

Evaluation Quality Characteristics for Developed Energy-Saving Water pump

Maryam Khalid Abdul Wahid¹, Lamyaa Mohammad Dawood²

¹MSC. Candidate in University of Technology, Department of Production & Metallurgy
Industrial Engineering Division
E-mail :maryamkhalied88@gmail.com

²Prof. Dr. in University of Technology, Department of Production & Metallurgy
Industrial Engineering Division
E-mail : Lamyaa_alkazaai@Yahoo.com

Article Info

Volume 83

Page Number: 11039 - 11049

Publication Issue:

March - April 2020

Abstract:

The purpose of this research is to evaluate the quality characteristics of developed power saving Water pump. This Water pump is used in domestic Air cooler to raise and circulate water inside the Air cooler. The objective of this study is to evaluate the environmental requirements demand and collected throughout 100 copy of questionnaire distributed in Baghdad government. These requirements were prioritized through AHP methodology, GQFD phases were performed. The developed Water pump is modeled throughout CAD Version 7 further, Prototype is made to test and evaluate quality characteristics of the product. Result show that customers are not always interested in low prices, they rather interested in safety in the developed Water pump the electrical part is removed. Offering power saving, Safe to human and environment, and less parts 17 part versus 22 in the current Iraq Water pump and less noise. Therefore offering eco-friendly product that conform customer requirements. It is concluded that Water pump of less number of parts is easier in manufacturing, assembly, disassembly, offers more than 50% of environmental requirements.

Keywords: Product development, Questionnaire, AHP, Environmental requirements, Bar chart, Quality characteristics, Energy Saving.

Article History

Article Received: 24 July 2019

Revised: 12 September 2019

Accepted: 15 February 2020

Publication: 13 April 2020

1. INTRODUCTION

Quality is designed to meet the needs and expectations of internal and end customers. Actually, enhanced quality increase the demands of customers, and result in increased profit and production [1].

Competition drives matured product, increasing customer demand for quality, increasing the number of quality-related litigations, the global economy is of high importance in enhancing the importance of quality. The word "Quality" is often used to signify "excellence" of product or service [2].

Products and services quality are important factors influencing customer satisfaction. Where Customer Satisfaction (CS) is critical to improve customer-centric products and services.

The Voice of Customer (VOC) is the input of high importance to management in the case of mapping areas that must be prioritized. VOC is used for describing such unstated as well as stated requirements of customers. VOC might be captured in many approaches as; questionnaire, field reports, observations, focus groups, .e.t .c [3].

Quality can be specified through International Organization of Standardization (ISO) as "The

totality of features and characteristics of a product or service that bears on its ability to satisfy stated or implied needs”[4] or quality could be defined as the source basic and important since it results in satisfying customers and increasing the loyalty as well as increasing the degree of profitability with regard to medium and long term in organizations [3].

2. QUALITY AND QUALITY CHARACTERISTICS

According to the importance related to quality characteristics, it can be divided into, key quality characteristics, important quality characteristics and general quality characteristics[3] or it could be classified [5] as:

- i. By quality dimension; Function, performance, reliability, compliance, durability, serviceability, appearance, perceived quality, etc.
- ii. By parameter type; Quantitative characteristics and qualitative characteristics.
- iii. By attributes; Geometric characteristics, mechanical properties, physical properties, chemical properties.
- iv. By level; Product level, component level, part level, characteristic level, process level, etc.
- v. By forming; Process Design quality characteristics, manufacturing quality characteristics, assembly quality characteristics, the use of quality characteristics, etc.
- vi. By importance; Key quality characteristics, important quality characteristics, general quality characteristics.

Where principles to define key quality characteristics are [5]; Affecting the loss of safety and function, characteristics of product life, performance and adaptability and

Searching for historical data from waste products, defects, and nonconforming products.

3. ENERGY CONSERVATION

Customers are increasingly becoming aware of environmental requirements of products or services. Since energy saving is an important criterion of environmental requirements, also it is undeniably very important to all human beings due to the fact that we are relying on what we do each day [6,7].

