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Advance Railway Control System

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Abstract

Nowadays railway transport is a very popular way of travelling in Bangladesh and the number of train travelers is increasing day by day. So we need to make railway travelling more efficient, comfortable & safe. In Bangladesh the railway controls are not still totally digitalized. Due to some natural human errors train accidents have become very common. Most of the unwanted events occur due to the lack of precise control of train engine, tracks & traffic gates/rail crossings. Accidents can be reduced if we start using automatic control systems such as, smart train engine, railway track control. This can be further extended to meet the demands according to situation like GPS monitoring. With the help of advance railway control system, railway transport can be attracted to the people & also beneficial to the national sector.

Keywords: Railway, Engine, Track, Gate, Automatic.

1. Introduction

In Bangladesh railway & trains are controlled by human hands. Due to some natural human errors train accidents have become very common. Most of the unwanted events occur due to lack of precise controlling of train engine, railway tracks & traffic gates on the rail crossings. Such accidents can be prevented towards a minimum number if we start using automatic control systems. Such as, train engine control at the stations, railway track control when to change track of the train, rail-crossing gate control etc. can be very helpful to ensure safety & also make train travel more organized.

2. Objectives

The main objectives of this work are
- Controlling train engine at emergency when the driver is unaware of it.
- Changing rail-tracks more easily where there are more than two/three train roots.
- Closing the safety gate automatically at rail-road crossing.
- Prevent possible accidents due to human errors.

3. Smart train engine

The project involves intelligent train speed control. The idea is whenever any engine observes a red signal on its track it will start decreasing its speed gradually and stops automatically at some distance from the signal pole. After then when it gets green signal the train will start automatically or manually started by the driver & go on. In the mean time when train has not stopped yet and a red signal becomes green then it crosses the signal pole with low speed and then driver can slowly increase the speed. Speed can also be controlled digitally.
The whole idea based on Pulse Width Modulation Technique. So now before the driver observes the red signal the engine itself observes it and automatically starts decreasing speed and then stops. The driver can feel relax in driving because he doesn't have to take care about red signal. Even if he forgets to take any action on red signal then also we can avoid accidents by the implementation of this idea. Also this technique can be used at the destination stations to stop the train automatically.

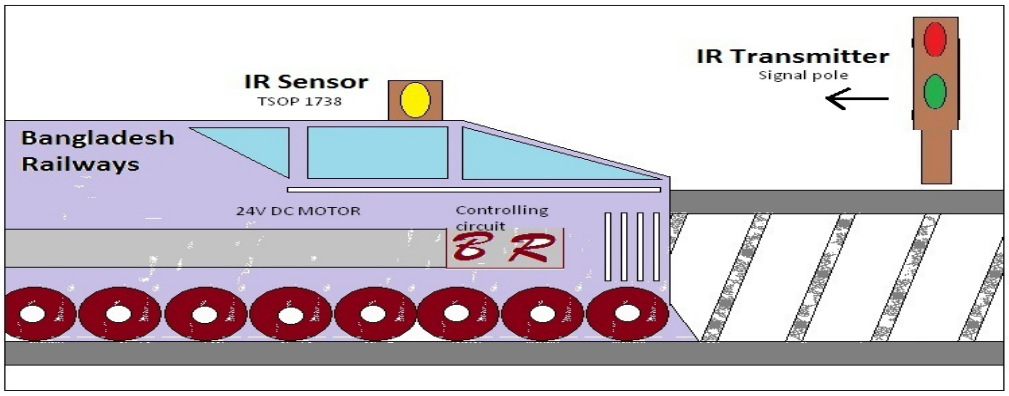

Fig. 1. Smart train engine control

Design & working procedure

What we have to do is to attach a RF transmitter with signal pole which will start transmitting signals only when the red light is on. If the green light is on then there will be no transmission. The engine has a receiver which catches these transmitted signals and takes desired actions. Both the transmitter and receiver are RF type with minimum range of 2 Km. so that train can get enough time to decrease its speed and stop before the signal pole with minimum swapping distance of 100-200 meters.

Bangladesh railways use 480V DC Diesel-electric motors to run train engines. We have successfully controlled a 24V DC motor & the same procedure can be designed to control a 480V DC motor. The train engine motor speed can easily be varied by varying applied voltage. The 230 VAC is stepped-down to 24 VAC by 12-0-12, 2 Ampere step down transformer. Movable tapping are taken from this line and fed to the internal circuit of engine and give continuous supply to circuit. The RF sensor is placed at the top of the engine, senses the signals transmitted by RF transmitter attached to signal pole. The transmitter has to be placed about 20 ft. high signal pole on a straight line track.

Sensor will detect the RF signal and gives the interrupt to Atmega32. Atmega32 will indicate the interrupt event on first (green) LED and energizes only one particular relay through ULN chip. When red light is on, microcontroller gets signal and the speed of the motor decreases because of less voltage. And after some time it finally stops. The time required is 10 second to stop the train. Now at the time the sensor becomes green the speed of the train increases gradually. The direction and speed of the train can also be controlled digitally. Now if the signal is green then train will cross the pole with same speed, but if signal becomes red in between then RF sensor will detect and interrupts the Atmega32.

Now Atmega32 will wait for some time (2 to 3 sec) and train goes on with same speed. Again if still red signal is on, Atmega32 will be interrupted and this time it will switch the operating voltage of the motor to a lower value and after 10 seconds the voltage will be zero. So now when red signal becomes green driver can reset the controller or the engine will reset automatically in 2 minutes.

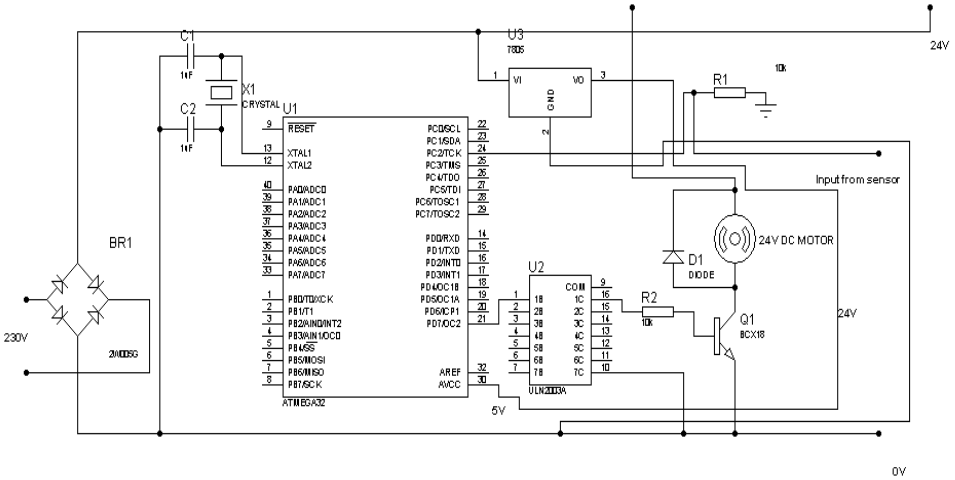

Fig. 2. Circuit diagram of smart train engine control

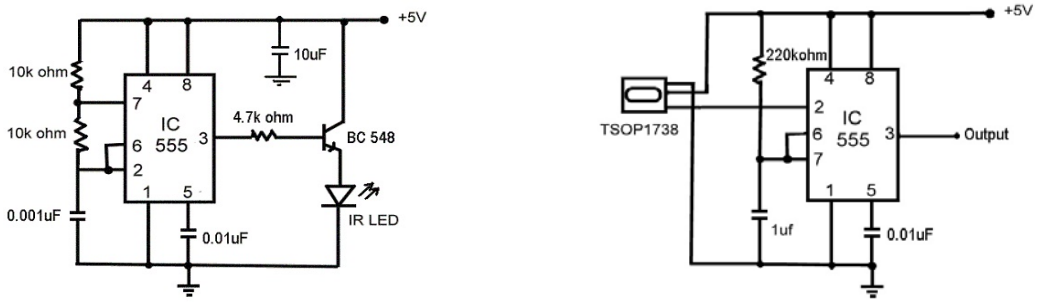

Fig. 3. RF transmitter & receiver.

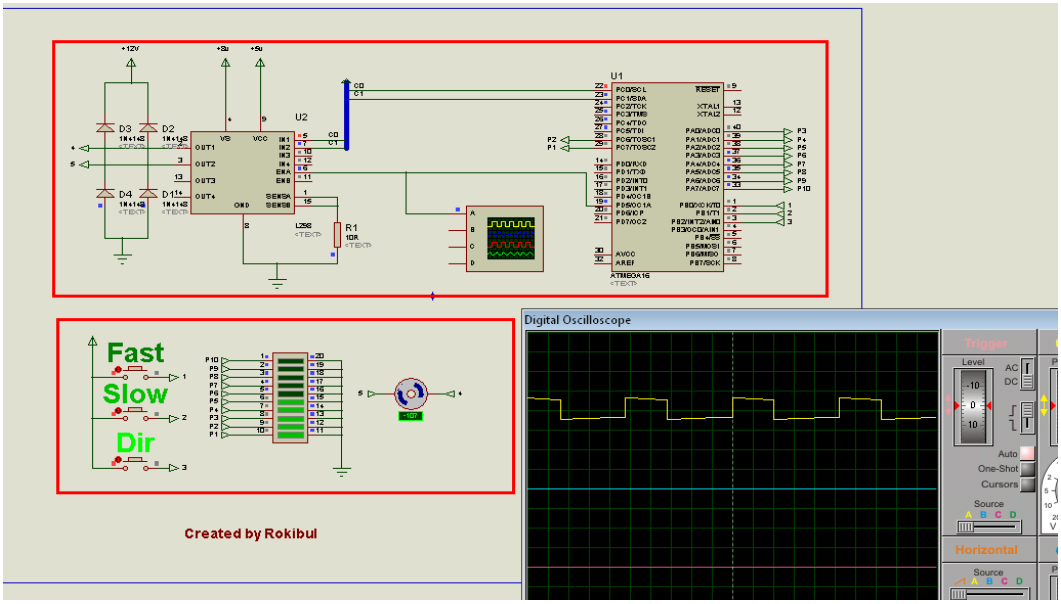

Fig. 4. ISIS simulation

4. Automatic railway gate & track control

Aim of this project is to control the unmanned rail gate automatically using embedded platform. Today we see in news papers very often about the railway accidents happening at un- attended railway gates. Present project is designed to avoid such accidents if implemented in spirit. This project is developed in order to help the railways in making its present working system a better one, by eliminating some of the loopholes existing in it. Based on the responses and reports obtained as a result of the significant development in the working system of railways.
This project can be further extended to meet the demands according to situation.
This can be further implemented to have control room to regulate the working of the railway system. Thus becomes the user friendliness. Using the same principle as that for gate control, we have developed a concept of automatic track switching. Considering a situation where in an express train and a local train are traveling in opposite directions on the same track; the express train is allowed to travel on the same track and the local train has to switch on to the other track. Indicator lights have been provided to avoid collisions.

Design & working procedure

We have used AT89c51 Microcontroller Integrated Chip in this project. The program for this project is embedded in this Microcontroller Integrated Chip and interfaced to all the peripherals. Stepper motors are used for the purpose of gate control interfaced with current drivers chip ULN2003 which is a 16 pin IC. When foreside sensor gets activated, interrupt is sent to the microcontroller the microcontroller then instructs the gate motor to be turned on in clockwise direction and the gate is closed, the motor is stopped by limiting switch and stays closed until the train crosses.
When the foreside sensor is interrupted the same time the buzzer and traffic signal for the road users seton. After the train passes through the gate and reaches aft side sensors. The aft side sensor gets activated and sends signal to microcontroller which indicates the motor to turn in anti-clockwise direction and gate opens and motor stops.

After the aft-side sensor is activated the microcontroller stops the buzzer and turns the traffic signal light to green. Using the same principle as that for gate control, we have developed a concept of automatic track switching. Considering a situation where in an express train and a local train are traveling in opposite directions on the same track; the express train is allowed to travel on the same track and the local train has to switch on to the other track. Indicator lights have been provided to avoid collisions. Here the switching operation is performed using stepper motor. In practical purposes this can be achieved using electromagnets. Two sensors are placed at the either sides of the junction where the track switches.

If there's a train approaching from the other side, then another sensor placed along that direction gets activated and will send an interrupt to the controller. The interrupt service routine switches the track. Signal light for train 2 is turned red. Here the switching operation is performed using a Stepper motor. After the Train passes on to the switched track the Train is detected by a sensor on the switched track. The stepper motor rotates in anti-clockwise direction and the track switches back to normal and the train signal turns green.

Thus the train passes on the other track. Sensors are fixed at 1km on both sides of the gate. We call the sensor along the train direction as 'foreside sensor' and the other as 'aft side sensor'. When foreside receiver gets activated, the gate motor is turned on in one direction and the gate is closed and stays closed until the train crosses the gate and reaches aft side sensors. When aft side receiver gets activated motor turns in opposite direction and gate opens and motor stops. Buzzer will immediately sound at the fore side receiver activation and gate will close after 5 seconds, so giving time to drivers to clear gate area in order to avoid trapping between the gates and stop sound after the train has crossed.

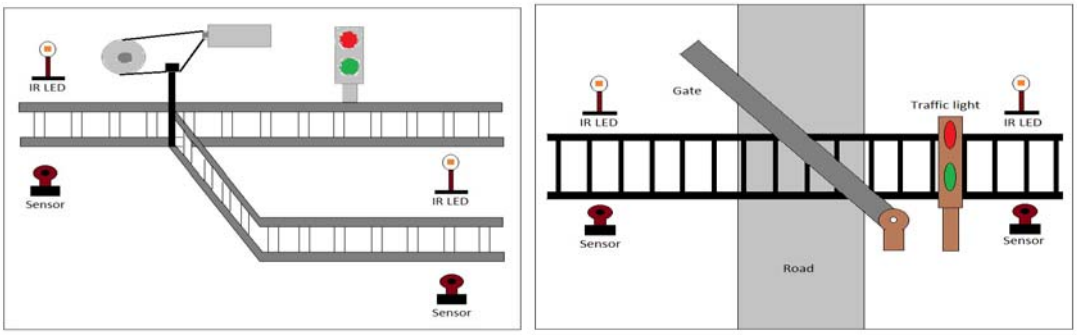

Fig. 5. Automatic railway gate & track control

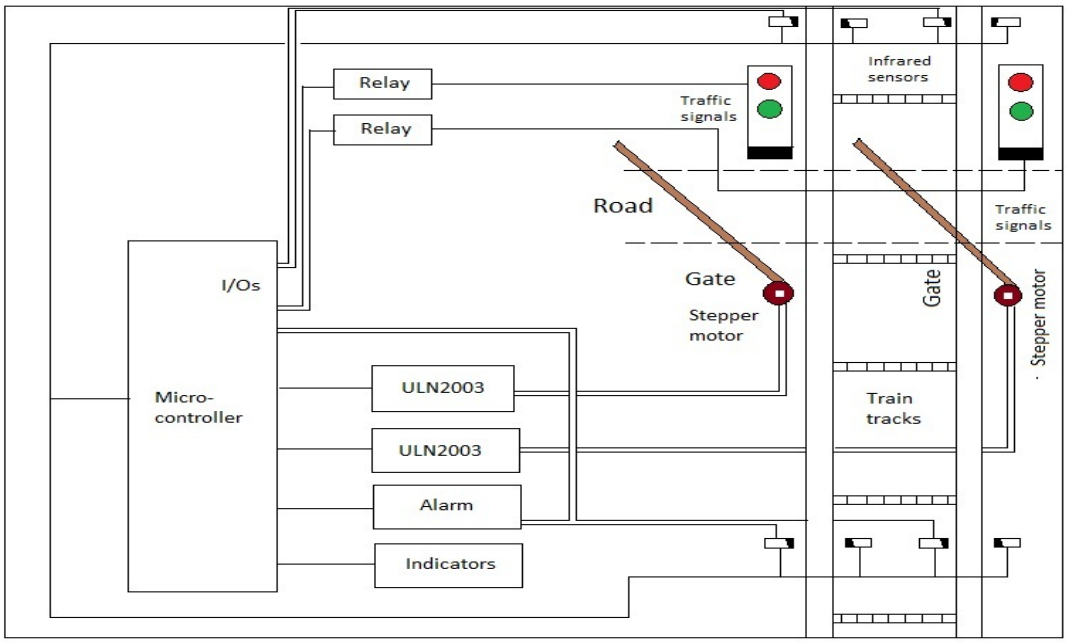

Fig. 6. Circuit diagram of automatic railway gate & track control

Algorithm

STEP 1 : Start.
STEP 2 : Set the variables.
STEP 3 : Make initial settings of the signals for the train and road users.
STEP 4 : Check for the arrival of the train in either direction by the sensors. If the train is sensed go to step 5 otherwise go to step 4.
STEP 5 : Make the warning signal for the road users and set the signal for the train.
STEP 6 : Check for the presence of the obstacle using sensors. If there is no Obstacle goes to step7 otherwise repeat step6.
STEP 7 : Close the gate and stop the buzzer warning.
STEP 8 : Change the signal for the train.
STEP 9 : Check for the train departure by the sensors, if the train sensed to next STEP. Otherwise repeat STEP 9
STEP 10: Open the gate.
STEP 11: Go to STEP 3
STEP 12: Stop

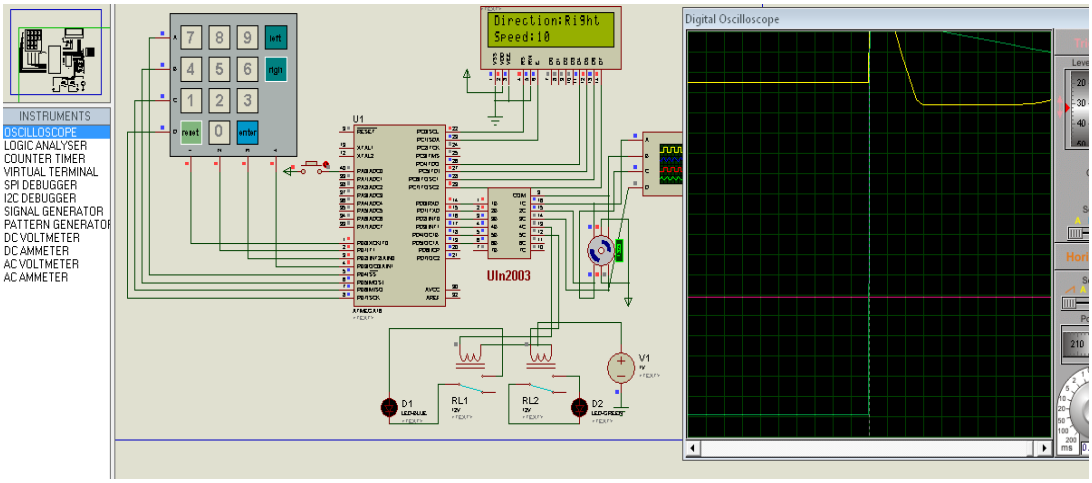

Fig. 6. ISIS simulation.

