Smart Faucet Co.

Product Definition & QFD

Team 5

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Introduction

Taps are one of the most important components in kitchens, restrooms, restaurants, hotels, casinos, malls, sports arenas, as well as residential properties or any other place correlated to hand-cleaning. In rest-room designs taps play huge role defining the ambiance of the place where it's put. Apart from looks, taps are the important for water conservation as well as saving money. A normal faucet will operate differently than an automatic one as a result there will be some advantages and disadvantages of choosing one. An automatic will provide user many other advantages as well as it helps saving money and water. It's easy to operate and it helps preventing water over-flows as well as it prevents the spread of germs and bacteria and scalding injuries. During the time that hands move while reaching the soap or trying to adjust the heat there will be a waste of water which an automatic one would not allow. The water consumption importance can be shown by this example; "Automatic faucets are water saving devices, helping save 70% of the water that would otherwise swirl down the drain unused and conserve as much as 3-5% of the water used by a standard household"**[1]**.

Ordinary faucets need many functions to operate comparing to automatic ones, where automatic faucets only need an operator to function. So choosing an automatic faucet over a regular one provides us many advantages in any ways. "Computer circuitry and infrared technology have brought new products and lower operating costs"**[2]**. In every place where a tap needs to be put it's much better to choose an automatic faucet than a regular in many ways. The faucet which its water heat can be controlled is even much better than a regular automatic faucet itself.

To understand the better version of an automatic faucet we must first understand the mechanism of the regular one. What we call as an automatic faucet can be considered as a regular faucet with a sensor put on it and helps the user to start and stop the water flow by one move of his hand. It has a valve which opens and closes by this hands-free move of the user. The faucet that we plan also provides user to control the heat by a hand move. In regular automatic faucets user has the ability to only start and stop the water, but the product we design offers the user to control the heat by only a small move of hand to left of right, than your water will flow with the heat exactly as you want.

Functions of the Product

1. **Electronic Sensor Faucet**

Smart faucet will turn on automatically as you put your hands in front of it and stop the water flow when you get your hands away from the sensor. For this we will buy an electric sensor faucet where we can work on to finalize our product. The functions of the faucet also include manual temperature adjusting, clever timers to avoid water consumption and water flooding.

2. **Electronic Sensor Temperature Control**

Electronic sensor temperature control will be a device built on top of a regular electronic sensor faucet and it will allow you to control the water temperature by your hand movements without touching any valves. This will be possible by infrared sensors, and an electric motor.

3. **Infrared Sensor Technology**

Infrared sensors are widely used in devices automatically powering on when interaction with a person, or simply anything that changes the infrared characteristics of the environment. When you interfere with the device, it automatically powers up the system.

4. **Electric Motor**

Electric motor will be placed on top of the water temperature valve of the faucet, and with a mechanical system that allows the rotation of the valve will adjust the voltage temperature according to the signals coming from the microcontroller.

5. **LED Display**

This LED display will show the current water temperature level with different colored LEDs lined side by side. This will help the user adjust the water temperature to their desired level.

6. **Smart and easy-to-use**

The product will be user friendly as it will help the user control the water temperature using a simple and easy-to-use logic. User will be guided with instructions and graphics placed on

the faucet to show how to adjust the water temperature and use the faucet. There will be two sensors used to water temperature controlling; the user will move their hand from one to another and according to which sensor is activated first the water temperature will be increased or decreased. Once the first sensor is activated, the device will automatically start temperature adjustment, and the change will be simultaneously shown at the LED display for the user to stop the adjustment at the desired level. (There might be an additional sensor, 3 in total, in order to control the changes more accurately.)

7. **Easy set-up**

The setup of the device will be simple as a regular faucet, and it will only require an additional 9V battery to be able to operate.

8. **Design**

The additions to a regular electronic sensor faucet that our product offers will be small, ergonomic, and useful. It will not stand out when you look at the faucet, it will be shaped, designed, and placed in order not to disturb the user at all.

Interfaces of the Product (Revised)

Figure below is the final product, which is an electronic sensor faucet with certain add-ons and upgrades both functionally and visually.

[1]

Figure 1: Interface of the final product

1. **Infrared Sensors**

The sensors will be placed on the side of the faucet as shown in the figure below. There will be 3 sensors sside by side allowing easy access and control for the water temperature.

