-1995	2007	AHRI 550/590
		ANSI/ASHRAE 37-1988	2007	AHRI 340/360
		AHRI 260	2007	
		AHRI 350	2007	
		OM-5-2009	2008	Eurovent 1986
		JS 60335-2-40	2007	JS 1590:2003
		EN 55011:1991	1998	
		EN 61000-4-3:1995	1998	
		EN 61000-4-6:1996	1998	
		EN 61000-4-2:1995	1998	
		EN 61000-4-4:1995	1998	
		EN 50204:1995	1998	
		5	Marketing and sales	ISO 9001:2008
ISO 14001:2004	1999			ISO 14001:1996

**Table 3 – Key standards used in the business functions**

## **4.7 Selection of operational indicators to measure the impact of standards**

In the table below, operational indicators are given for the selected business functions which are applied in section 4.8 to measure the impacts of standards. It should be noted that no indicators have been defined to measure the impact on marketing and sales.

	Business function	Indicator	Measurement of the indicator
1	Management and administration	<b>1.1</b> Reduced risk of liability claims for defective products, due to conformity of product and components to standards, and having obtained certifications for critical components	Average cost of liability claim * Number of potential claims
		<b>1.2</b> Decrease in training costs due to the use of standards	Difference in training cost if trainees are trained externally versus actual internal training cost
		<b>1.3</b> Savings due to the use of recycled (treated) water for irrigation purposes	Amount of treated water used for irrigation * price of 1 m3 of water
2	Research and development and design	<b>2.1</b> Reduction in design manpower due to computerized documentation system (based on ISO 9001) and design software, which also reduced design time	Differences in the design cost from year to year = (cost of designers per design + cost of software including software development and maintenance per design) * 10% [the impact of the use of standards is estimated to be 10% of the savings]
		<b>2.2</b> Savings due to the use of validated software since testing type approvals are avoided	Annual savings in testing type approvals = cost of testing type approvals if software is not used – cost of software including the validation cost
3	Procurement and inbound logistics	<b>3.1</b> Savings in the cost of testing inputs due to purchasing from certified suppliers, taking into account the increase in purchase cost when purchasing from such suppliers	(Cost of testing inputs (10% of purchased quantities) + cost of purchased inputs) in case of non-certified suppliers – (cost of testing inputs (1% of purchased quantities) + cost of purchased inputs) in case of certified suppliers
		<b>3.2</b> Savings due to higher reliability/quality by using standardized components (decrease in number of returns)	Changes in the cost of returned items from year to year
4	Production and testing	<b>4.1</b> Decrease in number of inspectors due to the existence of clear work instructions and quality assurance at the design stage	Savings in cost of inspectors = difference in total salaries of all inspectors from year to year
		<b>4.2</b> Savings due to testing in Petra's approved labs instead of external testing in US labs	Cost of external testing including cost of shipping – cost of internal testing in Petra's approved labs

**Table 4 – Operational indicators**

## 4.8 Calculation of the economic benefits of standards

In this section the operational indicators given in section 4.7 are applied to calculate the economic benefits obtained by Petra. The benefits are expressed as a percentage of the average sales revenue from 2006 to 2010.

	Indicators	Contribution as a percentage of revenue (%)
1.1	Reduced risk of liability claims for defective products due to conformity of product and components to standards, and having obtained certification of critical components	0.018 %
1.2	Decrease in training costs due to the use of standards	0.024 %
1.3	Savings due to the use of recycled (treated) water for irrigation purposes	0.009 %
<b>Business function total : Management and administration</b>		<b>0.051 %</b>
2.1	Reduction of design manpower due to computerized documentation system (based on ISO 9001), and to design software which also reduced the design time	0.0001 %
2.2	Savings due to the use of validated software since testing type approvals is avoided	0.432 %
<b>Business function total : Research and development and design</b>		<b>0.432 %</b>
3.1	Savings in the cost of testing inputs due to purchasing from certified suppliers, taking into account the increase in purchase cost when purchasing from such suppliers	2.212 %
3.2	Savings due to higher reliability/quality by using standardized components (decrease in number of returns)	1.492 %
<b>Business function total : Procurement and inbound logistics</b>		<b>3.704 %</b>
4.1	Decrease in number of inspectors due to the existence of clear work instructions and quality assurance at the design stage	0.001 %
4.2	Savings due to testing in Petra's approved labs instead of external testing in US labs	0.010 %
<b>Business function total : Production, testing, quality assurance</b>		<b>0.011 %</b>
<b>Total contribution (as a percentage of Petra's average sales revenue between 2006 and 2010) :</b>		<b>4.2 %</b>

Note: At Petra's request, the contribution of standards is given in the form of percentages of the average annual revenue and not in absolute figures.

**Table 5** – Calculation of economic benefits of standards

## 4.9 Qualitative and semi-quantitative considerations

In addition to the measurable results shown in section 4.8, there are many examples of benefits from the use of standards that cannot be directly quantified, such as :

- Better environmental management and health and safety management compliance leading to an improved reputation for the company in the market
- The storage area and processing time needed for supplies handling could be reduced as a result of procurement from certified suppliers, according to standards
- Efficient customer service resulting in higher customer satisfaction
- Compliance to standards contributes to an increase in product market share, and is often a precondition of initial market entry

## 4.10 Evaluation of results

The overall result shows a total financial impact of over 4 % of the average annual revenues for the period 2006 and 2010.

The scope of the study included five business functions of the company decided on as a result of interviews, and an analysis of company functions where standards appeared to have a particularly strong impact :

### 4.10.1 Management and administration

Petra accomplished a saving of **0.051 %** of total revenues resulting from certification to, and implementation of, ISO 9001 and ISO 14001.