Since it can result in increased environmental quality (save energy to reduce pollution). Generally, energy conservation is the major economical solution to energy shortages[7,8].

There are a lot of advantages to meet the power requirements with minimum energy. The pollution and cost of the power plants can be avoided with the use of less power. Also, it enhances the reliability of the systems as well as reducing the overall cost of energy[9].

He Yizhou (2010) studied the way of reducing central Air-conditioning energy consumption, considered as case study to enhancement of the Nanchang HKLS air conditioning system in China. Energy-saving measures, that are regulating the quality related to air-conditioning through decreasing cooling load demand. Their approach of energy-saving is by improving the effectiveness of the system via enhancing the design of the central air conditioning as well as coordination related to controlling devices. Five percent to Ten percent in whole energy-saving regarding the central air conditioning system is resulted as they reported [10].

In this research a developed prototype of Water pump used in domestic Air cooler is developed based on customer demand captured throughout questionnaire. The developed Water pump is power saving since it will save money, reduce pollution, and result in safe environment.

4. MATERIAL AND METHOD

Previously researchers (Osama Malik [11], Samah Ali [12], Dr. Khalied [13]) reflects their interest in developing the current Water pump throughout saving energy, or improve Process Capability , or improving processing of Water pump. While other researchers are interesting in power saving where:

Shameer A. P, et.al (2015)[14]:Green computing is considered to be environmentally responsible use regarding the computers in addition to the related with effectively with no or minimal effect on environment and adequate e-waste's disposal. The major aim is to save the consumption of electricity in computer science labs in India as well as raising awareness regarding green among facility members and students depending on the analysis. The case study results indicated that the savings in electricity with regard to CRT and LCD monitors, fans, personal computers have been in OFF mode when the work is finished.

Ramya L.N.(2015)[15]:Focused on the significance related to energy conservations for class room in educational institution in India as well as taken into account the consumed energy via loads. Energy conservation could be the most effective solution for the growing demands on energy. Energy conservation reduces the consumption of energy through the use of less energy services. The results indicated to installing 5-star rating fluorescent lamp which replace the current fluorescent lamps, as well as ceiling fans of 5-star rating appliances for reducing the consumption of energy by 82.37kWh for each month. Furthermore, incorporating sensor-based switching model might decrease the consumption of energy by 18.95kWh for each month. Similarly, CF6 emissions have been controlled to more extent in the case when using 5 star rated appliances, therefore making the system environment friendly.

Samir B.Salman Al-Badri, et.al (2016) [16]:In utilizing air cooler type BF3 size 2500 m³/ hr. of

two speeds motor works. Researchers added another water pump to work with the first water pump for the purpose of increasing the amount regarding water drop over pads. The result shown that addition of another water pump is very important to the cooling efficiency. Furthermore, addition of another water pump has a extremely important impact on inside temperature which improves the performance of air cooler.

D. S. Soegoto (2018) [17]:The major aim of this research was to analyze eco-friendly product quality as well as the eco-friendly preference in addition to their implications on the satisfaction of customers either simultaneously or partially. Quantitative approach has been applied with multiple linear regression analysis. The method of collecting data utilized saturated random sampling with one-hundred respondents (customers of modern markets). The obtained results indicated the increase in eco-friendly product quality and eco-friendly preference will also increase the implications of customer satisfaction either simultaneously or partially. In the case when eco-friendly product quality is enhanced, then the implications impacting the satisfaction of customers will also increase in modern markets in Bandung. Customers receiving benefits are going to be satisfied against company and company eco-friendly products.

5. METHOD

Air coolers are commonly used in Iraq on summer season. These coolers (manufactured locally or imported) use electrical Water pumps to circulate Water inside the air cooler. In this research , One of the problems that have already been raised, locally manufactured electric pump.

Iraqi Water pumps are manufactured at State Company Of Electrical Industries (SCEI) in Baghdad/Iraq are of price almost account as (6-10%) of the whole air cooler cost depending on the size of the Air cooler .This price is almost twice of that imported Water pumps (Chinese or

Iranian). The components of the current Water pump are shown in Table (1) below.