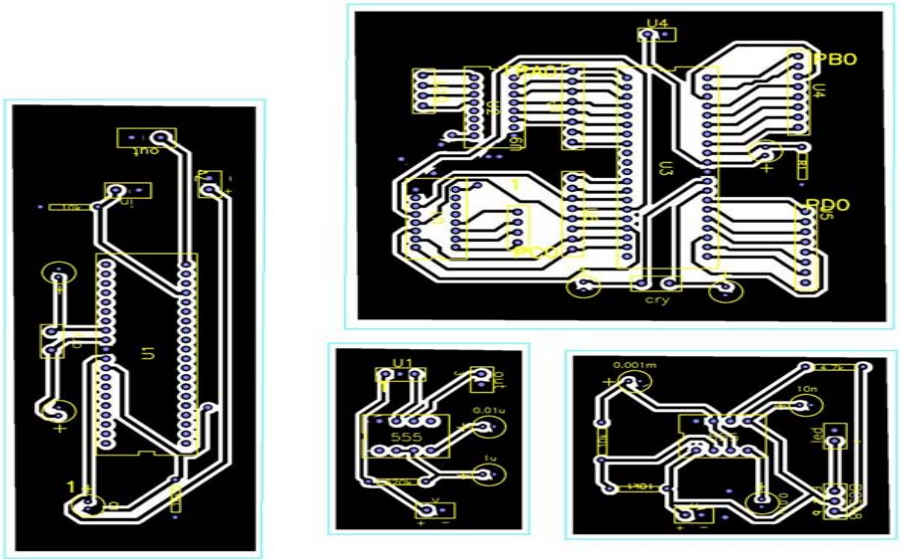

Fig. 7. PCB of the circuit.

5. Conclusions

From the above discussion and information of this system we, up to now surely comes to know that it is highly reliable, effective and economical at dense traffic area, sub urban area and the route where frequency of trains is more. As it saves some auxiliary structure as well as the expenditure on attendant it is more economical at above mentioned places than traditional railway crossing gate system. It also provide human work reduction, better efficiency, no operation time lag & manageable from remote place.
The mechanism works on a simple principle and there is not much of complexity needed in the circuit. We know that though it is very beneficial but it is also impossible to install such system at each and every places, but it gives certainly a considerable benefit to us, thereby to our nation.

6. Future work

In our technique though it has many merits, but still the power supply of 223V AC power is required for functioning of the motor. It can be avoided with the help of a battery charged by a Solar Cell. Since solar energy is an inexhaustible natural source of energy. Instead of using IR sensor, weight sensor can be used for better accuracy. Also with the help of GPS technology & computerized system simultaneously on line monitoring of railway system can be possible.

7. Acknowledgement

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Automation of belt conveyor for carrying products

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Abstract

Belt conveyors are highly used in various industries for continuous path movement in carrying products. Sometimes it is seen that time interval of keeping products on the belt conveyor is greater than the time required for half revolution of conveyor (i.e. cycle time). Again in some cases, time interval between two products keeping on conveyor is not same. Consequently, unwanted cost arises. This increases the production cost. For overcoming this constraint conveyor can be switched on when product(s) is on the conveyor; otherwise the belt is switched off, when there is no product. In this project conveyor belt has been made automated. Belt only switches on when there is product(s) on the belt. This is how it minimizes idle movement of conveyor. So this automated belt conveyor is productive and cost efficient. Finally this paper addresses the complete automation of belt conveyor by reducing its operating cost and time.

Keywords: 3-5 conveyor belt, material handling,automatic, control unit.

1. Introduction

A conveyor system is a common piece of mechanical handling equipment that moves materials from one location to another. Conveyors are especially useful in applications involving the transportation of heavy or bulky materials. Conveyor systems allow quick and efficient transportation for a wide variety of materials, which make them very popular in the material handling and packaging industries. Belt conveyor is most common in this case. Generally, belt conveyors have continuous motion in carrying products. The motor is always on whether there is product on the belt or not. This paper describes an automated belt conveyor that only run while the product is on the belt and it is off or is motionless while there is no product on the belt. This job is actually done by using microcontroller and other objects as IR sensor, relay, with a basic belt conveyor.

2. Construction

A conveyor belt (or belt conveyor) consists of two or more pulleys, with a continuous loop of material - the conveyor belt - that rotates about them. One or both of the pulleys are powered, moving the belt and the material on the belt forward. The powered pulley is called the drive pulley while the unpowered pulley is called the idler[1].

2.1 Construction of current conveyor belt

The following figure (Fig. 2) shows the current conveyor belt.

1. Powered pulley: Conveyor pulleys consist of cylindrical devices that move the belt along its designated route.Powered pulley is powered with motor. While it is operating, the pulley adds pressure to the belt, which causes friction and produces a pull. Spiral or wing pulleys are designed to pull conveyor belt or tracks and are generally used for industrial conveyors. [2]
2. Idler: It is also a pulley but not powered. It just guides the belt for its destination. This provides adequate tension force and as low friction coefficient as possible. It can be adjustable for various values of tension force. A belt conveyor can have one or more or no idler.
3. Conveyor belt: Conveyor belts are typically made out of rubber or silicone, depending on the type of product being moved. Lumber plants generally use belts composed of wire mesh. Conveyor belts are also made to withstand extreme temperatures. Most belts are less than 1 inch thick, so the movement is smooth with other conveyor components. The two pulleys need to rotate simultaneously to help the belt along its designated route [2]. But for the purpose of this project we use motor cycle tube as belt.

4. Guide: It is used for guiding the products so that products don't fall from the belt. But this is not required for most of conveyor belt. As we use the motor attached with powered pulley directly, there is a large amount of vibrations. Again the belt is less wide. Do we have used guide.

Fig. 2. Current conveyor belt showing its various parts

5. Motor: Motor is one of the most important parts of conveyor. It is used to provide power to the powered pulley. This motor should be so powerful that it can supply power so that will rotates conveyor belt with products on it exceeding friction force. In this project we have used a AC 0.25Hp motor.
6. Power supply: To drive motor there is required a power source. It may beelectric(AC or DC), hydraulic, pneumatic etc. AC power has been used in this project.
7. Basement: A wood made basement has been used in this project. This is portable but in practice basement is fixed with the floor.

2.2 Construction of developed conveyor belt

To make the current conveyor belt automatic we have used a control unit(CU), in addition. CU consists of the following units

1. IR(infrared ray) producer
   It consist of

   a.Frequency producer for creating IR
   b.IR LED

2 IR receiver
   It consists of
   a. IR receiver circuit
   b. IR sensor
   c. Microcontroller
   d. Relay

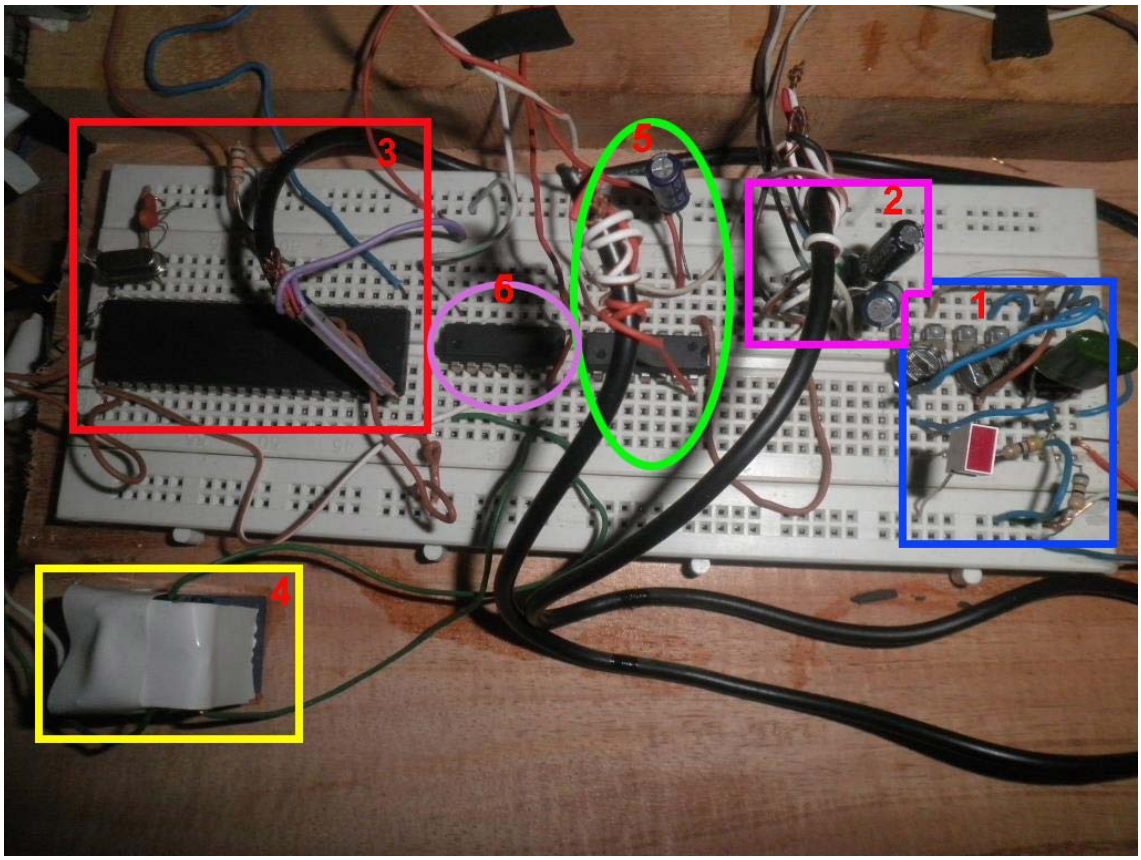

Fig. 2.2. CU(control Unit) of Automatic conveyor belt

3. Working Principle

To illustrate the working principle of automation function of the internal part is described below

3.1 IR producer

a. Frequency producer: It is circuit which can produce frequency of different values. To create IR it is necessary to make frequency 400000-1400000 m/sec [3]. Varying the variable resistor this frequency is achieved.

b. IR LED: Frequency produced from frequency producer is transmitted to IR LED. And it creates IRR(Infra-Red Ray). It can be seen using low resolution camera.

3.2 IR receiver

a. IR sensor: This is a readymade device that can sense the interruption of IRR on it. Fig. 3.2 shows IR sensor.When there is falling of product(s) on the belt, it makes an interruption of IRR on the IR sensor. So from sensing interruption IR sensor makes a pulse (short time 0 signal).

b. IR receiver circuit: This help to show the output(2.5-5 V) found from IR sensor. But this output is weak. To make it strong an inverter (inverter 4) has been used.

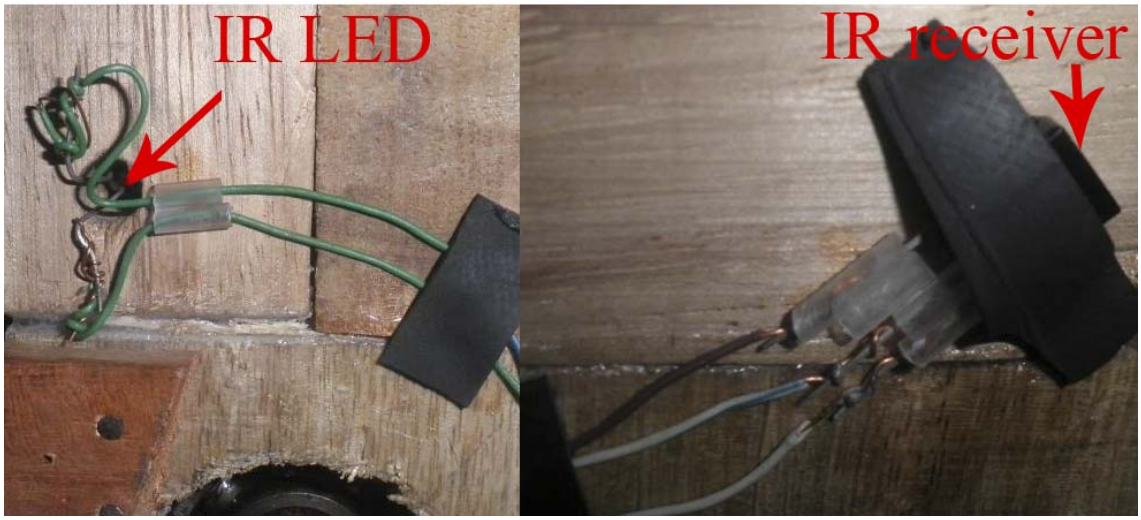

Fig. 3.2. IR LED & Receiver

3.3 Microcontroller

This is the heart of CU. It gets a pulse from IR receiver and gives an output (5V weak) for timedurationsuch that a product can be transmitted to its destination. I this project we consider cycle time 1.3 sec with some allowances. So again to make this output an inverter(inverter 5) has been used. But output comes as 0 i.e. ground, so to make it positive another inverter is used.

3.4 Relay (6V)

Relay(6V) is one kind of switch that becomes on when it gets around 5 volt input. So getting output from relay it makes the switch on and motor starts. When the products reach to their destination relay gets 0 (zero) signal and motor become stop. The developed automatic conveyor belt is shown in Fig. 3.4.

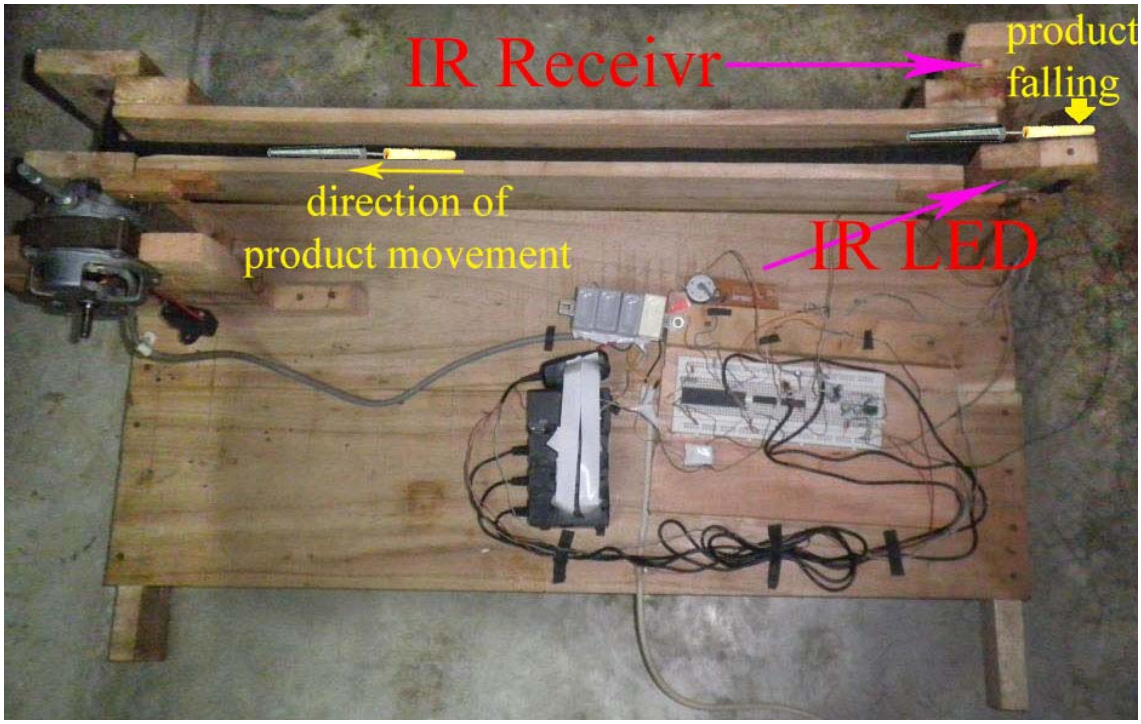

Fig. 3.4 . Automated conveyor belt

So when there is falling product on the belt, relay becomes on and stays for 1.3 sec. If another products fall within the time 1.3 sec, it remains on for more 1.3 sec from the time of last product falling. This process continues for infinite of time.

4. Result

After all an automated belt conveyor has been made that carry products whenever it falls on belt. After reaching the products to its destination, the belt become stop automatically. The belt become stop on the basis of time it requires to reach its destination.

5. Discussion

This automated conveyor belt can be used widely in various industries small or large. The cost of CU is not high rather low and it is around 1500 TK. The same CU can be used for very large conveyor belt without any problem. This conveyor can only be used if theproduct falling takeslarger than cycle time to fall. It can be used and will be efficient if products don't fall continuously within the cycle time.

There are some other limitations in this conveyor. First, if the products are a) transparent b) very thick c) falling speed is very high having small thickness or d) fallen like flow, IR sensor will not work. Consequently belt will remain stop. Second, if products fall on the be belt on other position than the position of IR sensor, belt will not stat. Third, when product(s) get hampered on its way and stop or proceed with a low motion IR sensor cannot sense it; so belt will stop keeping products on it.

However, the limitations mentioned above are not found in most case. So in this case this automatic belt conveyor can be used easily.

6. Conclusion

Making automatic belt conveyor is accomplished successfully. But in the figure it is seen that circuits have been kept on circuit testing board not on the circuit board. It is done for facing problem when plotting circuit on the circuit board.

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Program for Control and Operation of PUMA Robot by 'C' and Microcontroller

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Abstract

Operation of robots is simply a combination of feedback controls. PUMA robot can be used in loading and unloading operations of industrial process. In this study, this robot is utilized, operated, and controlled with a 'C' program loaded in microcontroller, which is very cost effective and easy to operate. Furthermore, a microcontroller AVR Atmel8 is utilized under the scope of the study. The motion of three motors is controlled properly where time variation is considered flexible. The power supply of microcontroller is rated 220V as well as 6V motor relay is used successfully. This study covers the entire work for operation and control of loading and unloading robot with program incorporated with microcontroller and specific operation and delay time. The outcome of this research work will be a real beneficial to operate robots in many applications such as loading, unloading, and transferring of loads in the industries which will be efficient and cost-effective.

Keywords:PUMA, microcontroller, feedback, control.

** previously worked as a lecturer*

1. Introduction

Robot is widely used in industries of modern world. The word 'robot' was first used in 1921 in a drama named Rossum's Universal Robot [1]. The drama was written by Czech playwright Karel Capek. It is originated from the Czech word "robata" which means 'forced laborer'. The robot in this play is similar to C3-P0 in the 1977 film namely "Star Wars."

In 1921 the word "robot" was first used, but the field of robot "robotics' was introduced in 1942 by Issac Asimov in his story [2]. He presented the three rules of robotics. His "Three rules of Robotics":

- A robot may not injure a human being or though inaction allows one to come to harm.
- A robot must obey the orders given it by human beings except where such orders would conflict with the first law.
- A robot must protect its own existence as long as such protection does not conflict with the first law.

2. Objectives of the study

The main objectives of the study are set as follows:

I. To develop program for PUMA robot with C.
II. To run program for PUMA with microcontroller.
III. To operate and test PUMA with developed program

3. Scope of the study

The application of robot in Bangladesh is being continuously growing very slowly for different situation as the labor cost is very low relatively to other places. But, in many industries where chemical processes are operated by some under-aged children and are appointed illegally in dangerous environment, robots can be utilized in those harmful situations due to exposures to high chemical reactions, high temperature, and pressure. When heavy load has to be operated in loading, unloading or transferring, robots can play very helpful role. Moreover, when high precision is critical in terms of large scale production, then it is profitable to use the robot in an efficient and effective manner.

The industrialists of Bangladesh will be able to join with multinational companies World-wide if robots become available in our emerging and promising industries. Assembling and other steps of work can be done in our country which will earn a great amount of foreign currency and open the doors for eligible market segment in the job arena.

In this study, the control and operation of robot is handled with a microcontroller although the control of robot can be done in many ways. Keeping the cost of controlling a robot low, the project highlights the major components of experimental set of such conditions. So, when a robot will be available in Bangladesh, control of them can be done with microcontroller.

4. Literature review

The literature review section is divided into the following sub sections.

PUMA robot

The PUMA robot (Programmable Universal Machine for Assembly or Programmable Universal Manipulation Arm) is very famous in industries. They are versatile, easy to operate, and program and seemingly last forever.