Height: 1.5cm Width: 1cm Length: 1cm Weight: 5 grams

Figure 2: Infrared Sensors' place on faucet **[3]**

2. Control Body

Control body will be a water-proof enclosure with the necessary electronic circuitry and components inside of it. There will be connections to the sensors, LED display, and the electric motor from the control body. The body will be placed on the sink next to the faucet and electric motor.

We will get a plastic enclosure with a battery socket from Altınkaya Elektronik Cihaz Kutuları. Height: 5cm Width: 6cm Length: 10cm **[4]**

Figure 3: Controller Body's on faucet **[3]**

3. Electric Motor

Electric motor will be placed on top of the water temperature valve which is placed on the side of the faucet. Height: 23mm Width: 12.2mm Length: 29mm Weight: 9 grams

Figure 4: Electric Motor's place on faucet **[3]**

4. LED Display

LED display will be placed on top of the sink for user to easily see and adjust the water temperature. LED display will also have a water-proof enclosure for safety. This circuit will light up the LEDs according to the voltage signals coming from the controller. There will be 5-7 LEDs, showing the water temperature level accordingly.

Figure 5: Electric Motor's place on faucet **[3]**

Technical Specifications (Revised)

The sensors will be placed on the side of the faucet for easy accessibility. The main body enclosure will be placed at the back of the faucet where the connections from the sensors and the electric motor will be made. The electric motor will be built on the water temperature valve as shown in the figure above.

The working principle of water temperature control due to hand gestures will be explained here in order to easy the understanding of the coming parts in the report. The hand will be placed on the side of the faucet where the sensors are, and the optimal distance from the faucet is 5-15 cm. The infrared sensors we chose are allowing us to work with only infrared light, hence the color of hands, lighting of the environment, and any similar issue will not be a problem. This is because the sensor has a built in day light filter, which operates only with infrared light, hence only the infrared light that bounces back from the hand when the hand is in front of the sensor. The infrared component of human body or light bulbs on the environment will be negligible and will be compensated with the software. Another issue is the speed of the hand gesture, and this will not be an issue as well. The sensor is fast enough to recognize the hand gesture, as we are only checking if there is a hand or not, and do not require a detailed data like the distance or the angle of the hand.

The first part is the hand gesture, as the figure below visualizes if we are looking from the side of the faucet, the water will be heated if the hand moves from right to left, and the water will be cooled if the movement is from left to right. Simply, the direction of the movement determines the action. The second thing is the speed of the hand gesture. Depending on how fast or slow you make the hand gesture; the change in water

temperature will be decided. For example, if you move your hand fast, the water will be heated rapidly; but if you move your hand slow the water will be hated only slightly so that you can finely adjust the water temperature level.

The direction and the speed of the hand gesture will be determined by the software of the microcontroller, the data from 3 sensors will be used to do this. Once the process is done, the microcontroller will send signals to change the water temperature and the LED display. The shaft of the motor will be fixed to the shaft of the water temperature valve core to core. According to the direction of the hand gesture, the motor will rotate to the left or to the right. Hence this will rotate the valve, and increase or decrease the water temperature. The limits of the valve are -90^{o} to $+90^{o}$. The second part is the speed of the hand gesture which determines the step of water temperature change. For example; if the hand gesture is fast the position of the valve will be changed by 30^{o}, and if the speed is slow the position of the valve will be changed by 5^{o}. There will be different speed – rotation degree couples determined in the software which we will design for optimal usage. Finally LED display will show the corresponding water temperature level according to the position of the valve to help user decide on the temperature level if they do not want to check it directly from the water.

For the final product, we will use a regular 9V battery, as most of electronic sensor faucets are powered up by these batteries. The product will operate for short periods of time, and the power consumption of the whole product will be small, allowing us with a common power source, 9V battery. All of our additions will be on the original faucet, hence the weight and size of the final product will be nearly the same with the original faucet we will use. The biggest addition will be the controller body, which is a cigarette pack sized box placed at the back of the faucet which weights around 300 grams. Other than that, smart faucet will be installed just like a regular electronic sensor faucet, and will start working by putting a 9V battery in it.

Cost

Our expected total cost of the final product is:

Sensors: 3x5TL = 15 TL
Microcontroller, LED display and circuit components: 10 TL
Electric motor: 20 TL
Plastic enclosure for all components: 10 TL

Total: 55TL

The total cost allows us to easily set our product on any faucet, without considerably raising the cost of the initial product, allowing our price to remain in the market range.

Standards

We are not using any protocols or standards that are widely used, our product will have **ISO9001:2008** standard for quality managing of both the product and the company.