Table 1: Components of Current Iraqi Water Pump manufactured by SCET[sceei@yahoo.com]

Part No.	Name	Part No.	Name
1	Stator (lamination)	12	Small Bushing
2	Rotor lamination	13	Fan
3	Shaft	14	Nuts
4	Bearing Cap	15	Rivets
5	Sheet Metal	16	Plastic Support base
6	Alloy in rotor	17	Top plastic Cover
7	Copper strip	18	Final plastic Cover
8	Winding Wire	19	Impeller
9	P.V.C lead Wire	20	Plastic impeller cover

10	Clamp cell	21	Bottom end shield
11	Large Bushing	22	Top end shield

In order to develop this Water pump, the VOC is collected by questionnaire where 100 copies (as shown in figure 6) are distributed in Baghdad governments since it is the capital of Iraq with growing population (expected to be the number of Iraqi population in Baghdad 12 million population in 2020 [18]).

Where each family of members (as average) use one Air cooler therefore, the need of Air cooler consequently of Water pump is continuously increasing.

The responds be of customers' requirements where interpreted and categorized as shown in Figure (1) below, the number over each bar chart shows the total counts of customer responds.

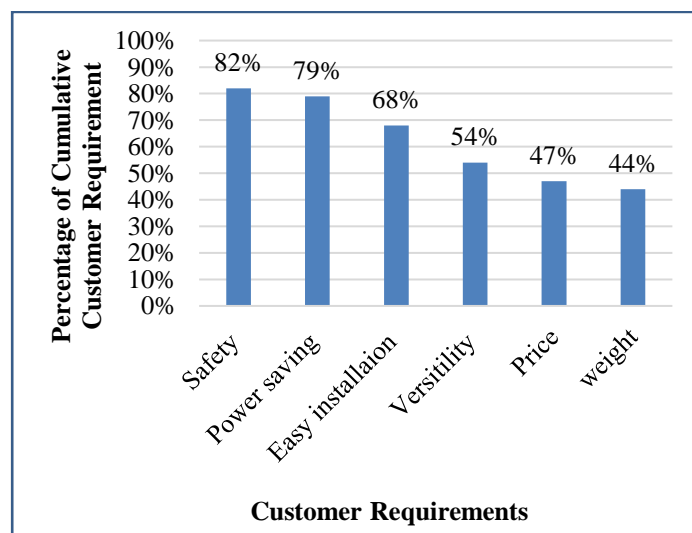


Figure 1: Prioritization of Customers' requirements

The data is analyzed using Analytic Hierarchy Process (AHP) to obtain the priorities. Since AHP is the approach for multi-criteria decision making. Where AHP indicate flexible and primary

modeling method and utilized in various aspects to solve complex problems [19,20].

Figure (2) show the prioritization of customer's requirements reflected as quality characteristics in

the 1st level (level 1). While level (2) extended these characteristics toward improving Water pump design.