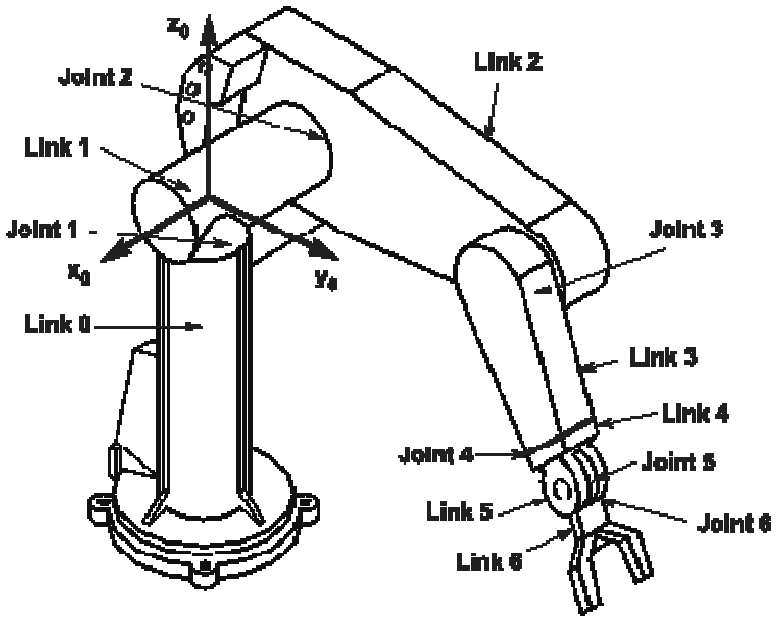

Fig.1. The schematics of PUMA robot

Microcontroller

A microcontroller is a computer -on-chip used to control electronic device. A typical microcontroller contains all the memory and interfaces needed for a simple application, whereas, a general purpose microprocessor requires additional chips to provide these functions. A microcontroller has following key features:

Central Processing Unit –usually small and simple –

- Output and input interface such as serial ports
- RAM for data storage
- Peripherals such as timers and watchdog circuits
- ROM for program storage
- Clock generator- an oscillator for a quartz timing crystal, resonator or RC circuit

Features of AVR microcontroller

The main features of AVR microcontroller are as follows:

- Less expensive.
- Operating voltage 2.7 to 5.5 v.
- 16 programmable I/O lines.
- Speed grades 8 MHz.
- 8k bytes In- System Self programmable Flash program memory
- 512 bytes EEPROM
- Fully static operation
- 32x8 general purpose resistors

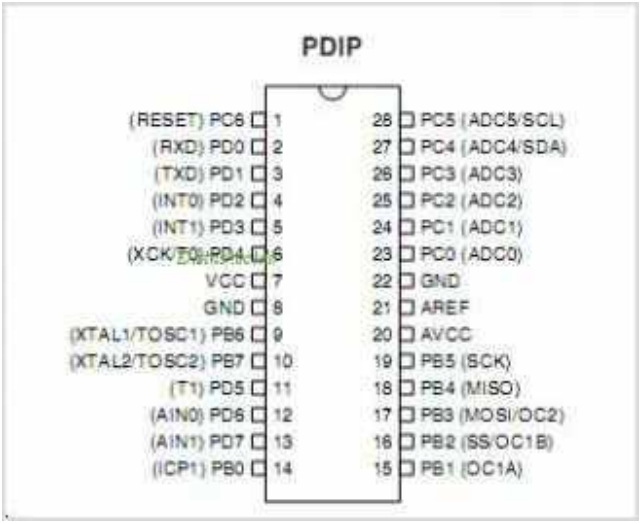

Fig.2. Pin configuration of ATmega8L

Servomotor

A servomotor is an electromechanical device in which an electrical input determines the position of the armature of a motor. Servomotors are DC motor equipped with a servo mechanism for precise control of angular position. The RC motor has rotation 90 degree to 180 degree, often 360 degree or more. A servo motor is an assembly of DC motor, a gear reduction unit, potentiometer and control circuit [3]. The servos are used precision positioning. They are used in robotic arms, legs, sensor scanners, RC toys like helicopter and cars.

5. Experimental setup

The main experimental set up is briefly described in the following subsections.

Necessary equipments

For a single PCB construction, the following components are required as shown in Table 1.

Table 1. List of components used in printed circuit board

Components	Ratings	Quantity
PCB	16x16cm	1
ATmega8L		1
IC	7805,7806	Each one piece
Crystal	8MHz	1
Capacitor	22pf,27pf,10uf,1000uf,1uf	Each one piece
LED	Green, Red	7
Transformer	12-0-12V,1amp	1
Transistor	BC547	6
Diode	1N4007	8
ON/OFF switch		3
Push switch		2
Resistor	4.7k,1k,10k	6,10,2
IC Base	14pin	2
Plastic Connector		16
Soldering Wire		1yrd
AC Cord		1
Connecting wire		1yrd

PCB

The schamtics of the PCB components are shown in Figure 3.

Fig.3. PCB attached on a wood board

6. Performance testing

Performance analysis

For performance testing first of all the base motor is placed with gear. Then PCB is connected with the motors of robotic arm and power supply (6V DC) is given through the DC power supply. Then, the base motor along with the first and second joint motor rotate sequentially .The motors stop working for three seconds. The motors work for three different time duration.

Cost analysis

The cost required for controlling the robotic arm by microcontroller is cheap than PLC control. Total cost breakdown is shown in Table 2.

Table 2. List of cost required to make the breadboard and PCB

Component	Unit price (Tk)	Quantity	Total price(Tk)
Printed Circuit Board	120	1	120
Breadboard	220	3	660
IC	12	10	120
Transistor	5	12	60
Transformer	250	1	250
Capacitor	5	10	50
Resistor	1	20	20
Microcontroller	130	2	260
Wire	50	5yrd	250
Switch	10	5	50
AC cord	70	1	70
PCB layout			500
Diode	6	15	90
Total Amount (BDT)			2500

7. Results

Microcontrollers are cores that will do anything once programmed them to do properly. They probably can be used in many applications, but with varying effectiveness. As always, one's work is in discerning which option will work best in a given situation. After completing the setup, the robot is tested and the program worked rightly the way it was expected. So, the motors ran according to the program installed in the microcontroller. This indicates that the test is conducted successfully.

8. Discussions

The construction of the PUMA robot has been conducted earlier. Only the control and operation is done in this project with microcontroller. While choosing the microcontroller the power required for running the controller itself and running the motor of robot are very crucial. Firstly, 8051 microcontroller was selected in this project. However, it did not meet all the criteria necessary to run a 24volt 21watt DC motor. So, microcontroller of AVR family has been chosen for this test. It meets all requirements and also it is cheap and easily programmable.

Programming could be done in both assembly language and C for a microcontroller. C is preferred here because of the availability of C compiler and the ease of the programmer.

While doing the wiring, a total of six relays are used. Although the program became complex, the program could be made is relatively easier when twelve relays are used.

Controlling of end-effectors is a difficult job as well as accurate positioning. Time is controlled from outside with the help of variable resistor. Often the hand strikes the base motor. However, this problem was overcome with the help of resistors.

9. Concluding remarks

The entire project consists of different steps of tasks as discussed above. To complete the project in a successful manner was a challenge. At first, program was developed for operation of robot by microcontroller. Then, PCB was designed and connected with the robot and it was tested. Thus, all the objectives are accomplished. Finally, the robotic arm moved satisfactorily.

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Paper ID: ET-P08

Reducing the Wastage of Water by Efficient Water Faucet

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Abstract

Of all the water in the world, only 3% is fresh. Nearly 70% of that fresh water is frozen in the icecaps of Antarctica and Greenland; most of the remainder is present as soil moisture, or lies in deep underground aquifers as groundwater not accessible to human use in fact, less than one third of 1% of this fresh water is available for human use. Freshwater withdrawals have tripled over the last 50 years and about 1.4 billion people live without clean drinking water. On the other hand many of us use water thoughtlessly. The average person wastes up to 115 liters of water every day. About 4 liters of water is wasted in 20 sec by leaving the water running during hand washing just for scrubbing hands with soap, which is sufficient for a person to drink over two days. The efficient and improved water faucet designed over the traditional water faucet by integrating a soap dispenser in a water body to minimize the water wastage. Water flows from the one side and soap dispenses from the other side of the faucet. After watering hand when a user takes step to dispense soap, water flow is automatically stopped and thus keeping a check on unnecessary water wastage during scrubbing the hands with soap. This design facilitates to use soap and water individually in fact the user cannot use both soap and water at the same time. Eventually, this product saves water all the time while washing hand. Using mechanical energy, this faucet becomes more effective than other water saving faucet by its low cost, high efficiency and durability characteristic. The newly efficient designed of water faucet can be equipped in restaurant, public restroom and community center to reduce the wastage of water during washing hands. It can also be used everywhere instead of traditional faucet.

Keywords: Faucet, water waste, reducing water wastage, user.

1. Introduction

The use of water faucet is playing an important role in the daily life of people. With the gradual improvement of living standard, the design idea of faucet has changed to hygiene, practicality, convenience, water-saving, environment-friendly, healthy, user-friendly from simple function and complicated operation gradually. Now more and more water saving faucets are used in public places such as hotel, airport, recreational center, hospital, office as well as factory and private places like villa, high-grade residence etc. and always keep upgrading. Some of existing water saving faucet in the market is automated faucet. Some are timer faucet and some are sensor faucet. These faucets definitely help to conserve water but they do come with some unavoidable problem. First, they demand built in energy cost. Most automatic faucets operate on battery or A/C power and require sensors to work. This can be costly and inconvenient when the batteries run out and need to be replaced. Second, if you choose to use an automatic faucet in your home, you will more than likely need a professional plumber to install it for you. The installation process can be tricky. Not only does the automatic faucet require power in the form of electricity, and sensors, but it is installed differently than a traditional faucet. Third, these faucets are much more expensive than any other faucet and this is the main reason of less use of these faucets than expected. Also, the installation cost and energy cost of these faucets are greater than any other faucet. And usually the more stylish models are going to be the most expensive. Fourth, sometimes user need the water keep running to get enough water in the tub for washing. If the normal faucets are replaced by automatic once, user should have something staying under the automatic sense switch. It will bring a lot of troubles. Even if the

automatic sense switch can be changed for the regular once, it will cost more effort in daily life to switch from one to the other. Fifth, in timer faucet, if the turning down time is too short, the water might not enough for use and if the turning down time is too long the water might be wasted. Sixth, the automatic faucets are normally not as durable as the normal once. The valve in the faucets is the key. The automatic faucets are cost more, but if something wrong with the sensor, the switch will not be active as the good ones. The water will not be able to turn on and off in time. Thus a user may have to spend more effort and money in this regard. And finally, the worst thing is that a new study of automatic faucet shows they may be more hospitable to bacteria than the manually-operated faucets. On the other hand efficient water faucet is a manual water faucet with water saving features. So it comes without the problem of automated faucets.

2. Design analysis of efficient water faucet

Efficient water faucet is powered by mechanical components. So there is no use of electricity. The efficient water faucet is designed such a way that it becomes easy to manufacture, cheap in price, durable and convenient also.

Basic parts of efficient water faucet

Efficient water faucet consists of nine basic parts. Every part has its specific significance.

Cover

The cover is the fundamental part of the product. For the unique design of the cover the faucet becomes aesthetic and gorgeous. The cover of this product is made of stainless steel. It also protects the faucet's inner parts from direct corrosion of weather. It is also a support of lever and it carries the total load of faucet.

Handle

Handle is the major part of the efficient water faucet. It is the only part that has a relation with user. The user rotates handle to get water and liquid soap respectively from faucet and soap dispenser. It is an aesthetic part also. It is designed user friendly. There is no compromise with aesthetic and as it is convenience to use hopefully it will satisfy user. It is also designed as user can also use the handle with the dorsum of hand.

Gear

Gear is a vital part of this product. The gear is connected to the handle but it stays inner side of the cover. The force which is imposed on the gear is converted to pressure. In fact user rotates handle thus the gear rotates also with the same angle. And this gear is meshed with another pinion which is permanently attached to a lever. When user rotates handle, gear transmits this force to pinion which creates pressure in to check valve or soap dispenser through connecting rods.

Lever

The lever is the functional part of this product. The main function of this lever is to transmit the force of user into pressure and hold the connecting rod. It also converts rotating motion into linear motion. This part is like a common mild steel bar with 10mm thickness which bears the whole load of connection rods and gear.

Lock

Lock is a technical part of this product. Its main function is to lock the gear in any position so that the user can create a continuous pressure on the check valve with a single rotation of the handle. Thus it ensures the continuous flow of water. When user pushes the handle slightly to the backward direction, the gear meshes with the lock. Hence, it restrains the rotational motion of gear.

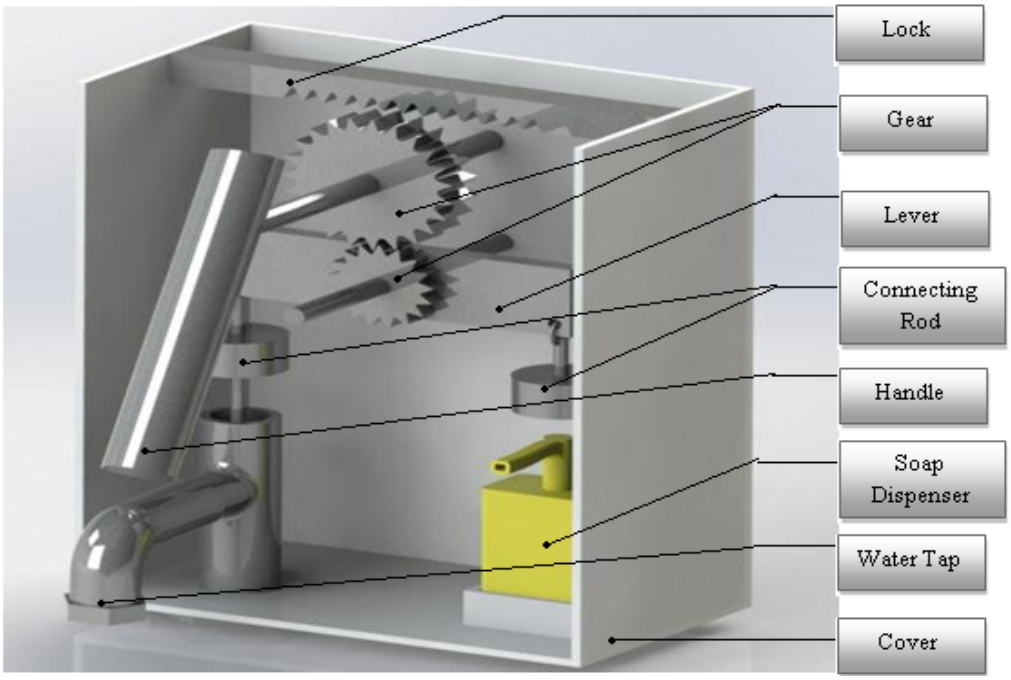

Fig 1. Efficient water faucet without front and top cover

Connecting rod

The connecting rod is multifunctional and multi-usable part of this product. Its main function is to create pressure on check valve and soap dispenser. Here there are two connecting rods. And these connecting rods are also used as the weight required for producing enough pressure to soap dispenser and check valve. It moves linearly when the user rotates the handle.

Check valve

The check valve is one of the most important parts of this product. Without this the whole mechanism will change. A check valve is a mechanical device, a valve, which normally allows fluid to flow through it only in one direction. The check valve is most available part in any hardware shop.

Soap dispenser

Soap dispenser is also a fundamental part of this product. Its main purpose is to dispense liquid soap. This built in soap dispenser feature makes efficient water faucet more convenience for washing hands.

Material selection of efficient water faucet

Material selection is important for the process of designing any physical object. In the context of product design, the main goal of material selection is to minimize cost while meeting product performance goals. Systematic selection of the best material for a given application begins with properties and costs of candidate materials. In efficient water faucet stainless steel is used in the body for both practical and aesthetic reasons. Stainless steel's resistance to corrosion and staining, low maintenance and familiar luster make it an ideal material for the body of efficient water faucet. For gear, lock, connecting rod and lever mild steel is used as it is cost efficient and easy to machining. And for the check valve brass is used as it is corrosion resistant and durable. Lastly plastic is used for soap dispenser as it is light in weight and cheaper than any other material.

3. Principle of mechanism

The efficient hand washer has been designed to dispense both water and liquid soap in two step lever mechanism. When the lever remains in neutral position there will be no dispensing of both water and liquid soap. In the 1ststep, when the user moves the handle, a rotational motion of gear is converted into linear motion of the lever and so a connecting rod pushes the check valve and thus the water is dispensed. And then user can lock the gear by pushing the handle slightly to the backward direction to get continuous flow of water. In the last step, after wetting hands with water, when the user unlock the gear and moves the handle to the opposite direction to dispense soap, another connecting rod pushes the soap dispenser and release pressure from the check valve. Hence water flow automatically stops and soap dispenses from the soap jar. After dispensing soap, it automatically returns to the neutral position.

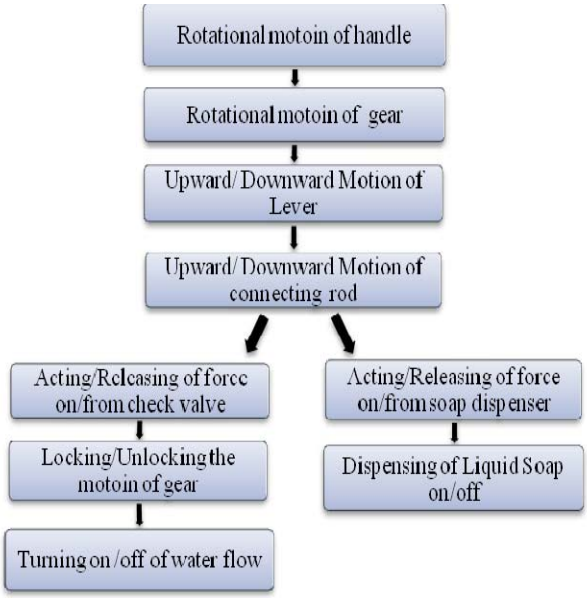

Fig 2. Flow chart of mechanism of efficient water faucet.

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4. Benefits of efficient water faucet

The efficient water faucet is different from the other traditional faucet. This faucet is highly effective in reducing water wastage during washing hands. This faucet is fully mechanical so it doesn't need any electrical energy. Thus the faucet is easy to repair and it is durable also. There is no chance to leak of water. The installation process of this faucet is very much easy. In fact anyone can install it. The efficient water faucet is also convenient and environmentally friendly. The user can turn on or off the water manually and the turning on and off system is very simple. So there is no chance of irritation for turning down time as too long turning down time waste water and too short turning down time might be unable to deliver sufficient water. Moreover if user rubs both hands with soap then they can use their dorsum or wrist of hand to turning on the water. And the most interesting thing is that it has built in soap dispenser feature. So the user doesn't need to buy additional soap dispenser. The efficient water faucet is actually very cost effective than any other water saving faucet. You can use this product not only for hand-washing purpose but also for other household or cleaning purposes.

5. Conclusion

Saving water should never become a public concern only in times of drought when water is undeniably scarce. The world water supply is finite. Every drop of water wasted is a drop less in a wild and scenic river, a drop less of a needed salmon run. Every drop of water that circles a drain unnecessarily wastes energy through the manufacturing of chemicals in the cycle of sewage treatment. It's high time to concern about to save water. Now water savings is possible by using technology in water faucet even when you wash your hands. Water faucets in various designs are hugely used now days in public washrooms, restaurant, and community center etc. Among these, little number of faucets uses technology to eliminate water wastage. This type of faucets is highly inspired as available fresh water is decreasing tremendously. People mainly waste water by faucet during washing hands. Efficient water faucet eliminates water wastage during washing hands which is cheaper and efficient than other water saving faucet. Through customer surveys, it is come to know that this product is highly acceptable by people who are concerned about water saving. No matter how efficient it is, it will definitely increase public consciousness about water saving which we badly need.