EN 50065-1:2001—Signaling on low-voltage electrical installations in the frequency range 3 to 148.5 kHz—Part 1: General requirements, frequency bands, and electromagnetic disturbances; Amendment A1:1992 to EN 50065-1:1991; Amendment A2:1995 to EN 50065-1:1991; Amendment A3:1996 to EN 50065-1:1991.

Quality Function Deployment:

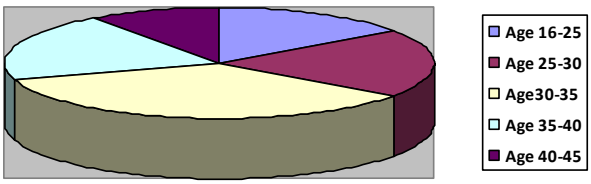
Survey and Collecting Data:

The purpose of preparing QFD is to get the general idea about the target customer opinions expectations and needs about the product. According to the customer wills and expectations we formed charts about technical and general product characteristics for our project after analyzing what kind of product is going to fit the customer needs and expectations produce that product and deliver.

To get the general idea about our product or similar products in market, we made a survey searching for the best characteristics that are most popular among target market. We made the survey in Bilkent University among the workers of BİLTEM, in Real and in Cepa. The survey is made for understanding if the faucet which can perceive hand moves and adjusts water heat like ours could both replace the old-fashioned faucets with no sensor and with sensor. The results of surveys can be found on Appendix [1].

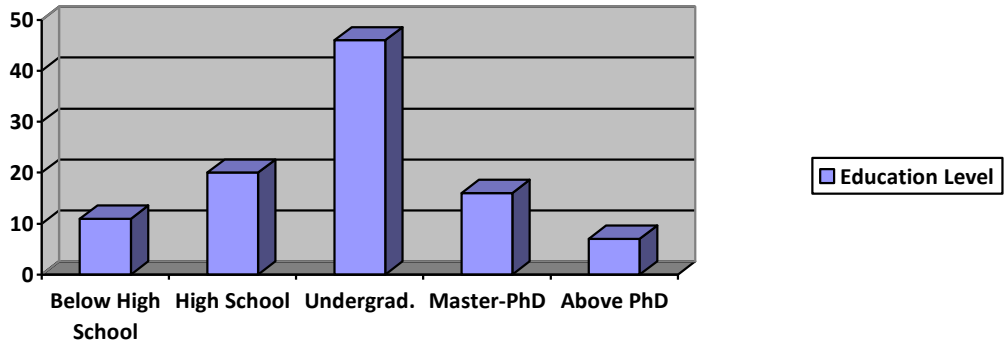
A. Age Interval of Participants of Survey:

Age 16-20: %15
Age 25-30: %20
Age 30-35: %35
Age 35-40: %20
Age 40-45:% 10



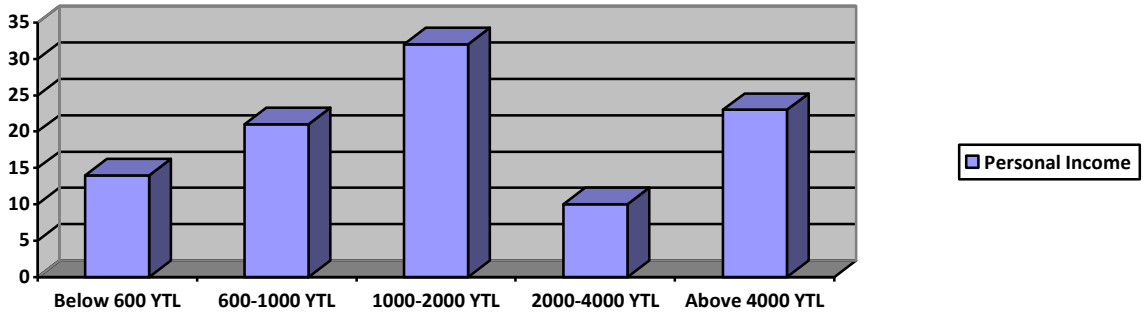
B. Level of Education of Participants of Survey:

Below high school :%10
High school:%40
Undergrad. :%43
Master-Phd: %5
Above Phd: %2