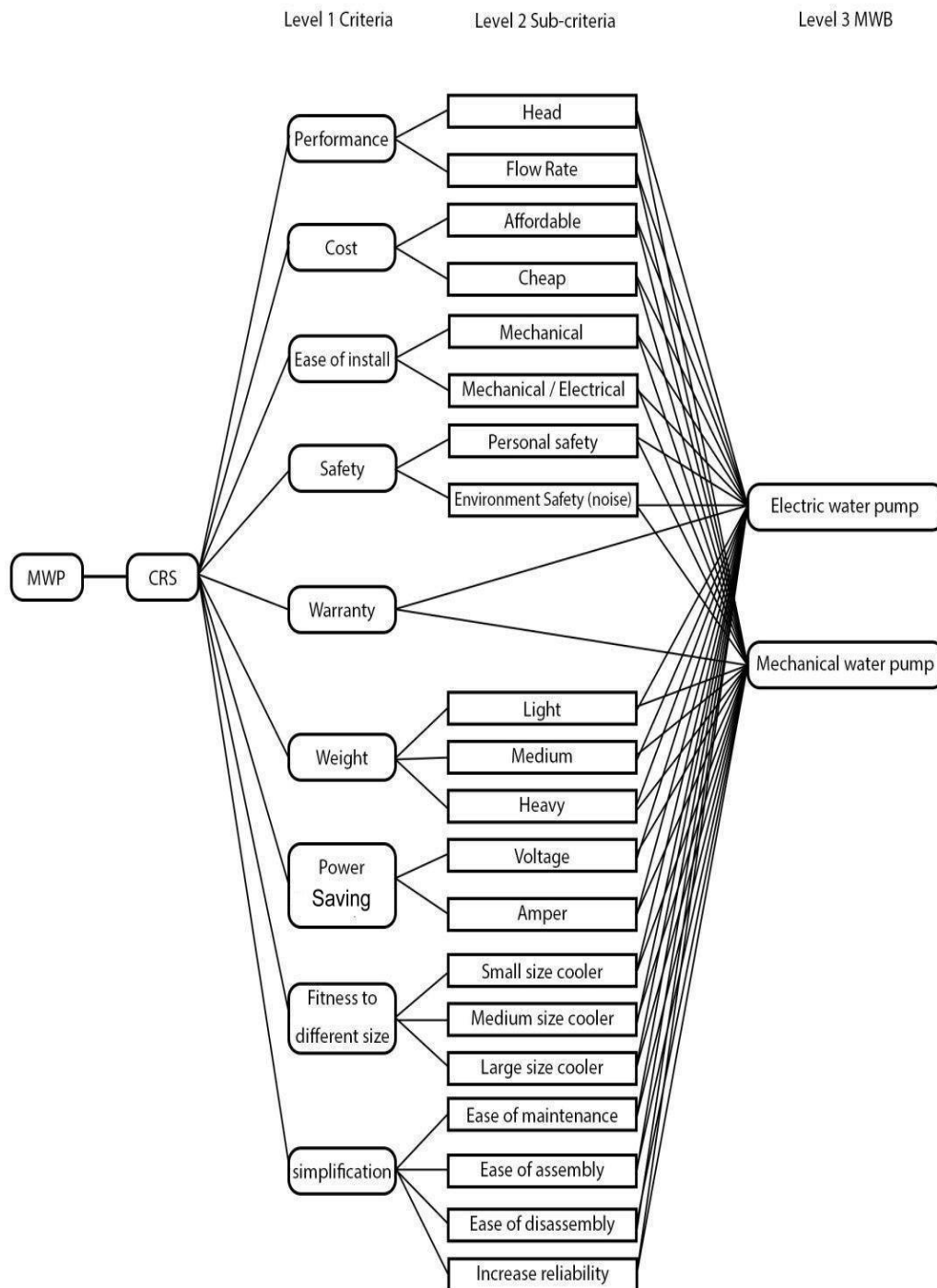


Figure 2: Analytic Hierarchy Process for prioritization customers' requirements

The prioritization of customer requirement sare represented in with their relative percentage share is shown in figure (3) below.