6. Acknowledgement

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Paper ID: ET-P10

A SOLUION TO THE POWER CRISIS USING THE COASTAL ZONE OF BANGLADESH

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Abstract

Bangladesh is a developing country but the power problem is not letting itself to develop fast. No country can develop itself with a lack of power. Bangladesh is blessed by the nature with wind and tidal power. They are used all over in the world in a wide range but in our country it is limited. They are cost efficient because of low maintenance cost. Bangladesh has a long coastal area with a 2-8 m tidal head rise and fall [2]. This height is enough to produce power. The coastal area in the southern part of our country has provided us a huge potential of wind power generation. By the use of the coastal area we can think of a hybrid solution or a minimization of the power problem. This paper is all about hybrid power generation plant.

Keywords**:** Bangladesh, Energy crisis, Wind energy, Tidal energy, Hybrid system.

1. INTRODUCTION

In our country major power stations are run by natural gas and the rate is very high in which the resource is being used. If this alarming rate continues it will a matter of time when the reserve will be fallen. There is no creation of energy; it can only transfer from one to another. Bangladesh is blessed by the nature with the availability of renewable sources and which leads us to them for an alternative solution .The electric load demand of Bangladesh is nearly 6250 MW[7]. Maximum generation is 5787 MW leaving a shortage of 463 MW [7]. With the use of hybrid power generation sources we can solve the problem very much .Wind energy holds a good prospect to this problem. The wind speeds of the coastal regions are considered in this paper. The research on wind energy in Bangladesh is running from 1960 but at then the process of the collection of data was weak compared to now. Tidal energy is the future energy production. In the early past tidal energy were used at tide mills. Britain and France are using this energy for milling grains. But the first large scale tidal power plant was operating in 1966. It was 240 MW rated, generated by 24 turbines [2]. Then Canada constructed a 16 MW tidal power plant. China has many tidal barrages of 400kw or less [2]. Bangladesh has a long coastal area which can be used in different issues. Some recent researches have suggested that the coastal area is ideal for harnessing tidal power. Bangladesh can use the tidal power for electricity generation and can minimize the energy crisis.

2. WIND ENERGY

Wind is the kinetic energy of the moving air. Its power is directly proportional to the velocity. Bangladesh has a coastal length of 724 km along the Bay of Bengal. Winds are available in Bangladesh mainly during monsoon or around of it. Wind speeds are around 3 – 6 m/s which are enough for power generation. This wind blows over our country from March to September. The power increases three times for one time change in the wind speed. For harnessing this power only installation cost is needed. So it is cost efficient over other power stations running. Except for the above mentioned period of four months, a windmill if properly designed and located, can supply enough energy to be marketable.

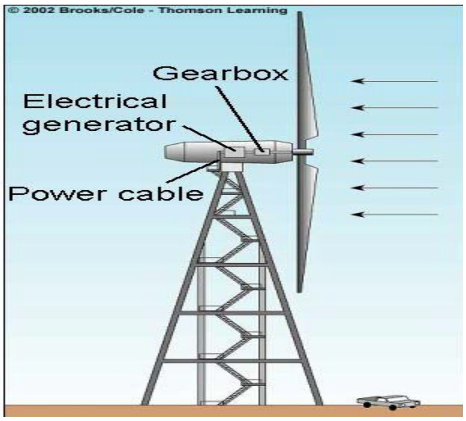


Figure 1: Wind turbine

We cannot convert all the wind energy into electricity. We can convert only 59%, according to "Betz limit" [6]. Although in practical conversion of wind energy to electrical energy is less than that. The output equation for a wind turbine is [6]:

$$P = (\frac{1}{2}) \times \rho \times A \times v^3 (\text{in Watts})$$

Where,
P= power generation;
A= area covered by the rotor;
P= density of wind;
V= velocity of wind;

BPDB is implementing a pilot project of 0.90 MW capacity of the Grid Connected Wind Energy (GCWE) in the Muhuri Dam areas. All the research works in Muhuri indicate that it has a potential of 100 MW wind power capacity [7].

Table 1: Average wind speed in different locations (2003) [1]

Locations	Month						
	Mar	Apr	May	Jun	Jul	Aug	Sep
Teknaf	2.85	2.56	2.39	4.71	2.83	4.14	3.11
Kutubdia	3.78	12.02	2.37	4.71	5.73	4.78	2.92
Sandwip	6.23	8.34	2.28	3.93	5.44	4.44	5.18
Kuakata	3.07	5.26	3.10	3.69	4.28	3.37	2.03
Mongla	3.07	2.41	2.94	4.23	4.34	4.44	2.92

Table 2: Theoretical available power from different locations [1]

Locations	Months	Avg. wind speed (m/s)	Theoretical Available power (W/m^2)
Teknaf	March to Sep.	3.23	20.17
Kutubdia		5.19	83.74
Sandwip		5.12	80.53
Kuakata		3.54	26.68
Mongla		3.48	25.26

3. TIDAL ENERGY

Tidal barrage system is used to harness energy from tides [4]. A tidal barrage is a dam-like structure used to capture the energy from masses of water moving in and out of bay or river due to tidal forces. A tidal barrage first allows water to flow into a bay or river during high tides, and releasing the water back during low tides. This is done by measuring the tidal flow and controlling the sluice gates at key times of the tidal cycle. Turbines are then placed at these sluices to capture the energy as the water flows in and out. A tidal range of at least 7m is required for economical operation and sufficient water head for the turbines [4], [1]. Tides are generated by the rotation of the earth within its ocean envelop as shaped by the gravitational fields of the moon and sun [3]. To an observer at given location on the rotating earth, these causes local sea levels to periodically rise and fall according to highly predictable ,interacting harmonic cycles[4].

The moon's gravitation creates tidal "tractive forces" that create two "bulges" in the earth ocean envelop: one bulges on the side of the earth facing the moon, and the other bulge on the opposite side of the earth [3]. Rotation of the earth between this "bulges" result in two tides per day, or semi-diurnal tides, which is the dominant tidal pattern in most of the world's ocean [3].

The island on Sandwip is 50 km long and 5 -15 km wide [2]. Two diesel run generator is running there along with solar PV model to fulfil the electricity demand [2]. A flood control barrage exists across the entire island and contains 28 sluice gates [2].

The infrastructure needed for barrages and sluice gates are already present in this region [2]. These barrages and sluice gates can be used to generate electricity applying simple technology which can have widespread application. Since the barrages and sluice gates can be used in flood control and generation of electricity here capital cost for tidal power station is minimized which is the first concern for any power stations.

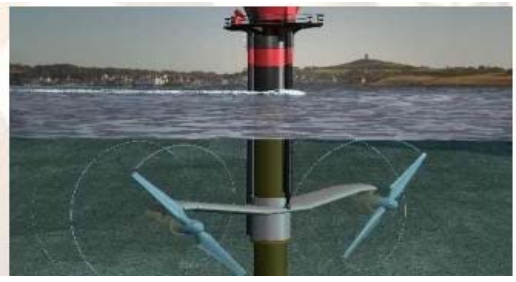
The energy available from a barrage is dependent on the volume of water. The energy contained in a volume of water is [4]:

$$E = \frac{1}{2} A \rho g h^2$$

Where:

- h is the vertical tidal range
- A is the horizontal area of the barrage basin,
- ρ is the density of water = 1025 kg per cubic meter (seawater varies between 1021 and 1030 kg per cubic meter) and
- g is the acceleration due to the Earth's gravity = 9.81 meters per second squared.

The factor half is due to the fact, that as the basin flow empty through the turbines, the hydraulic head over the dam reduces. The maximum head is only available at the moment of low water, assuming the high water level is still present in the basin.



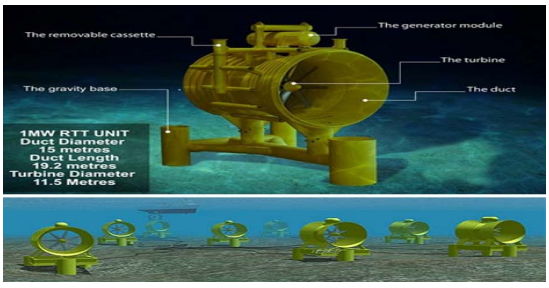


Figure 2: Tidal Stream power plant [5]

Figure 3: Under water Tidal Barrage power station [4]

For the same speed, tidal power plant is better than wind turbine. The power generated from tidal power plant is 9 times the power from wind turbine.

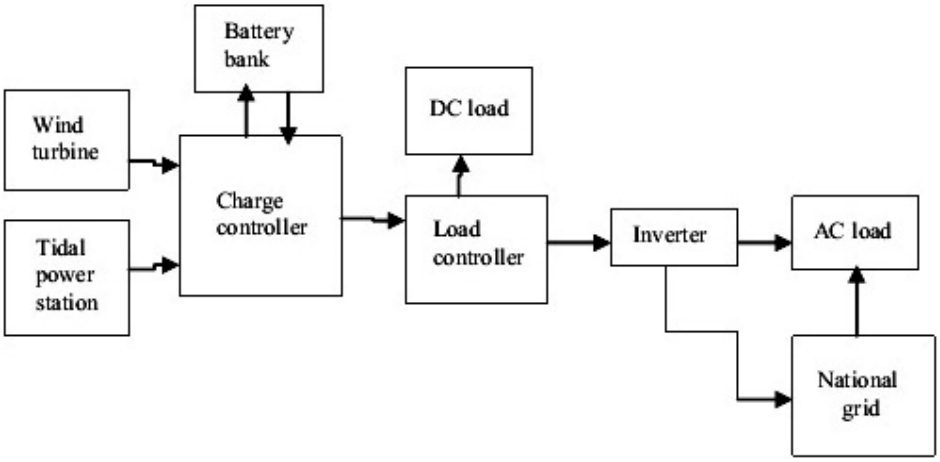
For a tidal power station [4]:
Say,

- The tidal range of tide at a particular place is 32 feet = 10 m (approx)
- The surface of the tidal energy harnessing plant is 9 km² (3 km × 3 km)= 3000 m × 3000 m = 9 × 10^6 m^2
- Density of sea water = 1025.18 kg/m^3

The maximum power can be harnessed is 31 MW (approximate). Because the available power varies with the square of the tidal range, a barrage is best placed in a location with very high-amplitude tides.

4. PROPOSED HYBRID SYSTEM :

Our proposed hybrid power system is shown in figure 6. It is consist of wind turbine and tidal power station. The system is designed to give both AC and DC output. DC loads are connected to the load controller where as AC loads are connected via an inverter. AC output is also connected to national grid. A battery bank is



connected with the charge controller. We considered the excess generated power will be distributed to the National Grid System.

Figure 6: Proposed Hybrid Power System

Since our shortage is 463 MW, in this paper we are trying to achieve that power using our hybrid power system. As we are using Wind Turbine we need to consider the fact, that capacity factor of a wind turbine is around 40%. We considered a 100 MW wind turbine system which consists of 1000 small turbines of 100KW each. Each 100 KW wind turbines cost is BDT 88 (lakhs), which when totalled becomes BDT 880(Cr.) and the area required for this case is 17, 49, 000 m^2. From these wind turbines we will harness around 40MW, which still lacks 423 MW. In this situation we used Tidal Energy Resource to meet the existing load. We proposed to use 430 MW Tidal Barrage Power Station which will cost BDT 1792 (Cr.). It consists 43 generators and the length required for this

case is around 1.4 Km long. Our consideration about the height of the Wind turbines is to be 50 m high from sea level. We considered the higher heights due to the availability of the greater wind speed.

Since the Sandwip, which is an island of 50 km long and 5 -15 km wide, which is a suitable location for the generation of power using Tidal Energy [2]. We can easily build a tidal barrage power station there.

Table 3: Total Installed capacity, Installation cost (Tk.), Area required for the Hybrid power system.

Sl. No.	Type of resource	Installation capacity (MW)	Turbine or Generator required	Total area/length required	Per MW Cost Tk. (Cr.)	Total cost required Tk.(Cr.)
1	Tidal energy	430	43	1.5 Km	4.1667/=	1792/=
2	Wind energy	100	1000	17,46,000 m^2	8.8/=	880/=
Total installation capacity (MW)		**530**			**Total cost Tk.(Cr.)** :	**2672**/=

5. Conclusion:

Hydrocarbon resources are reducing such a way, which is a matter of time when there will be no more. So alternative solution is must needed. In another sense they are the main cause for environment pollution, whereas wind and tidal are all natural sustainable energy with no pollution. Our government should take some immediate steps to use these two important elements of the nature. Due to low running cost, these power plants are the future because the other ways are quite expensive. We have a very long coastal zone which if we use, can give us a lot, but we are still too slow to harness power from them. Since our country lacks about 463MW power, we thought with the use of tidal and wind resources we can meet the required power. We used tidal as our main source and wind is to take the rest of the required power. We calculated the cost and land for the installation of the hybrid renewable system. With our proposed hybrid power system it will be a cost effective and reliable solution or minimization of the current energy crisis. The green energy of the nature must take place the current position of those Hydro-Carbon resources. We may use the power of nature to keep the environment clean and healthy for all of us.

There still need some research work to make the system:

- More reliable
- Cost effective and improve efficiency
- Developing the wind turbines which may low sound
- To make the system more Eco- friendly
- To add some more sustainable energy resources (High efficiency Solar PV module, Biogas etc.) to the system

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Acquisition of Sustainable Economic Growth through Proper Utilization of Renewable Energy Sources – A Study on Various Aspects, Challenges and Prospects of RE in Bangladesh

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Abstract

This paper explores that economic growth and development refers to a process whereby the people of a country or region come to utilize the resources available to bring about sustained and increase in per capita production of goods & services.. Economic growth depends on - rate of national income, technological progress, proper use of available resources, proper utilization of manpower, others. If we see the GDP rating we can see that the countries those are using technological advantages have the top position. So the Economy of a country can be strong with the proper use of technology. This paper then examine that there is a positive relationship between the technological use and economic growth. Energy is one of the most important ingredients required to alleviate poverty, foster economic growth, realize socio-economic and human development. Demand of electrical energy is increasing day by day because of increasing population and industrialization. Energy crisis is considered as one of the major problems all over the world in recent times. In this critical stage, renewable energy is considered as the most important alternative energy source. Renewable energy is energy, which comes from natural resources such as solar, wind, biomass, waste, small hydro, geo-thermal, tidal, wave etc. in different form which are renewable (natural replenished). Bangladesh is facing acute power crisis problem. The main goal is to develop, disseminate, promote and extend the renewable energy technology to meet the energy needs by using sustainable and environment friendly energy sources. This paper also compares the cost of generating renewable energy from different sources and examines the constraints to generate renewable energy. Lastly the paper concludes with exploring the prospects of RE in developing countries like Bangladesh with some suggestions regarding to generate renewable energy to foster the economic growth.

Key words – Sustainable Economic Growth, Sources of Various Renewable Energy, Cost Benefit Analysis, Multiple Energy System.

1. Introduction

Bangladesh has major problems with energy crisis, persisting poverty and environmental degradation. Only 49% of Bangladeshis are having access to electricity. The country can generate about 4500 MW electricity, while peak demand is about 6000 MW (USAID, 2011).Most of the supply is limited to urban areas; access to electricity in rural areas is less than 10%. RET can solve this problem by renewable such as sunshine, wind, tidal waves, waterfalls or river current, sea waves or biomass. Use of renewable energy can increase energy efficiency and enhancement of energy security constitutes a sustainable energy strategy approach. About 80% of the total populations are still un electrified. Usable biomass including cow dung, human excreta, poultry litter, kitchen organic waste, aquatic plants and weeds of a village in Bangladesh can produce the amount of biogas that villagers require for cooking. On the other hand, Bangladesh has one of the highest solar insulation on the earth. The average solar radiation varies here from 5.05 kWh/m2 day in winter to 8.03 kWh/m2 day in summer. As Bangladesh is a compact flat country with a little geographic variation, the solar radiation data collected from one point may be treated as that of the whole country. In other word, affordable availability of RETs to the rural area could be the panacea of poverty reduction and environmental fix in Bangladesh. At present, most of the large International Oil Companies (IOCs) have started serious business with renewable, like Shell and British Petroleum have individually committed US$500million for

renewable energy investment. Renewable Energy Technologies are mostly in the dissemination and demonstration phase in Bangladesh.

2. Objectives of the study

i).To examines the relationship between technological progress and economic development through renewable energy.
ii).To explores the development in the possible renewable energy sources in Bangladesh.
iii).To clarify the need for improve in the energy sector of Bangladesh
iv).Justify the present scenario & potentiality of RE in Bangladesh.
v).To identify the constraints for the improvement of RE in Bangladesh and provide some suggestions.

3. Methodology of the Study

A mixture of qualitative and quantitative methodological approaches was applied, giving explanatory information regarding electricity's influence on the quantifiable socio-economic data. To complete this information with field level data, an extensive household survey and individual short interviews with shopkeepers and owners of small businesses were conducted. The secondary data were collected mainly by reviewing the relevant organizations annual reports, publications, literature, internet searching and discussion with local people.

4. Relation between Technological Progress and Economic Growth

Technological progress is the progress developed by technology and great support from technology.With the progress of technology the economy of a country is growing up. So the GDP rate is increasing. If we see the GDP rating we can see that the countries those are using technological advantages have the top position. So the Economy of a country is being strong with the proper use of technology. There is positive relation between the technological use and Economic growth. The more technological use the more economic growth.

The relationship between energy and economic development is crucial; the process of economic growth requires the substation of energy mix in the performance of agriculture, industrial and domestic tasks. The lack of adequate energy in Bangladesh has economic costs not just at the individual and household level but at the national level as well. Development in Bangladesh without corresponding increase in per capita electricity and gas consumption is, therefore, not feasible. Consequently, energy is to be considered as a basic need along with food, water, shelter and others. The availability of adequate, reliable and reasonably priced source of energy is, therefore, prerequisite for the development of Bangladesh. Suggestions can now be made to the extent that the usage of RETs would launch a new era of appropriate technology, sustainable socio-economic and environmental development in the country.

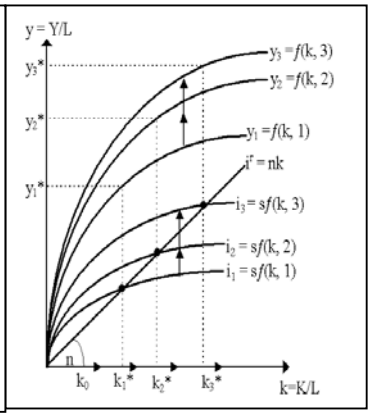

Fig. 1. Technological Progress

5. Importance of Renewable Energy

Energy is needed in the Production Farm, Electricity-Generation-Transmission-Distribution, Communication-Road, River, Train and Air, Telecommunication & Internet. Water supply, Rural Infrastructure.(Accountability and Transparency) e.t.c . Increasing cost of energy and, ,Environmental pollution hitting an obscene high, With the rise in population and more urbanization, commercial and engineering activities are also expected to increase, thus demanding larger share of energy in an already strained energy supply scenario., Provide energy for production, transportation, etc., renewable energy could be employed in a number of ways: for generation of electricity, providing irrigation. One such area is to provide Lamp Lights in far Rural & under Developed areas of the region; the strategy is to provide light without charging money to the villagers for their comfort & development. Electrification allows Rural families to extend workdays beyond sundown, which translates into more money. It encourages Literacy and provides electronic information, education & entertainment in far rural areas as well as to protect societies from Green House Effect, destruction of Ozone Layer and air pollution which cause acid Rain & smog.