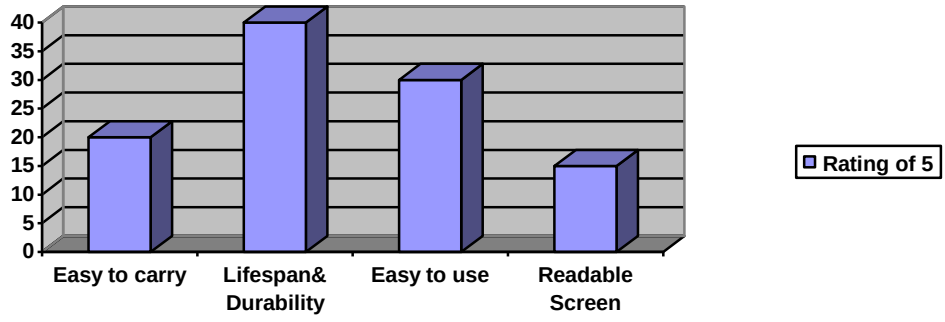
C. Personal Income of Participants of Survey:

Below 600YTL: %5
600-1000 YTL: %20
1000-2000 YTL: %45
2000-4000 YTL: % 23
Above 4000 YTL: %7

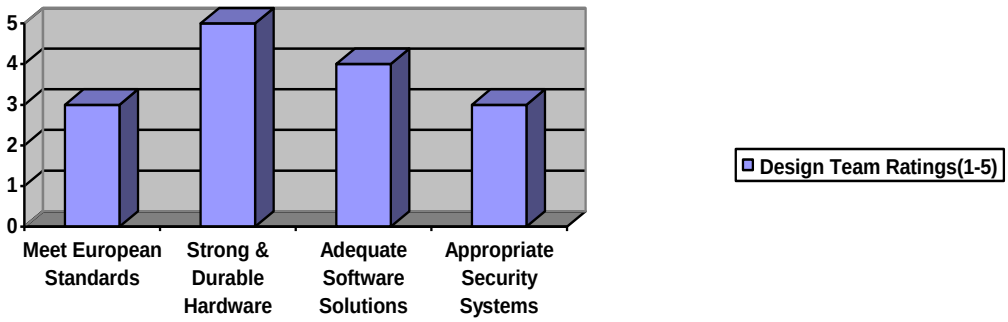


D. Customer Specifications of Survey:

Shopping Mall Customer Point of view:



E. Engineers' Opinion of Survey:



Product Characteristics and Quality:

Usability:
1. Easy to use
2. Reliability
3. Durability
4. Easy toadjust water heat

Performance:
1. Perceiving hand moves quickly
2. Safe of over-heat
3. Hygiene
4. Water Conservation

Customer Importance Ratings:

On a scale from 1 - 5, customers then rate the importance of each requirement. This number will be used later in the relationship matrix. The ratings are below:

Usability:	**Rating**
5. Easy to use	4
6. Reliability	2
7. Durability	3
8. Easy to adjust water heat	4

Performance:	**Rating**
5. Perceiving hand moves quickly	4
6. Safe of over-heat	4
7. Hygiene	3
8. Water Conservation	2

Technical Properties:

Performance Measures:
1. Meet European Standards
2. Sensitivity of sensor
3. No over-heat problems

Technical Details:

1. PIR Sensor
2. Control of electronic motor
3. Display of LEDs

Direction of Improvement:

Performance Measures:	**Direction of Improvement:**
1) Meet European Standards	↑
2) Sensitivity of sensor	↑
3) No over-heat problems	↑
Technical Details:	
1. PIR Sensor	↓
2. Control of electronic motor	↓
3. Display of LEDs	↑

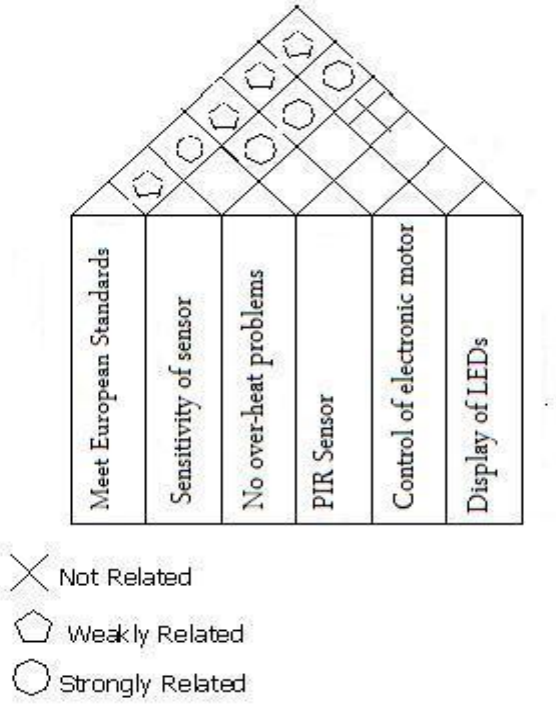
Organizational Difficulties

Performance Measures:	**Organizational Difficulty:**
1. Meet European Standards	3
2. Sensitivity	4
3. No over-heat Problems	3
Technical Details:	
1. PIR Sensor	4
2. Control of electronic motor	4
3. Display of LEDs	4