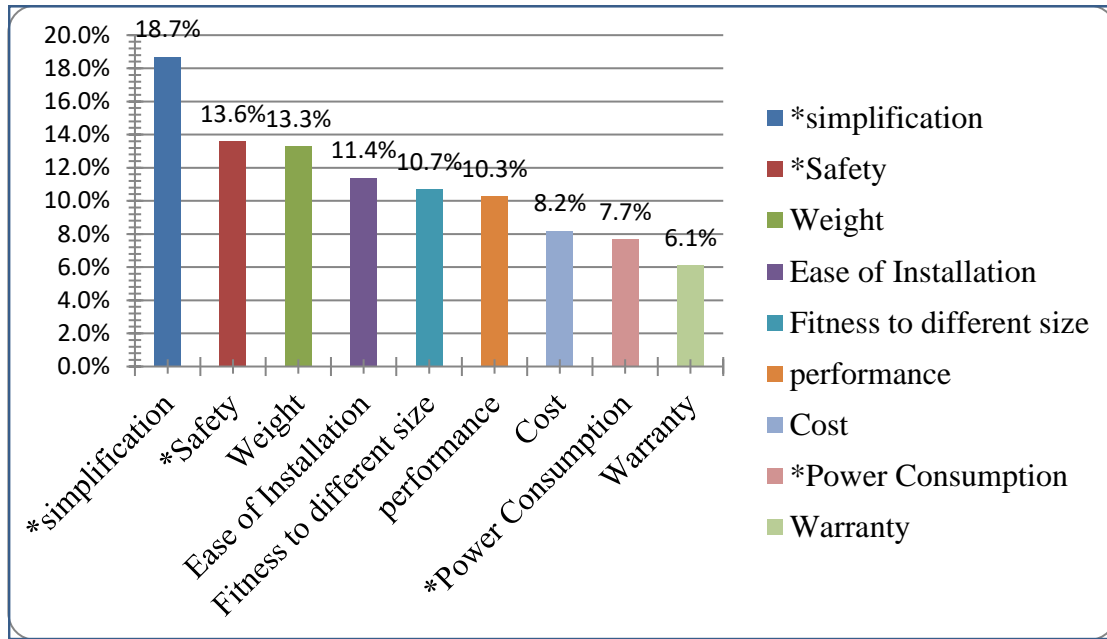


Figure 3: Customer Requirements Prioritization

According to AHP process to prioritize customer requirements, 40% of results are directed towards environment (Simplification, Safety, Power consumption) [21].

These requirements indicated are in figure 3 by *. Among these environmental priorities is safety, which shows that safety is on the second place in the sequence of priorities of (13.6%). Safe product should be safe to manufacture, use, and dispose after using. Safety can be defined as the product that does not result in property loss or injury. Recall related to unsafe product could be extremely costly with regard to tarnished reputation, replaced product, and product liability suits [21].

It was expected that customers prefer to buy at the lowest price products but results show that safety is more crucial to customers than cost according to figure (3).

6. RESULTS AND DISCUSSION

According to the above mention results of customer requirements Water pump is developed by means of Green QFD where all (CRs) i.e. general and environmental requirements are inserted in the 1st GQFD phase (Product Planning).

A giants engineering requirements phase two of GQFD is directed toward energy saving as the target in results to conform customers' requirements. also as energy saving results in money saving as well as related safety issues. The developed energy saving Water pump (2D) model is shown in figure (4) using Auto CAD software (version 7). While figure (5) shows a prototype of the developed water pump. Where the electrical part in the former water pump is cancelled so that the Rubber Slinger (no .1) in Table (2) below convert the mechanical movement to raise the Water in the Water pump, so that it will be further distributed to the inside area of the air cooler (never less the size).