6. Present scenario of Bangladesh's Power Sector

At present, 53% of the total electricity generation of Bangladesh is from the power plants under public sector and 47% of the net generation of the country is from private sector. Even though many extra units both from public and private sector have been added to the national grid, the power crisis is still a big issue in the country. So due to high demand, maximum generation of 2087 MW in 1995-1996, 2114 MW in 1996-1997, 3218 MW in 2001-2002, 3458 MW in 2002-2003, 3622 MW in 2003-2004, 3751 MW in 2004-05, 3812 in 2005- 06, 3718 in 2006-07, 4130 MW in 2007-08, 4037 MW in 2008-09 could not remove power crisis in the country . The demand of electricity cannot be met due to insufficient production of electricity around the country. And as most of our power stations depend primarily on natural gas as fuel, because of the shortage of gas supply some power plants are unable to produce power of their rated generation capacity. But the insufficient gas supply has decreased the power generation capacity in the whole country. In FY 2009-10 total generation capacity was 5, 376 MW (upto May'10) including 3,331 MW in public sector and 2045 Megawatt in private sector (including REB)

Table 1. Generation Capacity

Sl. No.	Items	FY 2009-10 (Up to May'10)
1.	Generation Capacity, MW	5,376
2.	Maximum Generation, MW (April 14 2010)	4,606
3.	Net Generation, MkWh (FY2008-09)	26,533
4.	Transmission Line, km	8,391
5.	Grid Substation Capacity, MVA	
	(a) 400 KV & 230 KV	6,850
	(b) 132 KV	9,626
6.	Distribution Line, km	2,66,460
7.	Number of Consumers (million)	12.00
8.	Number of Village Electrified	53,281
9.	Per Capita Generation, kWh	220
10.	Access to Electricity	47%

Generation Capacity and Demand

In the public sector, a good number of generation units have become very old and has been operating at a much-reduced capacity. As a result, their reliability and productivity are also poor. For the last few years, actual demand could not be supplied due to shortage of available generation capacity. Besides, due to shortage of gas supply some power plants are unable to reach their usual generation capability. Maximum generation of 4,606 MW (April 14, 2010) was supplied till to-date.

Industrial production and house hold life are regularly hampered due to regular load shedding problem which is hampering our economy as well as making us lag behind. We can get rid of this situation through renewable energy. Renewable energy can help us improve the condition of power crisis and help us move forward economically and environmentally. Moreover, the environmental drawbacks of renewable energy sources are minimum. In the perspective of Bangladesh we can solve the power crisis by bio diesel, biogas, solar energy, micro hydro, wind energy, ocean wave energy, tidal power and geothermal .Renewable energy scenario of Bangladesh is estimated on the basis of primary, secondary, noncommercial, traditional and renewable energy sources. The major sources of renewable energy have been identified as sunshine energy and waterpower. Wind and tidal forces are also expected to be the sources of renewable energy in this delta region. The patterns of total sunshine hours for a long period of time (10 years) have been analyzed by statistical methods. It has been observed that 1 sq. meter area has potential of generating 4~5 kwh/m2/day. Bio-mass and hydropower are in active use and supply about 70% and 0.15% respectively of the total amount of energy demand. Total installed capacity of electricity is 3208 MWand generation is 1385 MkWh. Estimated demand of electricity is 2370 MW and consumption is14003 MkWh. Estimated natural gas reserve is 47.69 MMBBL. The future trend of demand supply situation shows that energy demand is growing at a rate of 10% per annum. The power generated from other sources are, solar PV (800KW), wind turbine (20KW), wind pump(6),micro hydro (10KW) and biogas plants (10,000). The demand-supply situation in 2005 is 4597MW (D), 24,000 GWH (S) and in 2010 is 6779MW (D), 35,000 GWH (S). As solar power remains fairly uniform in this delta region, it is suggested that with suitable tracking system and storage facilities SPV system would be a reliable and environment pollution-free source of renewable energy in Bangladesh.

6.1. Sources of Renewable Energy

6.1.a) Biogas Technology and Bio diesel

Biogas is a proven and widely used source of energy in the country. Biogas can also be used to run small generator to produce electricity for running electrical household appliances like TV, electric light, fridge etc. Biogas technology is the most ideal technology for rural Bangladesh. Biogas plant is built with simple technology and uses raw material easily available with the rural households -- mostly cow dung. Biogas is a kind of gas generated when biomass i.e.

cow dung or other animal dung or biodegradable organic masses are stored in underground chamber in an anaerobic condition (absence of oxygen). It is a kind of anaerobic bacteria that produces the biogas from the organic debris. The composition of biogas is mainly methane (60 to 70%) with lesser amount of carbon dioxide (30 to 40%) and traces of hydrogen and nitrogen. It is a colorless gas and burns in similar way as natural gas (it actually burns at 800 °C compared to natural gas which burns at 1000 °C, both suitable for cooking and any other household application. In Bangladesh about 44 million tons of fuel wood is used in rural areas as cooking fuel each year (Islam and Islam,2011). These destroy our forest and have negative impact on weather, land and environment. Also, as other biomasses like leaves, cow dung and agricultural residues are burnt as cooking fuel, these can no more help as a natural fertilizer as part of the cycle that keeps the balance in the ecosystem. In all the above counts, use of biogas technology will bring about benefits to the environment and the people. It certainly upgrades an age old inefficient and poor energy use practice into a more efficient and scientific one. . In Bangladesh biogas is still a relatively new technology. In most of the places it is used to generate electricity to meet the household demands. But an agro-based country like Bangladesh produces huge amount of waste materials. Converting these waste materials into energy is economically advantageous as well as helpful to solve the issue of power crisis. In Bangladesh, recycling industry wastes raises a total of 436 t/d of material recovery. Moreover around 3,054 ton/d of wastes is expected to be collected in 2015 and cumulative disposal volume is estimated at about 9 million tones by the end of 2015. This huge amount of waste, most of which are compost able and have very good fermentation property can be easily used to produce electricity as well as the generated gas can be used for the cooking purpose. Waste to energy technology can be a huge asset for a developing country like Bangladesh.

6.1.b) Capacity Calculation of Biomass and Biogas

The potential for power generation from biogas and biomass has been studied together by using gasification technique. For instance, if 500 kgs of rice husk is used for a typical day considering only 50% efficiency and 5 hours of operation; the net power generation can be calculated Pbiomass = 10,000 Watts. This is approximately 10KW of power generation; assuming 2 Kgs of husk is needed in an hour to produce 1 KW of power. By using the same equation and same technique (Gasification), a biogas plant can also generate 10,000W of power in a day considering 5 hours of operation and 500 kgs of animal waste as a plant material. So, the generated power from the biogas plant is 10KW as well for the same amount of plant material.To reduce Carbon emissions and decreasing reserves of fossil fuels, Biofuel can be an attractive source of energy. In comparison to fossil fuels, biofuel can reduce the emission of CO2. Next generation biofuels can be a great solution to the global warming and the crying need of fossil fuels. Biofuel or Biodiesel is clean burning oil produced by Transesterification of oils with short chain alcohols. Now-a-days, researchers are turning their attention into the production of biodiesel from algae because of their higher productivity, abundance in the nature, high Triacylglycerides and they can be a major source for biodiesel production. Production of biodiesel from algae is less time consuming and cheaper than the petroleum diesel. So rather using petroleum diesel in the diesel generators in the power plants, we can use biodiesel which will both save our money and reduce our dependence on the diminishing fossil fuel reserves. This biodiesel can be used in the diesel generator to produce electricity. This will be cost efficient and as well as environment friendly.

6.1.c) Tidal Power

Tidal power or tidal energy is a form of hydropower that converts the energy of tides into electrical power.
As tides are more predictable than wind and sunlight, tidal energy can easily be generated from the changing sea levels. The coastal area of Bangladesh has a tidal rise and fall of between 2 to 5 meters .Among these coastal areas, with 5 meter tides experienced, Sandwip has the best prospect to generate tidal energy. Moreover, according to Reference, Bangladesh can generate tidal power from these coastal tidal resources by applying Low head tidal movements and Medium head tidal movements, low head tidal movements which uses tides of height within 2m to 5m can be used in areas like Khulna, Barisal, Bagerhat, Satkhira and Cox's Bazar regions and the height tidal movements which use more than 5m of tides can be mainly used in Sandwip. So we can say that with suitable tidal height available, this can be a great source of energy for Bangladesh.

6.1.d) Geothermal Energy

The thermal energy which is generated and stored inside the earth surface is called geothermal energy. It is very much cost effective and environmentally friendly. With this technology, we can use the steam and hot water produced inside the earth surface to generate electricity. Geothermal energy is generated about 4,000 miles below the surface, in the earth’s core. The process takes place due to the slow decay of radioactive particles, the high temperature produced inside the earth and it happens in all rocks. About 10,715 megawatts (MW) of geothermal energy is

generated in 24 countries worldwide. The northern districts of Bangladesh show the prospect to explore the geothermal resources. The demand of electricity in urban as well as in the rural areas is increasing, but our production of electricity is not increasing. The rural demand for electricity can be covered by the production of electricity through geothermal energy. According to Reference a Dhaka based private company namely Anglo MGH Energy has initiated a project to setup the country's first geothermal power plant with a capacity to produce 200 MW of electricity close to Saland in Thakurga on district. They have planned to set up 28 deep tube wells to lift hot steam and the lifted steam will be used to run a turbine and the turbine is connected to the generator to generate electricity. From the above discussion it is clear that geothermal energy can also be a great source of harnessing electrical energy in Bangladesh

6.1.e) Micro Hydro

Because of the geographic position, Bangladesh is a river rine country which is a huge advantage for the country. This huge amount of river currents and sources of low head of water falls can be used for generating microhydro-power. Micro hydro means generating up to 5-300 KW of electricity through hydroelectric power. It is a simple technology that converts hydropower to mechanical power. Micro-Hydro technology is very much suitable for a developing country like Bangladesh because it is an special source of energy which can generate energy without of fuel and the technology is very cheap. Because of the presence of many canals and tributaries of main river Karnafuli, Shangu, Matamuhuri which have very good potentials for setting up micro hydropower unit in Chittagong Hill Tracts region , recently Sustainable Rural Energy (SRE) under LGED has successfully demonstrated first micro-hydro power unit at Bamerchara, Chittagong. Although the installed capacity of the unit was 10 kW but due to insufficient water head only 4kW power was generated. A recent study on Sustainable Rural Energy shows that micro hydro power plants are able to provide necessary power supply for rural areas. The study was conducted on the micro hydro power plants of generation capacity starting from 3KW up to 30KW. These plants are in: Nunchari Tholipara, Khagrachari ,Chang-oo-Para, Bandar ban ,Bangchari, Bandar ban ,Liragaon, Bandar ban Kamalchar, Rangamati ,Thang Khrue, Rangamati ,Monjaipara, Bandar ban.

Table 2 . Potential small hydrro sites identifies by BPDB and BWDB

	Potentiality of Electrical energy (kW)
Faiz Lake	4
Chota Kumira	15
Hinguli Chara	12
Sealock	81
Lungichara	10
Budichara	10
Nikhan Chara	26
MadhabChara	78
Banga Pani Gung	616
Bhugai-Kangsa	108
Marisi	55
Badul	24
Chawai	32
Talma	24
Pathraj	32
Tangon	48
Punarhaba	11
Bari Khora	32
Fullkumar	48

6.1.f) Capacity Calculation of Micro Hydro Power

Peak power is used in the evening when the sun is not shining and the wind is not necessarily blowing. Batteries can be completely drained by morning with a solar or wind system. With a hydro system located on a year-round creek or river, power is produced steadily around the clock.

The hydro power in a stream or river can be calculated by using the "equation 5" which is as follows:

P (KW) = H × Q × g (in KW) ,Where, H=Gross water head (in meter), Q=Flow of water (in m3/sec), g=Gravitation force i.e. 9.81 (in ms-2) .For example, if the available flow is 0.15 cubic meters per second and the net head is 4.7 meters, then hydro power= 4.7×0.15×9.81 = 6.9 kW

To estimate the electrical power produced by a generator, the efficiency of the system must be taken into consideration. The system efficiency for electricity generation using micro hydro is typically between 50% and 60%.

Electrical Power = Hydro Power x System Efficiency

P hydro = 6.9 x 50% = 6.9 x 0.5 = 3.45 kW

Total Expected Capacity of the Proposed Hybrid Grid ,So the total expected power generation of our proposed on-grid hybrid system is: Ptotal(KW)= Psolar + Pwind + Pbiogas + Pbiomass + Phydro ,Ptotal(KW)=3.6+0.0735+10+10+3.45

Ptotal(KW)= 27.12 KW

Thus a total expected 27.12 KW electrical power can possibly be generated from our hybrid model. The sharing of the sources depends on which renewable source is sufficient at a particular moment. Such hybrid system is useful to provide electricity in all weather conditions. The capital cost for such a system is high but subsequent running costs will be low compared with a pure diesel system. In our proposed system the grid connection helps to provide

flexibility to the system and works as a back-up protection when the renewable sources are insufficient to produce electricity.

6.1.g) Nuclear Power

Going nuclear has also been a much talked about alternative. Earlier this month the government had discussions with Russia for two 1000-megawatt nuclear power projects. Nuclear power is also very capital-intensive, while fuel costs are relatively much more significant for systems based on fossil fuels. Development of nuclear power could provide work for local industries, which build the plant and also minimize long-term commitments to buying fuels abroad. The site is set at Ruppur. Such a project would also require heavy investment in power

6.1.h) Wind Energy

There are many hilly and coastal areas in Bangladesh which have huge potential for wind energy generation. Wind energy is a technique which converts the air flow into mechanical energy which is eventually converted into electricity without generating pollutants. Bangladesh has a 724 km long coast line and many small islands in the Bay of Bengal, where strong south-westerly trade wind and sea-breeze blow in the summer months and there is gentle north-easterly trade wind and land breeze in winter months. Along the coastal area of Bangladesh, the annual average wind speed at 30m height is more than 5 m/s . Wind speed in northeastern parts in Bangladesh is above 4.5 m/s while for the other parts of the country wind speed is around 3.5 m/s . Coastal locations of Bangladesh such as Chittagong, Kutubdia and Cox's Bazar have immense potential to produce electricity from wind energy. By using one year data of Bangladesh Centre for Advanced Studies, it has been found that at 50 meter height in these areas the wind speed varies from 4.1 to 5.8 meter/second with a power density of 100-250 w/m2 .An analysis of wind energy measurement done by RISOE shows locations with power density above 200 w/m2 over 2000 km2 which is very good to set up wind turbines and expand wind energy in Bangladesh We cannot convert all the wind energy into electricity: we can convert only 59%, according to Betz limit .The output equation for a wind generator is given by:
$P = (1/2) \times \rho \times A \times v3$(in Watts) , Where, A=area perpendicular to the direction of flow (in m2), v=wind velocity (ms-1), ρ =density of air (in Kgm-3) and P=power generation. To check whether wind energy can be a potential renewable source of electricity, small-scale wind turbines can be installed in areas in Bangladesh such as St. Martins Island, Patenga, Bhola, Barguna, Dinajpur, Thakurgaon and Panchagar . So from the above discussion we see that there is a huge possibility of extracting electrical or mechanical energy from the wind in Bangladesh.

Table 3 . Annual average wind speed of different sites of Bangladesh

Site	Annual average wind speed (m/s)
Teknaf	2.16
Cox's Bazar	2,42
Patenga Airport	2.45
Kutubdia Island	2.09
Sandip Island	2.16
Hatia Island	2.08
Bhola Island	2.44
Khepupara	2.36
Comilla Airport	2.21

Table 4 . Wind turbine installations in Bangladesh by different organizations

	Installed Capacity(Watt)
Grameen Shakti	12000
BRAC	5220
Bangladesh Army	900
IFDR	1700
LGED	400

In practice, the efficiency of commercially-manufactured wind rotors is typically 25% to 45%. Small wind turbines tend to have efficiencies at the lower end of this range. For instance, for a wind turbine with a blade diameter of 1.7 m and an operating efficiency of 25% at a wind speed of 6 ms-1. Then, to calculate how much power the turbine can generate at this wind speed: Rotor swept area: Area (A) = $\Pi \times (\text{Diameter}/2)2 = 3.14 \times (1.7/2)2 = 2.27$ m2 , Available wind power: , $P\text{wind} = (1/2) \times \rho \times A \times v3$, Where, A=area perpendicular to the direction of flow (m2), v=wind velocity (in ms-1), ρ =density of air which is about 1.2 Kgm-3. , Pwind= $(1/2) \times 1.2 \times 2.27 \times 63$,Pwind= 294.2 watts .Then the power that can be extracted from the wind assuming 25% turbine efficiency is: Pturbine=$0.25 \times 294.2 =$ 73.55watts.

6.1.i) Solar Energy

SHS has been a successful story in Bangladesh. Our rural people have accepted SHS on a mass scale. Once it was thought that solar energy was not affordable for the rural people. This myth has been broken. Along with thirty partner organizations in the country, as of August 2011, over one million SHS have been installed in Bangladesh, benefiting over 6 million rural people (IDCOL, 2011). On average, more than 35,000 systems are installed every month and within the next 1 to 3 years, this rate is likely to be triple. Bangladesh is situated between 20.30 and 26.38 degrees north latitude and 88.04 and 92.44 degrees east which is an ideal location for solar energy utilization. At this position the amount of hours of sunlight each day throughout a year is shown in the following graph .The highest and the lowest intensity of direct radiation in W/m² . Due to geographical location Bangladesh receives strong sunshine throughout the whole year. The average sunshine hour and average day length in various seasons are 6.69h (SH) & 10.05h(DL) in winter, 6.16h (SH) & 11.99 (DL) in summer and 4.81h (SH) & 11.67 (DL) in monsoon respectively. The average received global radiation is 3.69 kWh/m2 per day (winter), 5.065 kWh/m2 per day (summer) and 4.22 kWh/m2 per day (monsoon).

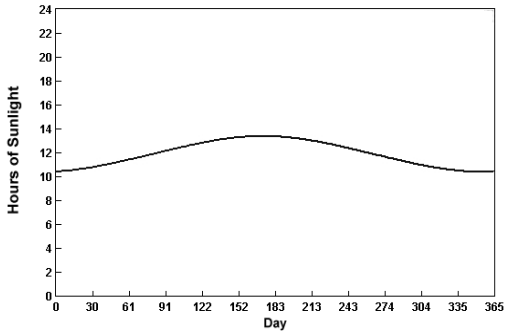

Fig 2 . The amount of hours of sunlight in Bangladesh

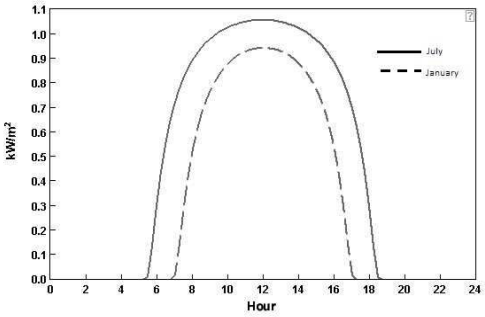

Fig 3. The highest and the lowest intensity of direct radiation in W/m²

In a recent study conducted by Renewable Energy Research Centre, it is found that average solar radiation varies between 4 to 6.5 kWhm-2 day-1 and maximum amounts of radiation are available in the month of March-April and minimum in December-January . So from the above figure and discussion we can say that there is a good prospect of harnessing solar power in Bangladesh. Moreover, in the rural areas where there is no electricity connection, photovoltaic technology can be a blessing. Although, the installment cost of solar systems in the house is very much costly, but once installed it can give service up to 20-25 years with proper maintenance. Moreover, in the northern territories of Bangladesh where the solar intensity is very high, solar thermal power plant can be installed. For both photovoltaic technology and solar thermal technology, Bangladesh is at a perfect location. In fact, Bangladesh government has recently taken many steps to encourage people to use photovoltaic energy. Almost every newly built apartment building is now using solar panels along with the grid connection to get support during the load shedding period.