The implementation of ISO 9001 provides assurance that documented procedures and work instructions are in place. It also requires continuous improvement and monitoring of processes through established quality assurance and control systems, and by regular audits and management

reviews. As a result, production variations and defects are reduced along with the risk of liability claims due to defective and unsafe products.

Having well documented systems with written procedures in which standards are integrated gives Petra the opportunity to train employees internally instead of externally. Since the company has its own qualified trainers, training costs can be reduced,

A more efficient use of resources has been achieved as a consequence of ISO 14001 environmental management system certification, following which water is treated for irrigation purposes resulting in reduced consumption.

Although, the company started implementing management system standards many years before this study, the effects of using standards are nevertheless clear because of the company's adherence to continuous improvement.

#### **4.10.2 Research, development and design**

The impact of standards is not very evident in software design. However, the use of validated software to perform type approval tests resulted in a saving of **0.432 %** of total revenues.

Standards are considered a major input to the design stage. Petra uses specific software for design purposes which is continuously updated to integrate any new or revised standards. As a result, man-days needed to produce a new design or revise an existing one are reduced, as are the number of designers needed. Nevertheless, the impact of standards is not very clear in this area since computerization has, in general, played a major role in supporting the work of the designers. A limited impact can be attributed to continuous improvement, since updates to standards are reflected in the software.



Also, the software is continuously validated thus saving Petra the cost of testing for type approvals that would otherwise be required in the absence of such software.

### **4.10.3 Procurement and inbound logistics**

Standards make the largest impact in this area with a contribution of **3.704%** of revenue. Purchasing from approved and certified suppliers leads to a reduction in the costs of inspection and testing, since the quality of purchased components is assured, and, because of the use of certified suppliers, the amount of testing can be reduced to only 1% of the purchased supplies.

If we were to assume that Petra purchases from non-certified suppliers, then it would need to test about 10% of the purchased quantities before using them in production in order to be sure the quality was up to requirements —resulting in a significant increase in costs.

Purchasing from certified suppliers who can deliver standardized high quality components that fit well with Petra's components and products has led to better quality and reliability in the finished products. This in turn has resulted in fewer returns from quality control check points during production.

### **4.10.4 Production, testing and quality assurance**

In the production area, updated procedures and work instructions based on new standards are made available to all staff. Processes have been improved as a result of internal audits, and the certification of the internal quality lab has led to faster and more efficient testing during the production process. The result is increased production efficiency, a higher quality end-product, and a contribution of **0.011%** to revenue.

Because of ISO 9001 implementation, fewer quality inspectors are required because work instructions are clearer and readily available during the process. Furthermore, it was possible to reduce in-process quality inspection during production due to quality assurance at the design stage.

In addition, Petra's testing labs are approved in conformity with standards such as UL and Eurovent, which has saved the cost of external testing of product samples.

#### **4.10.5 Marketing and sales**

The implementation of standards led to the introduction of Petra products in new markets such as the US, where UL standards compliance is a must. In addition, conformity to energy efficiency standards was a prerequisite of entry to the Saudi Arabian market, resulting in an increase in Petra's share in this market in 2010. However, we did not define operational indicators for this business function since entry into the US market, for example, had already taken place a number of years ago and was not related to continuous development.

### **4.11 Conclusions**

This study has demonstrated the positive impact of standards both in the national Jordanian and international markets, particularly as certification to certain standards is often a key condition of market entry. Petra employees interviewed during this assessment clearly expressed their impression of the positive effects of mandatory and voluntary standards, the implementation of which enable Petra to be a step ahead of its competitors.

## Annex 1 : List of key standards used by Petra Engineering Co.

Standards reference	Standards title
ISO 9001:2008	Quality management systems – Requirements
ISO 14001:2004	Environmental management systems – Requirements with guidance for use
AHRI 260	Sound Rating of Ducted Air Moving and Conditioning Equipment
AHRI 350	Sound Rating of Non-Ducted Indoor Air-Conditioning Equipment
AHRI 430	Central Station Air Handling Units
AHRI 440	Performance Rating of Room Fan-Coils
ANSI/ASHRAE 30-1995	Method of Testing Liquid-Chilling Packages
ANSI/ASHRAE 37-1988	Methods of Testing for Rating Electrically Driven Unitary Air-Conditioning and Heat Pump Equipment
EN 50204:1995	Radiated electromagnetic field from digital radio telephones – Immunity test
EN 55011:1991	Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement
EN 61000-4-2:1995	Electromagnetic compatibility (EMC) – Part 4 – 2 : Testing and measurement techniques – Electrostatic discharge immunity test
EN 61000-4-4:1995	Electromagnetic compatibility (EMC) – Part 4 – 4:Testing and measurement techniques – Electrical fast transient/burst immunity test
EN 61000-4-6:1996	Electromagnetic compatibility (EMC) – Part 4-6 : Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields
JS 60335-2-40	Household and similar electrical appliances – Safety – Part 2-40 : Particular requirements for electrical heat pumps, air conditioners and dehumidifiers [Jordanian Standard]
UL-2005	Heating and Cooling Equipment

## Annex 2 : Websites

Intertek: [www.intertek.com/marks/etl](http://www.intertek.com/marks/etl)

Jordan Standards and Metrology Organization (JSMO): [www.jsmo.gov.jo](http://www.jsmo.gov.jo)

Petra Engineering Co.: [www.petra-eng.com](http://www.petra-eng.com)

Underwriters' Laboratories (UL): [www.ul.com/global/eng/pages](http://www.ul.com/global/eng/pages)