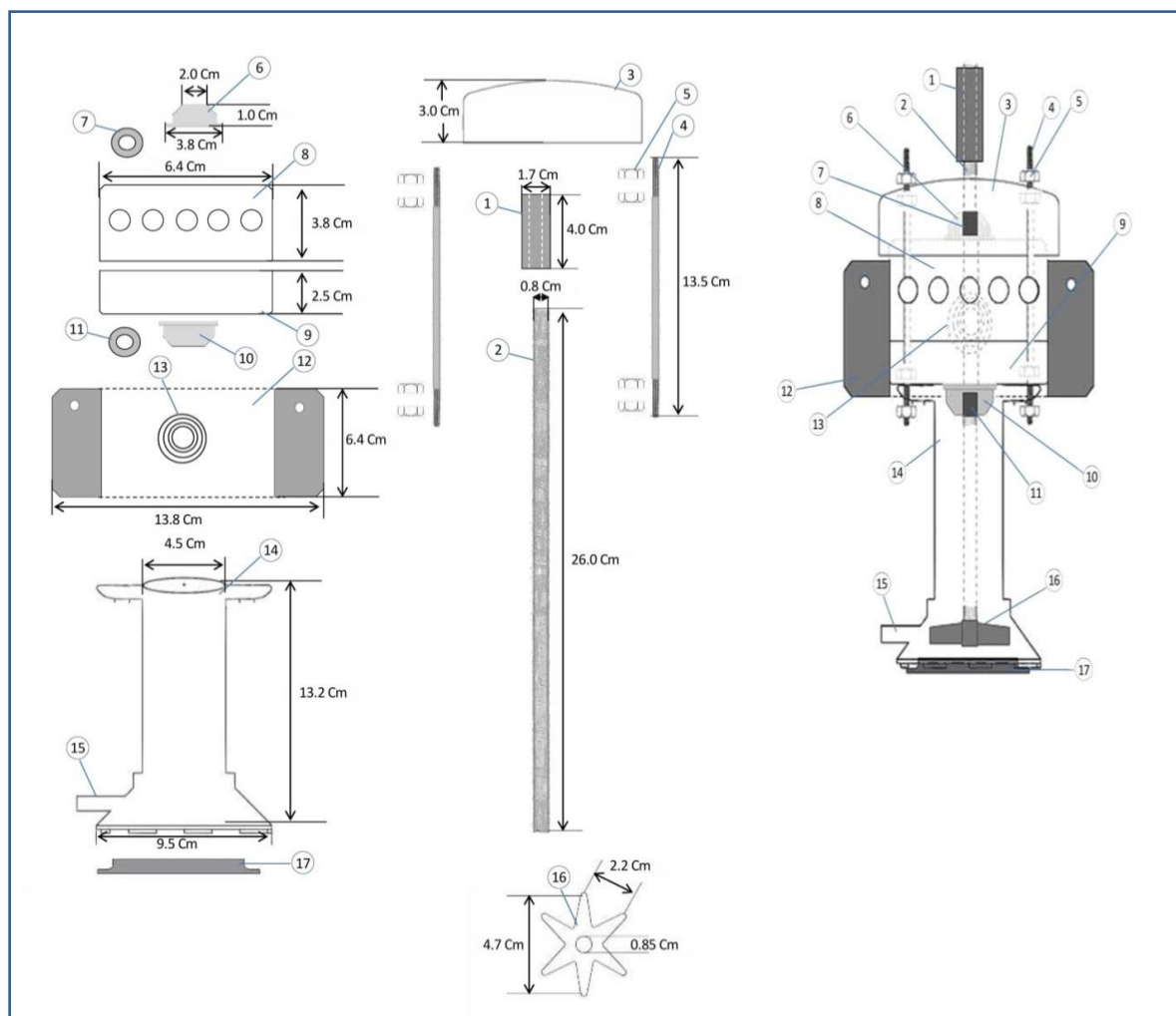


Figure 4: Detailed Drawing (2D) of Developed Power Saving Water Pump

It should be mentioned that all components of developed model are the same as the previous one (i.e.) it could be produced on the same machines available in (SCEI) but with less number of operations and less number of parts (i.e.). Power saving throughout manufacturing processes also. Also the removal of electrical parts results in Weight loss. Where the name of each part for developed water pumps as shown below in Table (2):

Table 2: Developed Energy Saving Water Pump Components

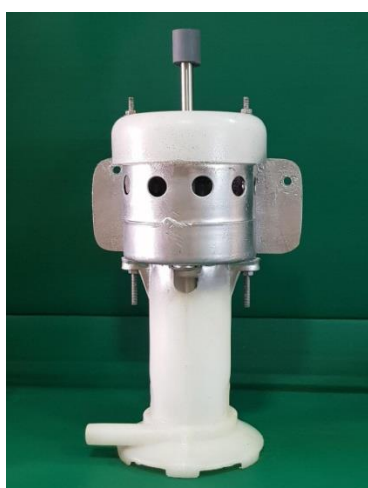
No.	Name	No.	Name
1	Rubber	10	LowerSlinger

	Slinger		Cover
2	Shaft (Stainless Steel)	11	Cotton Oiled slinger
3	Top Plastic Cover	12	Piece Iron for installation
4	Extended Studs	13	Spiral Spring
5	Nut	14	Plastic Support base

6	Upper Slinger Cover	15	Exit slot water
7	Cotton Oiled Slinger	16	Plastic Impeller
8	Upper Iron Cover	17	Plastic impeller cover
9	Lower Iron Cover		



(a)



(b)

Figure 5:(a) Current Water Pump, (b) Energy Saving Water Pump

Electrical measurement was applied to both (former electrical) and (developed Power saving) Water pump as shown in Table (3).