6.1.j) Capacity Calculation of Solar Power

The solar network will come into operation when there is a direct sun condition of the day. On average (as a general "rule of thumb") modern photovoltaic (PV) solar panels will produce 8 - 10 watts per square foot of solar panel area.
For example, let us consider an area of 20 feet by 20 feet which is 400 square-feet (20 ft x 20 ft).
In our calculation we are assuming that the solar panel will produce roughly 9 Watts per square foot of area. So, the generated power is: Psolar = (Area per sq- ft × watts per sq-ft) , Psolar= (400 × 9) , Psolar= 3,600 Watts.
The sunlight impinging on panels, i.e. irradiance or isolation (incoming solar radiation), is measured in units of watts per square meter (W/m2).We can use only 25% of sunlight radiation for PV module. The PV system power output (DC) has approximately a linear relationship to the isolation. Using the solar radiation available on the tilted surface the hourly energy output of the PV generator can be calculated according to following equation: $P = A \cdot x2 + B \cdot x + C$ (in Watts) (1) ,Where, x= solar radiation, P=power generation, and A, B, C are constants, which can be derived from measured data. By using above formula, we can predict solar power generation at any solar radiation.

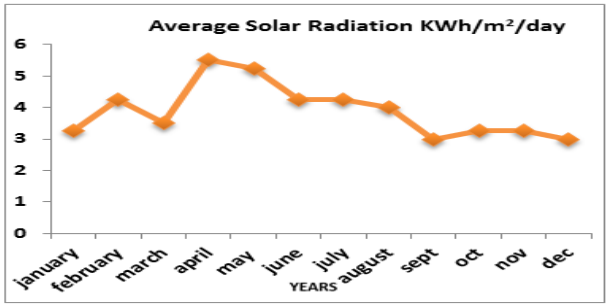

Fig. 4. Average solar radiation

Daily average solar radiation varies between 4 to 6.5 KWh per square meter. Maximum amount of radiation are available in the month of March-April and minimum in December-January. According to IDCOL, the total capacity of solar energy based installations in Bangladesh appears to be 20.75 MW .The amount is significant considering the upward trend of the number of SHSs (Solar Home System) installations in the country.

Solar panels are the medium to convert solar power into the electrical power. Sun beam is absorbed with the panel material and electrons are emitted from the atoms that they are bounded. This releases current thus solar power is converted into electrical power .When PV cells are joined physically and electrically and placed into a frame they form a solar panel or PV module. Panels joined together form a solar array. A powerful economic model has been created to make solar energy a part of rural life, integrating one of most sophisticated technologies with the aspirations, toils and successes of the rural people. A rural family can have bright light, watch TV and power their mobile phones at the same cost as kerosene, while escaping from dim light, foul smelling smoke including health and fire hazards. Rural businesses can increase their productivity and income through extended working hours and attracting more customers. This sector has been creating green jobs and linkage businesses especially in the rural areas. Hundreds of local youths are working in the rural areas as solar technicians. Rural women are assembling solar accessories in village based Technology Centers. Solar engineers are increasingly employed in designing SHS, working in battery factories, and other accessory related businesses. Bangladesh is on the verge of a Solar Revolution. Increased aspirations, failure of grid electricity, growing machination and disposable income have created huge potential for solar energy in rural areas. Solar Energy can be a great source for solving power crisis in Bangladesh.

6.2) Cost-Benefit Analysis of Solar Energy

The study based on cost-benefit analysis on data collected during field trip to typical SHS projects in village of Gazipur and Mymansingh district. Assume lifetime of SHS and kerosene lamp are 20 years and 3 years respectively. Repair and maintenance cost for SHS and kerosene lamp are 500tk/yr and 120 tk/yr. battery lives is 5 years and after five additional 10000 tk is needed to replace the battery for SHS. Number of family used 3 kerosene lamps for lighting. Each lamp consumes 2 liters kerosene per month. Assuming, Price of the kerosene at present market is 65 tk/liters. The price of SHS is 18000tk including installation charge, where the price of each kerosene lamp is 300tk only. Consider the discount factors at 10% interest. The fundamental principle of appraisal methods is to compare costs against benefits. Although the principle sounds simple but the analysis become somewhat difficult because of the fact that the costs and benefits are spread over a very long period of the time for solar home system, over a period of 20 years. The cost of the system has to be made up front. But the cost of replacement will be made some time in distant future, which makes the estimation difficult. But the more controversial issue is to estimate benefit or cost savings over a period of 20 years.

Kerosene lamp

1. No of lamps= 3 , 2. Fuel consumption= 2 lit/lamp/month*12 month* 3 lamp = 72 liter
3. Initial cost = 300taka*3 lamp= 900 taka , 4. Maintenance cost= 120 taka/year
5. Fuel cost= 65taka/lit* 72 lit =4680 taka , 6. Total cost= 4680 taka+120 taka= 4800 taka
7. Life time= 3 years

Solar Home system

1. Initial cost =18000 taka , 2. Maintenance cost=500 taka/year, 3. Battery cost= 10000 taka/each per 5 years
4. Life time of panel = 20 years

We know that,

$$\text{Benefit cost ratio} = \frac{\text{PV of cash inflow (Return)}}{\text{PV of cash outflow (cost)}}$$

$$\text{Discount factor} = 1/(1+i)^n$$

$$\text{PV (Present Value)} = FV/(1+i)^n$$

However, unlike the initial cost, the operational cost 500 taka/year SHSs are extremely low and On the other hand, households using kerosene, has to spend around 120 taka/year. This indicates a significant amount of savings on kerosene usage due to the installation of SHSs. After 20 years calculating a typical household's costs and savings, calculate the net benefits by subtracting the operational cost from the savings on kerosene, i.e. BDT 44023.14-BDT 34714.7 = BDT 9308.44. The breakdown of typical household's initial cost and details of the net benefit calculations have been summarized in the table. Apart from the standard monthly operational costs, users also have to pay for periodic replacement costs for the storage batteries. Provide solar panels to the villagers in a cheap price.

Table 5. Discounted Cash Flow Analysis for a Typical Solar Home System in Bangladesh

Year	Cash out flow (SHS)	Cash in flow (kerosene)	Discount factor	PV of Cash out flow	PV of Cash in flow
0	18000	900	1.0000	18000	900
1	500	4800	0.9091	454.55	4363.68
2	500	4800	0.8264	413.23	3966.72
3	500	5700	0.7513	375.65	4282.41
4	500	4800	0.6830	341.50	3278.20
5	10500	4800	0.6209	6519.45	2980.32
6	500	5700	0.5645	282.25	3217.62
7	500	4800	0.5132	256.6	2463.36
8	500	4800	0.4665	233.25	2239.2
9	500	5700	0.4241	212.05	2417.37
10	10500	4800	0.3855	4047.75	1850.4
11	500	4800	0.3505	175.25	1682.4
12	500	5700	0.3186	159.30	1816.02
13	500	4800	0.2897	144.85	1390.56
14	500	4800	0.2633	131.65	1292.64
15	10500	5700	0.2394	2513.70	1364.58
16	500	4800	0.2176	108.80	1044.68
17	500	4800	0.1978	98.90	949.44
18	500	5700	0.1799	89.95	1025.43
19	500	4800	0.1635	81.75	784.8
20	500	4800	0.1486	74.3	713.28
				Σ=34714.7	Σ=44023.14

6.3.Multiple energy generation system

The initial cost of solar energy system is high rather than other sources. So we need to establish multiple energy system for the development of energy sector as well as production of energy.

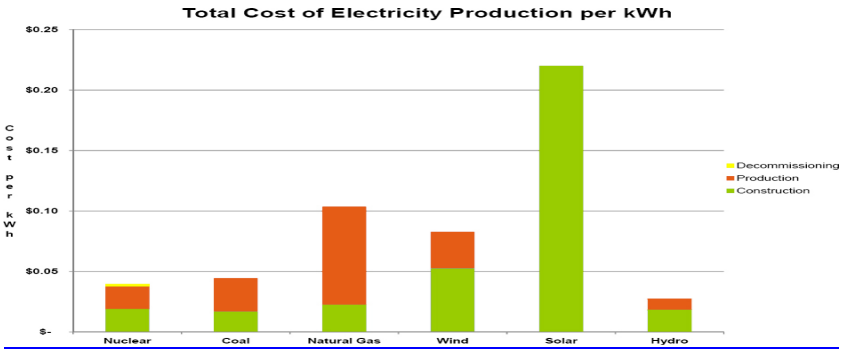

Fig .5 . Cost of electricity production

The following flow chart is exploring the multiple energy system.

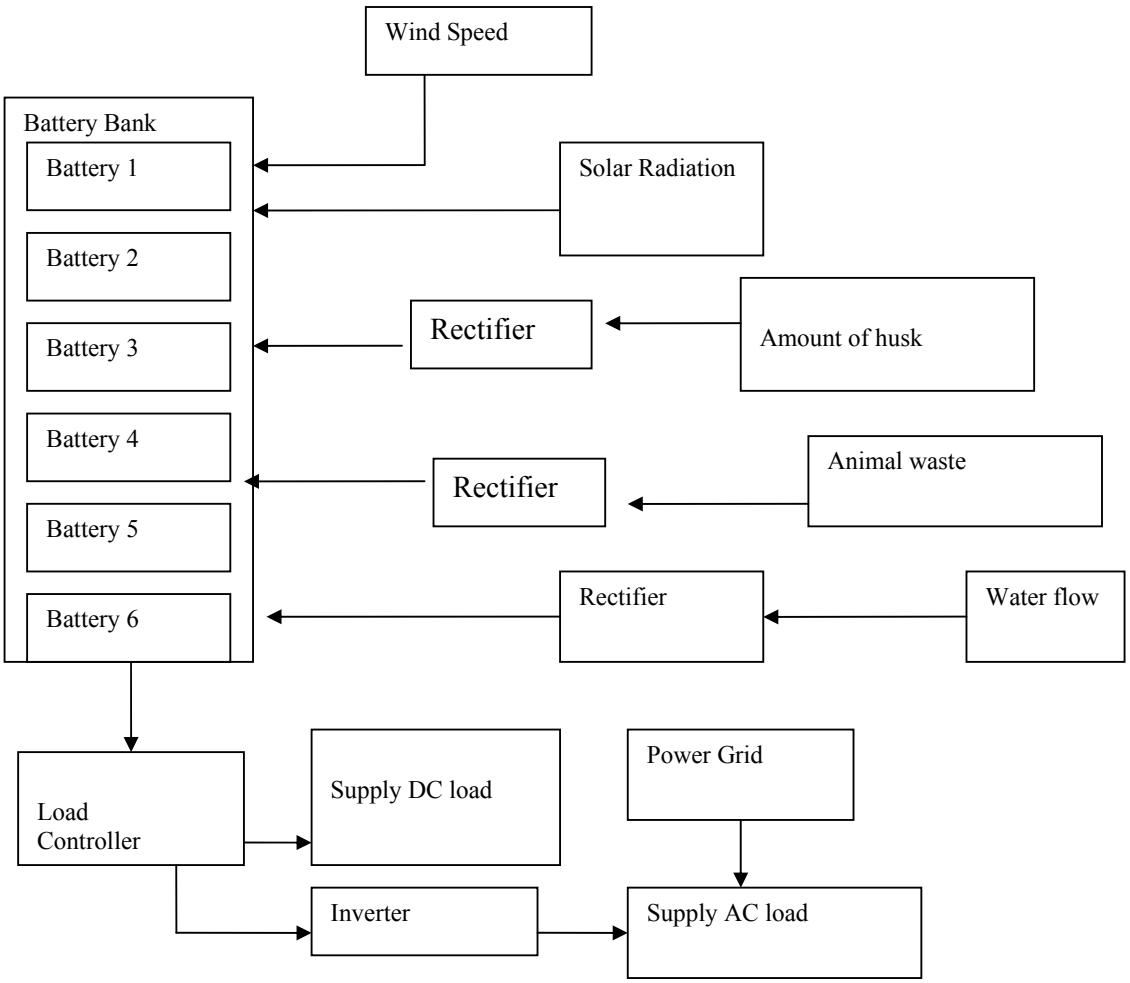

Fig. 6 . Flow Chart of Multiple Energy System

According to this flow chart we can see that at first we will measure the wind speed from wind generator; if the wind speed is greater than 4 ms-1 then the battery bank will charge, if not then it will go to measure the solar radiation. If the radiation is sufficient to produce electricity then the battery bank will charge or else it will go to measure rice husk (biomass) .If the rice husk is more than 10kgs then again the battery bank will charge or then will go to the biogas scheme. In case of the failure of biogas scheme eventually it will measure the speed of water flow of micro hydro generator. If the water flow is greater than 1000 ms-1 then the battery will charge or else the loads will take power directly from the grid if the grid power is available. However, in case of unavailability of the grid power, the system will again go to measure the wind speed and thus will repeat the entire process. Here the battery bank can feed electricity to the DC loads and to AC loads using an inverter in between loads and the battery bank as well. It has to be mentioned that the output voltage of the power system generator is 12v and the consumer uses 60% of the available power while the rest is being used for battery charging.

7. Main Constraints

- RETs have high initial cost, low level of technological development, availability and site dependence.
- Absence of approved policy framework.
- Absence of agency to handle the RE issues.
- Renewable energy activities are going on without any coordination.
- Bangladesh is failing to avail of the opportunities offered by international organizations.
- Lack of national and foreign investment in the RE sectors.

8. Govt. Policy for the improvement in RE

The prospects of solar PV and other renewable energy utilization depend on the role of the Government. The Government is facilitating RE development, which should be enhanced so that private entrepreneurs come forward to take the initiatives to disseminate renewable energy technologies. It is expected that RE will play a more extensive role in meeting the energy needs. Renewable Energy policy is adopted in 2008. The policy identifies the following major renewable energy sources namely – solar photo voltaic, solar thermal power/concentrating solar power, wind energy, biomass, biogas, micro hydro and mini hydro. The objectives of the policy are to harness the potential of RE, dissemination of RE technologies, facilitate both public and private investment in this sector, increase energy supplies to substitute indigenous non-renewable energy. To achieve the objective government has set targets for developing renewable energy resources to 5% of total power demand by 2015 and 10% by 2020.Energy is one of the serious problems in Bangladesh. It is a global crisis as of today. Now we are facing global warming issue especially in the developing Countries. Bangladesh could be one of the most effected Countries from the impact of pollution. That's why; CMB Power stands with the Government and the people of Bangladesh. The Government of Bangladesh is concerned about the impact of pollution, necessity of power for economic growth and stability, poverty, food, health and the current way of life. As a proud nation, Bangladesh has the responsibility to contribute to the war against global warming. By implementing green energy projects and proper irrigation systems in this agriculture based Country, Bangladesh can achieve the goal. At Copenhagen on December 18th, 2009 the US President Mr. Barack Obama expressed concern about global warming and its impact in the developing Countries especially in Bangladesh. He mentioned to cut down the emission 17% by 2020, and 80% by 2050. He also promised to help any developing countries which are willing to contribute to global warming. He promised to donate $10 billion by 2012, and $100 billion by 2020. Besides, Bangladesh is one of the fastest growing developing Countries in south Asia. We are providing the following snapshot to understand our project background, local market and economic structure of Bangladesh.

9.Recent Initiatives on RE:

Renewable Energy policy is adopted in 2008. The policy identifies the following major renewable energy sources namely – solar photo voltaic, solar thermal power/concentrating solar power, wind energy, biomass, biogas, micro hydro and minihydro. Present Solar Power Generation: 15-20 MW PDB, REB and IDCOL are distributing Solar Home System (SHS) to the people living in the off-grid areas. IDCOL through different NGO has already distributed 4.5 lakhs SHS through out the country. PDB has already installed nearly 11 KW solar power to the CHT area, nearly 230 W solar power in Angorpot and Dahagram chitmahal Aarea , installed 115 W in the WAPDA office building..A Solar Panel with capacity of 21.2 KW is installed at the Hon'ble Prime Minister's office.Nearly 10MW solar plant will be installed by PDB in Sarihabari (2-4 MW), Rigional Training Office, Rajshahi (1 MW), Rajabarihat, Godagari (2-4 MW), Kaptai Power Plant (4-5 MW) in IPP model. Preparation of tender documents is underway.PDPP has been prepared to cover 4 isolated islands under solar and wind power.REB has taken project for Solar Irrigation System. 20 irrigation pumps will be brought under solar power under this project Installed wind mill at Kutubdia and Feni: 2MW PDPP has been prepared for wind mapping.100 MW of wind power will be generated in the off-shore area of Anwara, Chittagong in IPP model. PQ has already been prepared, tendering is under process. Govt. has exempted income tax for next 5 years from commercial production from RE.

10. Suggestions for Creating a Sustainable Energy Future

- Need to increase access to electricity among the people living in off grid, isolated and in accessible remote areas by solar home systems (SHS).Improve the standard of living and increase income by introducing solar power and wind power.
- Need to increase the supply of power by installing offshore wind turbines.
- Explore the potential of other firms of renewable energy such as micro hydro, tidal energy, bio-mass and bio-diesel to meet the power and energy demand of the rural people and
- Must explore the potential of municipal wastes to generate electricity.
- Increase fuel efficiency standards for vehicle, appliances, buildings
- Need to reconstruct tax and other financial incentives for energy efficiency
- Provide facility to Subsidize renewable energy use, research and development
- Internalize externalities for fossil fuels
- By 2050: Increase renewable energy to 50%
- Cut coal use by 50%

- Phase out nuclear altogether
- Make project profile to seek FDI and Foreign aid.
- Increase Technological experiments
- Have to provide facilities & incentives to generate renewable energy in private sectors.
- Utilize the natural resources, solar, wind, rivers etc
- Building a Cutting Edge Entrepreneur Based Structure
- We can create village based SME entrepreneurs to popularize solar pumps, mini grids and biogas plants etc.
- Focusing on an Efficient, Cost effective Supply Chain.
- Passing Pro -renewable energy Laws.
- Investing in Capacity Development and R & D.