Absolute Importance and Relative Importance Percentages:

Performance Measures:	**Absolute Importance:**	**Relative Importance:**
1. Meet European Standards	80	20%
2. Sensitivity of sensor	88	21%
3. No over-heat problems	36	25%
Technical Details:		
1. PIR Sensor	60	13%
2. Control of electronic motor	36	11%
3. Display of LEDs	36	10%

Roof (House of Quality):



QFD

DIRECTION OF IMPROVEMENT											
HOWS / WHATS			Customer Importance	Performance Measures: Meet European Standard	Performance Measures: Sensitivity of sensor	Performance Measures: No over heat problems	Size of Range: No. of models	Technical Details: PIR Sensor	Technical Details: Control of electric motor	Technical Details: Display of LEDs	Customer Rating: Smart Faucet □ / Other Faucet Companies △ (1 2 3 4 5)
Smart Faucet	Usability	Easy to use	4		●			○			
		Reliability	2				△				
		Durability	3								
		Easy to adjust water heat	4		○						
	Performance	Perceiving hand moves quickly	4		●			●	●	●	
		Safe of over-heat	4	●		●					
		Hygiene	3	●							
		Water conservation	2	○				○			
		Organization Difficulty (5=Difficult, 1=Easy)		3	4	3	5	4	4	4	
Engineering Assessment	Our Company □ / Other Faucet Companies △		5 / 4 / 3 / 2 / 1								
ABSOLUTE IMPORTANCE				80	88	36	2	60	36	36	
RELATIVE IMPORTANCE				16	18,4	9	2	7,8	3,9	3,6	

● Strong – 9
○ Medium – 4
△ Weak – 1

Conclusion

We prepared our QFD chart to get a better understanding in customer needs, expectations and wills. To get the information from our target customers we made a survey including very large range of participants. And it turns out that the sensitivity of the product, which is sensitivity of the sensor for hand moves to change water heat in our product, is the most important thing to be considered. Meeting European standards and providing water conservation is important too however is not considered the most important.
As a result the most important thing in our product is the software design and electronic hardware which will provide us to make the sensitivity of the sensor better.

APPENDIX
[1]: The survey to search target customer's opinions about electronic faucets and our potential product, smart faucet is done among people from almost avery age and education range. The survey is done in Bilkent University among the workers of BİLTEM, in Real and in Cepa. Here are the datas about our survey:
It's done among 154 people.

Age Interval of Participants of Survey:
Age 16-20: %15
Age 25-30: %20
Age 30-35: %35
Age 35-40: %20
Age 40-45:% 10

Level of Education of Participants of Survey:
Below high school :%10
High school:%40
Undergrad. :%43
Master-Phd: %5
Above Phd: %2

Personal Income of Participants of Survey:

Below 600YTL: %5
600-1000 YTL: %20
1000-2000 YTL: %45
2000-4000 YTL: % 23
Above 4000 YTL: %7

References

1) http://en.wikipedia.org/wiki/Automatic_faucet

2) http://www.autotaps.com/benefits-of-electronic-taps.html

3) http://www.tekzen.com.tr/newsite/prd-657815001-rainy_fotoselli_batarya.aspx

4) http://altinkaya.com.tr/El_Tipi_Kutular/HH-004.html

5) **PIC 16F628A:** http://ww1.microchip.com/downloads/en/DeviceDoc/40044G.pdf
8-bit CMOS Microcontroller

6) **LM 7805:** http://www.datasheetcatalog.org/datasheet/fairchild/LM7805.pdf
5V Voltage Regulator

7) **Bühler DC Electric Motor with Reducer (1.61.065.408)**:
http://www.mugul.com/buhler/DC-gear-motor-1_61_065_en.pdf

8) **LEDs**
http://i.ytimg.com/vi/LqnXRdc4KFs/0.jpg