Table 3: Electrical Measurements for Former electric Pump and Developed Power Saving Pump

Developed pump		Electrical Water pump		
With load	Without load	With load	Without load	
220	None	220	220	Voltage(V)
1.85	None	2.32	2.06	Current (Amp)

Knowing that these Water Pump is tested with air cooler (Size 3500 m³). From this table it could be noticed the decrease in electrical voltage and current for the developed Water pump compared to the electrical one both of these Water pump are tested (with load) by attaching to Air cooler (size 3500m³). Comparison also are made for other quality characteristics, and as shown in Table (4).

The characteristics of this developed Water pump:

- Safe (to the environment) due to the absence of resulted gases from the former electrical motor causing less pollution. Also, it's safe to human during implementation, maintenance, assembly (during manufacturing), disassembly life cycle and use.
- Power Saving as the developed Water pump uses mechanical movement of the Air cooler motor as it is to be detached from both side using part(9) listed in Table (1).
- Environmental friendly due to the decrease of noise, Power, number of part.

Table 4: The Results of Measurements for Electric Water pump and Water Pump Developed

	Current Iraqi Water pump	Developed Water pump	Notes
Weight	1.584	1.100	

(Kg)			
Head (m)	1.40	1.60	With load
Flow rate (L/ sec)	4.59	81.6	With load
Noise (Decibel)	55	42.7	Noise meter (model GM1351)
Voltage (V)	220	None	INGCO Voltmeter
Current (Amp)	2.32	None	INGCO Current meter
Power (W)	65	None	Without load
Speed (R.P.M)	2800	46192	With load
Selling price (ID)	11000	*7000	*This Price is based on the cost of materials used in water pump

From this table it is obvious that the removal of electrical motor in the current Water pump (manufactured as SCEI) does not affect the head on the contrary it is increased i.e. for larger Air cooler sizes .The developed Water pump will be suitable and efficient.

7. CONCLUSIONS

- i. VOC is very important in developing any product.
 - ii. Customers are not always interested in low price products.
 - iii. The developed power saving Water pump is safe to environment as well as human being.
 - iv. Power saving Water pump is of less parts than the former electrical water pump ,Thus it is easier in assembly during manufacturing and in maintenance(easier in disassembly). Also this affected the time, cost of production and product price .
 - v. From the above i.e.(iv) it is clear that the developed Water pump is of higher reliability since it is of less parts and of one compel mechanical system.
 - v. The developed Water pump is eco-friendly since it conform most of the environmental requirements. Therefore environmental friendly products should be the new trend in Iraq as it is in the whole World.
- It is recommended to make comparison between the developed Water pump relative imported Water pumps that are available in Iraqi market.

1) Average number of Water pump to be replaced each year:
The number

2) Average number of operating hours of air cooler per day:
Hours

3) What type of air coolers do you have? Please choose.
Iraqi Iranian

4) Which Water pump you prefer:
Electric Mechanical

5) What size of Air cooler do you have?
Small Medium Large Very large

6) Does the price determine your choice of Water pump?
Yes No

7) Does the Weight of Water pump determine your choice?
Yes No

8) Does the consumption of electricity affect your Water pump choice?
Yes No

9) Easy installation of Water pump affect your Water pump choice
Yes No

10) Safety First ... Do you think this phrase important on using Water pump?
Yes No

11) Do you prefer to buy the same kind of Water pump for different Air cooler sizes?
Yes No

12) What do you prefer, Please mark the selection:
A - Iraqi Water pump (.9000 ID).
B - Chinese Water pump (.8500 ID).
C - Iranian Water pump (.8000 ID).
D - Iraqi mechanical Water pump at expected selling price (7000ID).