11. Conclusion

There are quite significant untapped renewable energy resources in Bangladesh, although the utilization is minimal today. Remote & rural households and other establishments can benefit from off-grid services of RETs. The solar industry has begun to develop commercially. The popularity of PV is increasing. To harness the potential of RE, concerted effort is urgently needed. Renewable energy is energy, which comes from natural resources such as sunlight, wind, rain, tides, and geo thermal heat, which are renewable (natural replenished). Solar home system (SHS) is becoming increasingly popular and a project is taken to generate electricity from wind power. The main goal is to develop, disseminate, promote and extend the renewable energy technology to the rural as well as urban people to meet their energy needs by using sustainable and environment friendly energy sources. A contemporary scenario of Bangladesh's renewable energy sector has been presented using data and illustrations, on the basis of careful literature review and fieldworks. It can be an excellent, cost effective and also a reliable solution to mitigate the existing power crisis if we can implement this project properly. It has a great impact on improving the socio-economic condition of rural people as well as will be a good sign of green energy technology. Bangladesh has got ample solar isolation throughout the country. Daily average solar radiation varies between 4 to 6.5 kWh/m2. Maximum amount of radiation is available on the month of March-April and minimum on December-January. There is bright prospect for applications of solar thermal and photovoltaic systems in the country. From the previous studies, it can be inferred that the small wind turbines can be installed in the coastal regions of the country. LGED's ongoing WERM project under "Sustainable Rural Energy(SRE)" program is expected to provide more valuable information regarding Wind Energy potential of Bangladesh for larger projects. There is limited potential of small hydro power plants in the hilly regions and existing irrigation project locations. BPDB and Bangladesh Water Development Board (BWDB) should work together to implement a pilot project at any of the prospective regulating structures of Tista Canal system. A comprehensive study should be carried out to assess the biomass potential of the country for modern applications like gasification. Waste-to-energy project should be given serious contemplation which will not only provide electricity, but also reduce the unpleasant waste disposal problems of metropolitan cities of the country. Recently, an initiative has been taken to explore the scope of integrated tidal power plants in the island of Sandwip. If the pilot project becomes successful, similar projects can be replicated to other coastal islands of the country. Most wanted UNEP´s Solar and Wind Energy Resource Assessment (SWERA) project will be finished very soon. It is expected that from the middle of the year 2014, energy planners or private entrepreneurs will have clear understanding regarding the solar and wind energy potentials at different parts of the country. Projects concerning multiple energy system can be a great innovation and achievement to the energy sector of Bangladesh. Renewable energy sources discussed above can help Bangladesh produce more power. Time has come to look forward and work in these renewable energy fields to produce electricity rather than depending wholly on conventional method. With the help of these resources Bangladesh can export electricity meeting the internal demand in the future. Therefore, the Government and the Private sector should work and in hand to emphasize more on renewable energy source to produce electricity to solve our power crisis problem.

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Feasibility of Wind Power Technology Schemes in St. Martin's Island of Bangladesh

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Abstract

Renewable energy is one of the most important alternative energy sources to extenuate the demand for energy and reduce fossil fuels consumption. Wind energy is one of the renewable means of electricity generation that is a part of the worldwide discussion on the future energy generation. In case of isolated island, it is very difficult to transmit power from the land area because of excessive cost. This paper presents the schemes to use this technology in St. Martin's Island in Bangladesh which is about 9km apart from the southern part of main land. It has an eight square km area in the northeastern part of the Bay of Bengal, where strong southwesterly wind and sea breeze blow in the summer season and there is gentle northeasterly wind and breeze in winter months. The scope of setting small scale wind turbine power plant in isolated areas will be discussed in this paper.

Keywords: Renewable Energy, Wind Power, Wind Turbines, Alternative Energy Sources, Wind Farm.

1. Introduction:

Bangladesh faces a severe crisis of electricity in the recent time due to increasing demand of it in every day. We have a good probability to increase our economic condition by utilizing our resources in a well manner. But we can't keep pace with others due to shortage of electricity. So it is a vital issue to increase our production of electricity as soon as possible. In spite of high running cost (about 18TK. per unit electricity), we are bound to use diesel power plant due to high demand. But it is a matter of pleasure that per unit electricity has a role of 32Tk. in GDP. Therefore if we can generate electricity in a large scale with minimum cost it will be very profitable to us. Wind power technology is such a scheme that produces electricity with a very low running cost, in fact no fuel cost.

Wind power technology is one of the renewable energy which provides electricity using wind. Usage of wind energy has been increased in recent times especially since government bodies have suggested using alternative energy sources and reducing fossil fuels consumption. In fact out of all renewable energies, wind power energy has increase with more ratio than any other technology for past two decays with growth rate of 30 % percentage per year.

The St. Martin's Island is one of the islands located at the eastern Bay of Bengal. It is one of the beautiful tourist spots of the country. But this Island suffers from chronic shortage of electrical energy due to non-availability of grid quality power. The People of this island depend on the expensive and often erratic supply of kerosene for their lighting needs. There are few small diesel generators supplying electricity to the markets of some villages, but the diesel delivery mechanism is not reliable. As the region has the characteristic of sensitive ecosystem, remoteness, inadequate infrastructure for transport sector, distributed demand for electricity and dependency on petroleum products imported from main land, there is an absence of diesel based grid systems set up by state electricity board. In this background the Renewable Energy Technologies can play a very effective role for electrification. Wind energy has been very promising in Bangladesh which varies at a speed form 4 m/s to 5.5 m/s at the height between 25m to 50m. This speed is enough to generate electricity requiring some design change from the windmill of other countries.

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2. Working principle of wind turbine:

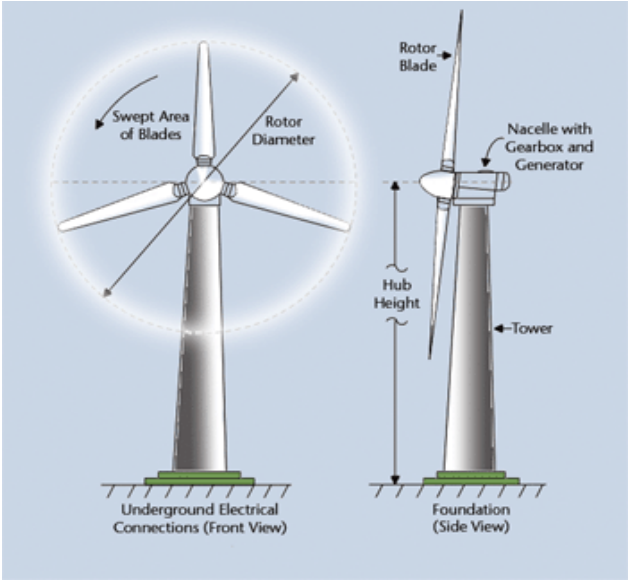

Fig. 1: Wind turbine schematic.

Wind is a form of solar energy. Winds are caused by the uneven heating of the atmosphere by the sun, the irregularities of the earth's surface, and rotation of the earth. Wind flow patterns are modified by the earth's terrain, bodies of water, and vegetation.

The terms wind energy or wind power describes the process by which the wind is used to generate mechanical power or electricity. Wind turbines convert the kinetic energy in the wind into mechanical power. This mechanical power can be used for specific tasks (such as grinding grain or pumping water) or a generator can convert this mechanical power into electricity.

So, to produce electricity a wind turbine works the opposite of a fan. Instead of using electricity to make wind, like a fan, wind turbines use wind to make electricity. The wind turns the blades, which spin a shaft, which connects to a generator and makes electricity. The electricity is sent through transmission and distribution lines to homes, businesses, schools, and so on.

3. Design of wind turbine power plant:

3.1. Considerations for designing wind power plant:

There are few considerations which should be taken care of while developing wind power plant. To produce more electricity, increased number wind turbines are required in wind farm. Bigger blade size can also help in increasing the electricity generation capacity; therefore always choose to have bigger blades. Only those places are suitable for building up wind power plants where strong and steady winds are present in most of the time in a day, more wind cross through propellers, more rotation it will take hence produce more electricity. Coastal areas, higher areas, top of the mountain are best areas for developing wind power plant as it will encounter more wind at such altitudes. To receive satisfactory performance from wind power plants it should be located where it faces about minimum of 5 m/s wind speed. Lower wind speed can also provide electricity however performance with consistency may suffer. Grid should not be build far from wind far, as this will increase costs of wire to provide electricity produced by wind grid station. Wind plant should keep closer to grid station for cost effectiveness.

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3.2. Selection of Wind Turbines:

Fig. 2: Two basic wind turbines, horizontal axis and vertical axis

There are two basic types of wind turbines: horizontal axis wind turbines and vertical axis wind turbines (shown in Fig. 2). Horizontal axis turbines (more common) need to be aimed directly at the wind. Because of this, they come with a tail vane that will continuously point them in the direction of the wind. Vertical axis turbines work whatever direction the wind is blowing, but require a lot more ground space to support their guy wires than horizontal axis wind turbines.

3.3. Factors in Designing Wind Turbine

An important factor in how much power that the wind turbine will produce is the height of its tower. The wind speed is varied in St. Martins Island throughout the year (Fig. 3).The power available in the wind is proportional to the cube of its speed. This means that if wind speed doubles, the power available to the wind generator increases by a factor of 8 (Fig 4). Since wind speed increases with increases to the tower height can mean enormous increases in the amount of electricity generated by a wind turbine.

It has been recommended that towers be 24-37 m (80- 120 ft) high. Installing a wind turbine on a tower that is too short is like installing a solar panel in a shady area. At a minimum, mount a wind turbine high enough on a tower that the tips of the rotor blades remain at least 9 m (30 ft) above any obstacle within 90 m (300 ft).

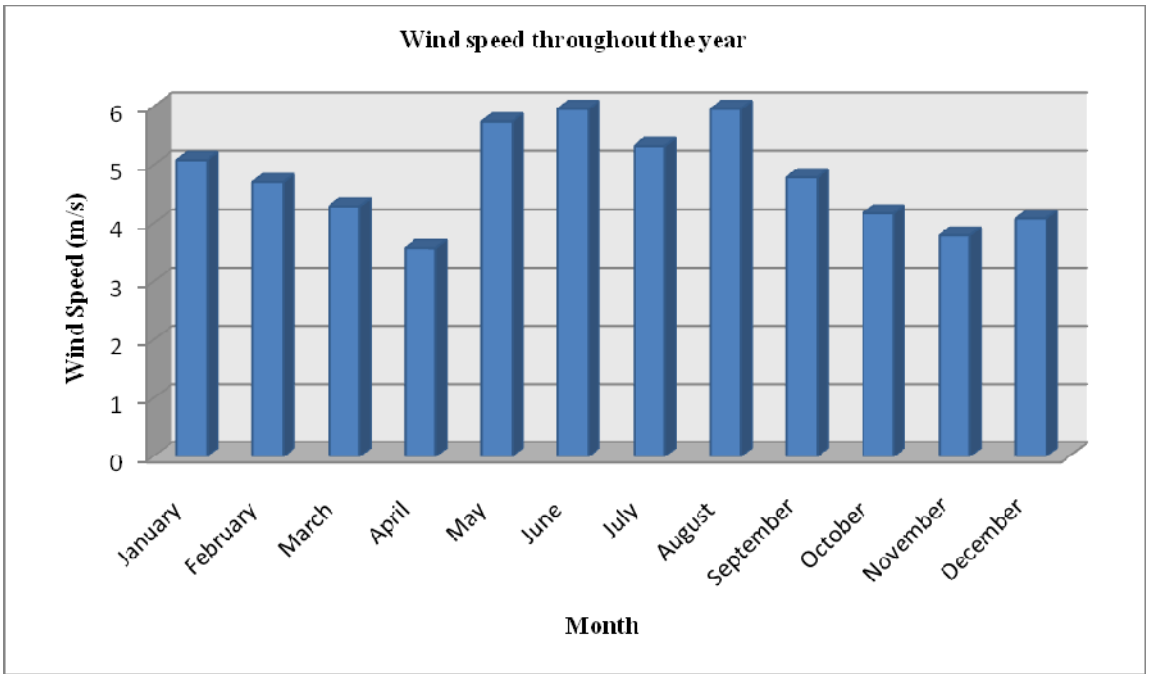

Fig. 3: Wind speed variation in St. Martin's island.

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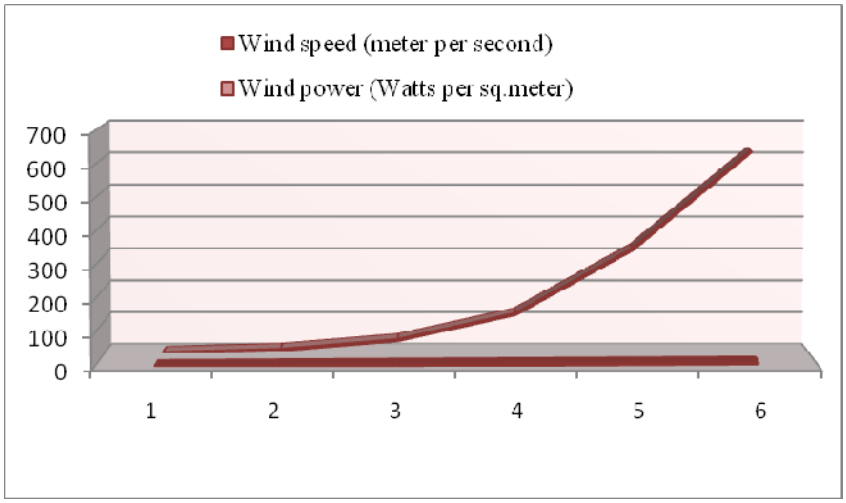

Fig. 4: Relationship between wind speed and wind power.

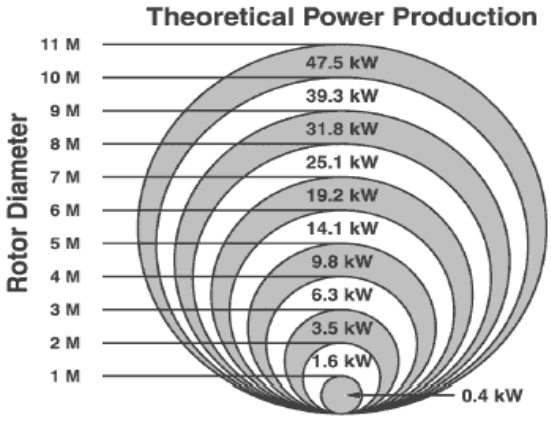

Fig. 5: Theoretical power production for small wind turbines when the wind speed is 10 m/s.

A modest increase in the rotor diameter will lead to significant increases in both the swept area of a turbine and the amount of electricity that the turbine can generate (Fig. 5). The values for power production shown are theoretical values, and only intended for illustrative purposes. The actual power production from a wind turbine will be influenced by many other factors, such as: the efficiency that the wind turbine is able to extract energy from the wind; the elevation at which the turbine is located; and other design characteristics of the wind turbine.

To get a preliminary estimate of the performance of a particular wind turbine, use the formula below:
AEO = 1.64 D2 V3

Where
AEO = Annual energy output, kWh/year
D= rotor diameter, meters
V = Annual average wind speed, m/s

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4. Proposed schemes:

Fig. 6: Placement of Turbines

Spacing between adjacent turbines needs to be at least several times the length of the turbine blades to prevent lowering the efficiency of the turbines due to one stealing wind from or causing turbulence for another. One rule of thumb is that placement between turbines should be about 3 to 7 diameters between adjacent turbines in a direction perpendicular to the wind, and 10 diameters spacing in a direction of the wind.

It is difficult to accurately measure the costs of wind plants. The costs for a commercial scale wind turbine ranged from $1.2 million to $2.6 million, per MW of nameplate capacity installed. Most of the commercial-scale turbines installed today are 2 MW in size and cost roughly $3.5 Million installed. Wind turbines have significant economies of scale. Smaller farm or residential scale turbines cost less overall, but are more expensive per kilowatt of energy producing capacity. Wind turbines under 100 kilowatts cost roughly $3,000 to $5,000 per kilowatt of capacity.

If we use the rotor of diameter 8m then we can be able to obtain 31.8 kW from per turbine. As the periphery of Saint Martin's is about 20 km, Therefore a scope of setting [(20000/ (4*8))] = 625 turbines per row, assuming space between the poles are four times of their diameter.
If the number of row is doubled then the total number of turbine = 625*2=1250
So total energy produced = 1250*31.8
= 39750kW or 39.75MW
i.e. we can easily generate about 40MW from the island using wind turbine.
The total cost would be about (40*1.5) or 60 million US dollars (4800 million TK.)

5. Cost comparison:

Table 1: Fuel, Transmission and Distribution Costs

Energy Technology	Share of Fuel Cost in the Each kWh	Initial Investment, O& M Costs for Each kWh	Transmission and Distribution Costs for Each kWh	Total cost for Each kWh
Coal	Tk.1.00	Tk. 1.00	Tk. 1.25	Tk. 3.25
Oil	Tk. 17.89	Tk.1.50	Tk. 1.25	Tk. 20.64
Gas	Tk. 1.11	Tk. 1.10	Tk. 0.85	Tk. 3.06
Wind Energy (11KV, AC)	Tk. 0.00	Tk. 5.91	Tk. 1.75	Tk. 7.66
Solar PV (11KV, AC)	Tk. 0.00	Tk.79.18	Tk. 1.50	Tk.80.68

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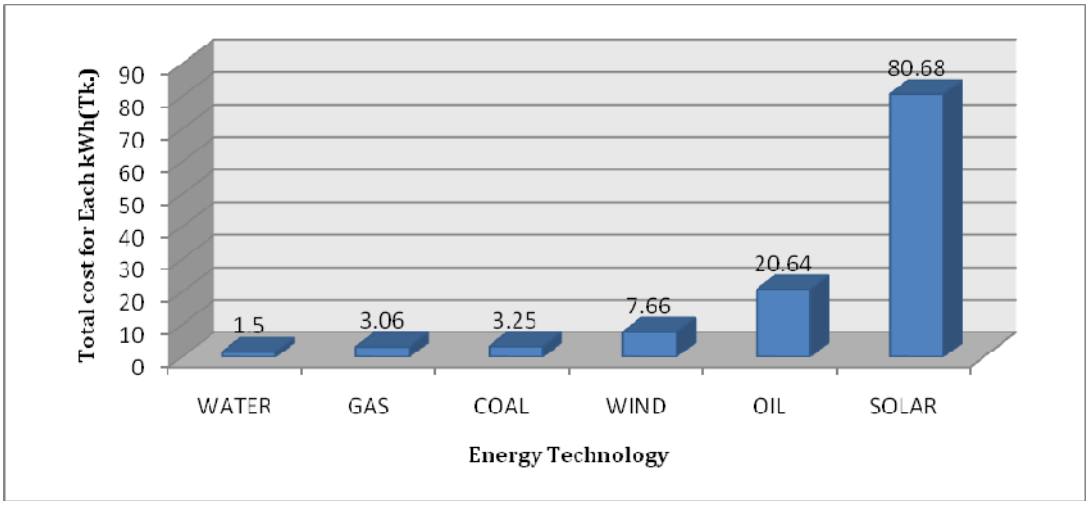

Fig. 7: Comparison of costs

The comparison is shown on the above figure. We have seen that in case of wind energy we need not any fuel cost whereas it would require about 20.64 Tk. when using oil as fuel. Though total cost for each kWh is 7.66 Tk. in wind energy plant due to high investment but actual running cost is about 1.18 Tk. (2 US cent) only.

6. Conclusion:

In Saint Martin Island, Wind Energy is one of the replacements of Solar Energy and it reduces a lot of cost. In the near future, wind energy will be the most cost effective source of electrical power. In fact, a good case can be made for saying that it already has achieved this status. The major technology developments enabling wind power commercialization have already been made. There will be infinite refinements and improvements, of course. So the government body should come forward to set up the project of setting this project and remedy the crisis of power in this island. The government can distribute the total work among different private companies so that the total project could be run within short periods. At the same time they must be sincere to proper maintenance of the ground equipments (especially from flood water) as from the past stories it has been found that due to lack of maintenance the wind turbine cannot give its maximum output.