13) When the electric Water pump malfunction, what do you do?
Replacement Repair

Figure 6: Copy of Questionnaire Distributed in Baghdad Government

REFERENCES

- [1] D.Natarajan; "ISO 9001 Quality Management Systems", Bangalore, India, Springer International Publishing AG 2017.
- [2] G. Knowles; "Quality Management", Download free eBooks at bookboon.com, 2011.
- [3] L.Atiyah; "Product's Quality and Its Impact on Customer Satisfaction A field study in Diwaniyah dairy factory", Challenges of Modern Management", November 3rd-4th, 2016, Bucharest, Romania.
- [4] P. Hellman, Yang Liu; "Development of Quality Management Systems: How Have Disruptive Technological Innovations in Quality Management Affected Organizations?", University of Vaasa, July 2013.
- [5] John S. Oakland; "Statistical Process Control", Sixth Edition, This edition published 2011 by Routledge.
- [6] Sandra Levine and Katie Kendall; "Energy Efficiency and Conservation: Opportunities, Obstacles, and Experiences", Vermont Journal of Environmental Law [Vol. 8, Issue 1 – (2006)].
- [7] G. D., Sharma B., Kerr D., and smith T.; "The Influence of Consumers Environmental Believe and Altitudes on Energy Behaviours", Energy Policy 39, No.12, (2011), p.p. 7684–7694.
- [8] R. Banerjee; "Importance of Energy Conservation", International Journal of Innovative Research in Advanced Engineering (IJIRAE) ISSN: 2349-2163 Issue 4, Volume 2 (April 2015).
- [9] S. Levine and Katie Kendall; "Energy Efficiency and Conservation: Opportunities, Obstacles, and Experiences", Vermont Journal of Environmental Law [Vol. 8, Issue 1 – (2006)].
- [10] Y. He; "Energy Saving of Central Air-Conditioning and Control System Caseb Study: Nanchang Hongkelong Supermarket", Master Thesis, Savonia University of Applied Sciences, Business And Engineering, Varkaus, (2010).
- [11] O. Malik Mohammed; "Design for X in Concurrent Engineering Environment", University of Technology, Department of Production, Engineering and Metallurgy, 2014.
- [12] S. Ali Awfi, "Application of Statistical Techniques to Improve the Ability of Processes", Master Thesis, University of Technology, Department of Production Engineering and Minerals, Industrial Engineering Branch, (2012).

- [13] Kh. I. Mahmoud, Zainab K. Hantoosh and Muslih Abdullah"; "Practical Application For Designing Quality House", Eng.and Tech. Journal, Vol.28, No.16, 2010.
- [14] Shameer A. P, Haseeb V. V., Mini Mol V. K.; "Green Approach for Reducing Energy Consumption-A Case Study Report", NAM College Kallikkandy, India, International Journal of Advanced Research in Computer Science and Software Engineering, Volume 5, Issue 1, January 2015.
- [15] Ramya.L.N; " Energy Conservation – A Case Study", KCG College of Technology, Chennai, International Journal of Applied Engineering Research ISSN 0973-4562 Volume 10, Number 9 (2015).
- [16] Samir B.Salman Al-Badri and Faiz F.M. AL-Makhul; "Study the Effect of Add Secondary Water Pump to Air Cooler Type Bf3 on the Efficiency of Air", Dept. of Agric. Mechanization/ College of Agriculture/ University of Baghdad, Dept. of Agric. Mechanization/ College of Agriculture/ University of Baghdad, Elixir Agriculture 96 (2016) 41211-41213.
- [17] D. S. Soegoto; "Analysis of eco-friendly preference and eco-friendly product quality; their implications to customer satisfaction", UniversitasKomputer Indonesia, IOP Publishing, Jl. DipatiUkur. No.99, Bandung, Indonesia.
- [18] A. Abdul Redhah; :Modeling a Framework for Baghdad Petroleum Product's Consumption", Thesis, University of Technology, Industrial Engineering, 2017.
- [19] M.Shu; "Quality Function Deployment Integration with Design Methodologies", Master of Applied Science (Quality System Engineering) at Concordia University Montreal, 2017.
- [20] H.yilmaz; "optimization of the product design through quality function deployment (QFD) and analytical hierarchy process (AHP): a case study in a ceramic washbasin, Zmir Institute of Technology in Industrial, Master of Science. 2009.
- [21] George E. Dieter, Linda C. Schmidt; "Engineering Design, Fourth Edition", The McGraw-Hill Companies, 2009.