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Customer Behavioral Segmentation at Banking System using Principal Components Analysis and Artificial Neural Network: The Quality Management

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Abstract

Banking system is very important and essential part our daily life. For bank and business purpose, customers are the key factors for prosperity and development. In that case the customer behavior trace is very useful for the progress of the bank. Customer behavior segmentation is a technique of dividing customers into separate, meaningful, and homogeneous subgroups based on various features and facts. Bank. This work emphasis on the improvement of the start-of -the -art in commercial practice through machine learning data mining. Proper technology to assess huge amounts of transaction data to count efficient Customer Behavior Segmentation (CBS) in an exact time is a fundamental problem. We analyze the date set by K-Medoids Algorithm (KMA) .Besides the KMA, we also imposed Fuzzy K-Means and Fuzzy K-modes algorithms. The Principal Component Analysis (PCA) is finally used to correlate the appropriate data set. We noticed that K-Medoids Algorithms is better only for the linear and Quantitative data set. On the contrary, Fuzzy K-Means is better when there are lots of mixed data sets, I mean both for Qualitative and Quantitative. We suggest both of the algorithms for separate environments and policies.

Keywords: *Bank fraud detection, machine learning data mining, Principal Component Analysis (PCA), K-Medoids Algorithm (KMA), Fuzzy K-Means and Fuzzy K-modes algorithms.*

1. Introduction

Financial sector of a country comprises with commercial banks, non-bank financial institutions, insurance companies etc. In the investment arena and financial system of the country Banks play significant role by mobilizing people's savings in the form of deposits. Banking business has been shaped as global business and the rest other business greatly depends on the strength of banking performance. Expansion of bank branches is also directed to increase the network of the banking system. In a sense, healthy banks and healthy economies seem to go together (Kashem & Ullah, 2005). A healthy banking system depends on the sound performance to satisfy the clients' need promptly in the appropriate manner. For bank and business purpose, customers are the key factors for prosperity and development. In that case the customer behavior trace is very useful for attaining the ultimate goal and progress of a bank. Benhabib and Spiegel (2000) argued that the economic growth is positively linked to financial development. Later on, it is observed that a country having a well-organized banking industry can achieve economic growth rapidly as a consequence of the financial development (Levine, 2005). Customer segmentation is one of the vital functions of the marketing management approach to marketing. This approach involves with the identification of the relevant market that the company is serving and the partitioning of the market into groups of customers (segments) with similar needs and/or characteristics who are likely to exhibit similar purchase behavior. The aim can range from a purely descriptive aim of creating better understanding of the situation in the customer base to a highly

normative aim of generating actions in order to influence the profitability of different segments of the customer base (Kaj Storbacka, 2009). Maintaining clients and performing cross sales play a determinative role in a bank's profitability, market segmentation and the examination of customer attitude and beliefs towards banking services. Customers today are demanding a more personalized service and look for an optimal customer experience. Direct in-person customer contact and customer advisory services in the branch provide opportunities for banks to enable a high-quality, differentiated customer experience supported by innovative technology, such as surface computing, interactive media, information/transaction terminals, and multifunctional ATMs (cash points), enhancing the customer value proposition.

2. Objective of the Study

The banking sector in Bangladesh has achieved unprecedented expansion in terms of number and diversity of business keeping the view of individual and national perspectives. Most of the banks are using value based segmentation; renewing and detailing their segmentation schema in line with their business objectives that will help them realize untapped potential. However, having a look into the past literature, the present authors found a significant research gap invariably relevant to the issues presented in this paper. The paper tried to portray a fruitful combination between modern sophisticated programming tools (Computer Algorithm and Artificial Neural Network) and the ultimate goal and functions of the financial service providing organizations like banks of a country. The authors assume that the study will have a far reaching value in understanding the behavior of different types of customers linking to banks and delivering timely services ensuring smooth functioning through proper customer segmentation. Thus, the paper aims at application of proper technology to assess huge amounts of transaction data to count efficient Customer Behavior Segmentation (CBS) in an exact time to deliver prompt services which will be helpful in accelerating banks' smooth functioning system.

3. Literature Review

There are many references in international literature on customer segmentation and the factors that affect the purchasing behavior of financial product consumers. Apart from the use and reliability of psychological characteristics as segmentation criteria and the supremacy of ad hoc segmentation, Harrison [7] and [10] further dispute the adequacy of demographic characteristics for market segmentation. Beckett [3] presents a model that characterizes consumer behavior during the purchase of a financial service. By using as determinative factors of behavior the involvement in the service and the uncertainly of choice, they result in 4 types of consumers, depending on the combination of two characteristics. According to Arthur Meidan [12], the factors affecting the behavior of financial product consumers are divided in internal (psychological such as motivation, perceptions, and personal such as life cycle, age, profession, economic status, personality), external (cultural and social) and purchasing procedures. Bank customers are today more informed than ever before and have a high level of confidence in choosing products and service providers for themselves. Dr. Markus Hamprecht and Frédéric Brunier [5] in their study titled "Enhancing the banking customer value proposition through technology-led innovation", analyzed the new customer requirements towards banks. The study sheds light on the importance of technology for the banking customer and provides practical advice and tools for bank managers. Islam and Yang [8] observed that service quality satisfaction and informational trust had important mediating effects on the Balance score card performance process. These two mediating roles explain that, when an institution creates and raises the levels of service quality satisfaction and informational trust, the results lead to a favorable customer interaction relationship and thus could help the institution achieve higher levels for Balance score card performance measure. W. Boyd et al [4] focus on demographic characteristics, such as gender, age, marital status and records customer preferences in selecting their bank. Marla Royne Stafford [13] also highlights the importance of demographic characteristics stating that even though other types of segmentation are used (e.g. consumer behavior, psychological factors), a marketing expert

should know and understand demographic criteria in order to be able to estimate the size, the approach and the effectiveness of the market. Moreover, demographic criteria constitute an easier means of segmentation. The paper of G. McDougall et al. [11] is also based on psychological characteristics, aiming at examining the way quality of offered services is perceived by different client groups.

4. Technical Classification

Any organization in the world will run by the influences and utilization of users. The users may be mass people throughout the world. The contribution by the users will make any organization stable and permanent. In the context of business users are called as customers or consumers. The business prospects of industry cannot be succeeding without satisfaction of the customers who remain loyal and develop their relationship with the organization. On the eve of customer happiness the company always tried to design strategy of welfare and benefit. To achieve the goals the authority can follow any process like CRM (Customer Relationship Management) for building, managing, and strengthening loyal and long-lasting customer relationships. CRM should be a customer-centric approach based on customer insight. Its scope should be the ‘‘personalized’’ handling of customers as distinct entities through the identification and understanding of their differentiated needs, preferences, and behaviors. In order to make the CRM objectives and benefits clearer, let us consider the following real-life example of two clothing stores with different selling approaches. Employees of the first store try to sell everything to everyone. In the second store, employees try to identify each customer’s needs and wants and make appropriate suggestions. Which store will finally look more reliable in the eyes of customers? Certainly the second one seems more trustworthy for a long-term relationship, since it aims for customer satisfaction by taking into account the specific customer needs. CRM has two main objectives:1. Customer retention through customer satisfaction.2. Customer development through customer insight.

5. Behavioral Segmentation

In behavioral segmentation the segments are identified with the application of appropriate clustering models on usage/behavioral data that usually reside in the organization’s data warehouse or data marts. Thus behavioral segmentation can be implemented with a high degree of confidence and relatively low cost. Attributes that can be used for behavioral segmentation include product ownership and utilization, volume/type/frequency of transactions, payment and revenue history, and so on.
Typical behavioral segments that can be found in banking include below:

Segmented Class	Functionalities
Depositors	Savings products – mostly deposit transactions using the network of branches.
Future investors	Insurance and investment products – few payment and deposit transactions.
Consuming borrowers	Consumer lending products (credit cards and consumer loans) – moderate to many transactions using all channels.
Frequent travelers	All kinds of products – many transactions through different channels and many international transactions.
Shoppers	Credit cards and other products – many transactions using mostly credit cards for purchases.
Needs borrowers	Mortgage loans and consumer loans – mostly payment transactions using the network of branches.
Classic users	Savings products and cards – moderate transactions mostly through branches and ATMs.
Transactioners	Payroll savings products with low balances – many transactions mostly for making small withdrawals for everyday needs.
Inactive	Unused savings accounts – no transactions. Typical behavioral segments that can be found in *mobile telephony* include
Roamers	Heavy users of all available services – the key differentiating factor is that they use their cell/mobile phones to make calls from abroad.
Superstars	Heavy users of all available services and all new cellular services (Internet, MMS, 3G, etc.).

Professional users	Heavy voice users – increased voice usage and a very high incoming community (the incoming community is the number of distinct callers that have called the specific
Classic users	Average voice and SMS usage.
Youth – SMS users	Heavy SMS users – they prefer using SMS to voice
Oldies – basic users	Voice usage only – very low incoming community.
Inactive	No outgoing usage for a significant time period. A detailed methodological approach for behavioral segmentation is presented in ‘‘A Guide for Behavioral Segmentation’’.

Table 1: Over all Bank behavior of the existing system.

6. Data Collection

We have visited five private bank and two government bank in Patiya regions of Chittagong city. We also talked with the Branch manager as well as the senior employers of the Bank. Mr.Ifteler branch manager of Brack Bank told us that customers want the benefits from them in all sides especially when there are huge congestions. Some customers are very excited when they did not get quick responses. When customers are not getting their demands they become very much furious to the respective employers. Mr.Sumon, a senior officer of the EXIM bank told us that the female customers are more polite but they do not have any idea on banking transaction.

Bank Name	Customer Name	Loan ID	Loan Account	Location
Brack Bank	Tapos Bormon	4001	124782	Patiya
Brack Bank	Afjal Hossain	4012	783141	Do
Brack Bank	Abdul Aziz	4902	321574	Do
Brack Bank	Hira Das	4092	492345	Do
Brack Bank	Morjina Begum	4982	438921	Do
Dhaka Bank	Earsad Ullah	8723	234120	Do
Dhaka Bank	Emam Uddin	8701	234045	Do
Dhaka Bank	Abul Khair	8728	230912	Do
Dhaka Bank	Towhidul Islam	8723	234570	Do
Dhaka Bank	Karim Uddin	8703	249072	Do
UCBL Bank	Jahedul Islam	5423	764848	Do
UCBL Bank	Nishita Shaha	3452	658392	Do
UCBL Bank	Moktar Hossain	4563	652310	Do
UCBL Bank	Abutahar Mia	4567	680213	Do
UCBL Bank	Khursad Fazil	7832	602343	Do
Janata Bank	Asis Mia	0923	984536	Do
Janata Bank	Farhan Ali	0876	908765	Do
Sonali Bank	Tipu Sultan	3424	214567	Do
Sonali Bank	Korim Monshi	3214	213468	Do
Agrani Bank	Absar Mia	0123	987566	Do
Agrani Bank	Josim Uddin	0342	982342	Do

Table 2: Customer information from different banks.

7. The K-Medoids Clustering Method

i. Determine ***k*** data set arbitrarily
ii. For each pair of non-identified data set ***h*** and determined data set ***i***, calculate the total swapping cost TC_{ih}
iii. For each pair of ***i*** and ***h***,
    1. If $TC_{ih} < 0$, ***i*** is changed by ***h***
    2. Then assign each non-determined data set to the most similar data set.
iv. repeat steps 2-3 until there is no change

Total swapping cost

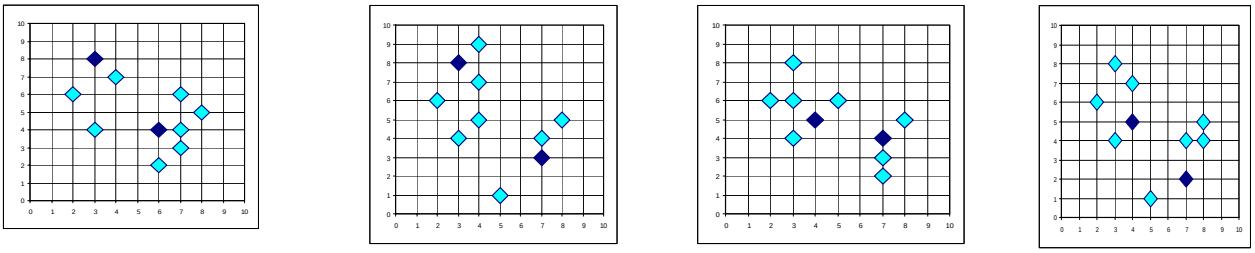


Figure 1: The K-medoids clustering for various customer segmented mentioned at table 1.

8.THE *K-MEANS* CLUSTERING

Given *m*, the *m-Means* algorithm is implemented in 4 steps:

i. Partition objects into *m* nonempty subsets
ii. Calculate pivotal points as the centroids of the clusters of the new orientation. The
iii. Partitioned each object to the cluster with the nearest pivotal point.
iv. Go back to Step 2, stop when no more new assignment.

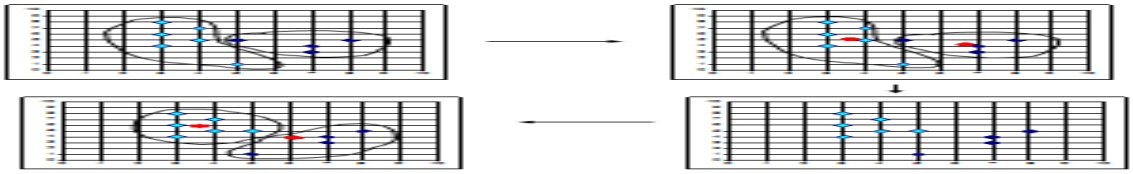


Figure 2: K-Means Clustering Algorithm.

9. Principal Component Analysis

From *k* original variables: $x_1,x_2,...,x_k$:

Produce *k* new variables: $y_1,y_2,...,y_k$:

$y_1 = a_{11}x_1 + a_{12}x_2 + ... + a_{1k}x_k$

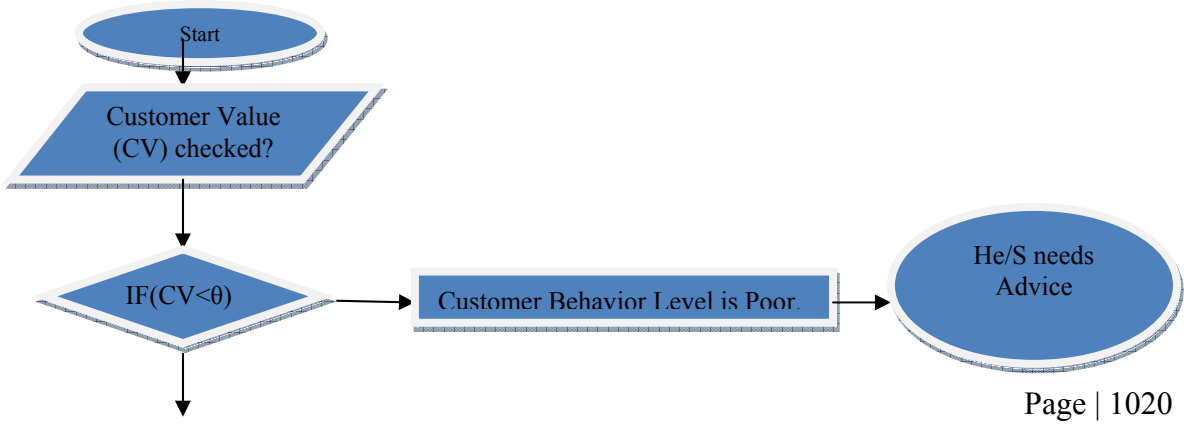
$y_2 = a_{21}x_1 + a_{22}x_2 + ... + a_{2k}x_k$

...

$y_k = a_{k1}x_1 + a_{k2}x_2 + ... + a_{kk}x_k$ From *k* original variables: $x_1,x_2,...,x_k$:

10. Implementation

Here we have segmented the three categories of the customers based on their attitudes, gestures, patients, movements, demands, body languages, communication skills and literacy. According to the algorithms of K-Means and K-Medoids Clustering, we have noticed that K-Medoids perform very well and finally the Principle Component Analysis (PCA) correlates all the classifications results. We define a threshold value of standard behavior after talking with Branch managers of five banks including two governmental Banks. Based on their opinion we then check this parameter with the K-Medoids Algorithm threshold value. Then we finalized the value is θ=0.24. The flow chart of the process is given below.



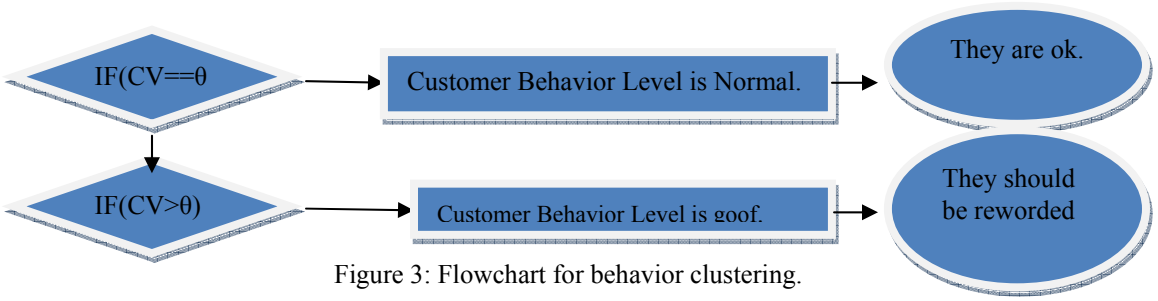


Figure 3: Flowchart for behavior clustering.

11. Result

Bank Name	Customer Name	Loan_ID	Loan Account	Location	Segmented
Brack Bank	Tapos Bormon	4001	124782	Patiya	Good
Brack Bank	Afjal Hossain	4012	783141	Do	Poor
Brack Bank	Abdul Aziz	4902	321574	Do	Ok
Brack Bank	Hira Das	4092	492345	Do	Ok
Brack Bank	Morjina Begum	4982	438921	Do	Poor
Dhaka Bank	Earsad Ullah	8723	234120	Do	Poor
Dhaka Bank	Emam Uddin	8701	234045	Do	Poor
Dhaka Bank	Abul Khair	8728	230912	Do	Poor
Dhaka Bank	Towhidul Islam	8723	234570	Do	Poor
Dhaka Bank	Karim Uddin	8703	249072	Do	Poor
UCBL Bank	Jahedul Islam	5423	764848	Do	Poor
UCBL Bank	Nishita Shaha	3452	658392	Do	Poor
UCBL Bank	Moktar Hossain	4563	652310	Do	Good
UCBL Bank	Abutahar Mia	4567	680213	Do	Ok
UCBL Bank	Khursad Fazil	7832	602343	Do	Poor
Janata Bank	Asis Mia	0923	984536	Do	Poor
Janata Bank	Farhan Ali	0876	908765	Do	Good
Sonali Bank	Tipu Sultan	3424	214567	Do	Good
Sonali Bank	Korim Monshi	3214	213468	Do	Ok
Agrani Bank	Absar Mia	0123	987566	Do	Ok
Agrani Bank	Josim Uddin	0342	982342	Do	Ok

Table 4: The resultant part of the experiment.

12. Conclusion

Developing effective strategies across a range of behavior segmentation disciplines requires broad insights into customer value, potential value, behaviors and needs. By implementing Customer Relationship Management (CRM.) and creating client databases, it is possible for financial institutions to analyze and perform effective and profitable market segmentation. This is possible through assessing information collected in order to determine common preferences and ways of behavior, depending on common characteristics of the various customer groups, such as demographic, geographical, psychological, etc. Managing different banking relationships and comparing products and services between different providers is becoming easier for customers through direct channels, Internet blogs, and forums, and social networks. The present paper stimulates the future researchers in this field opening a new dimension in the existing literature regarding the issues of banking customer behavior segmentation using Principal Components Analysis and Artificial Neural Network in order to accelerate the modern banking system.

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A Case Study: Supply Chain Uncertainties and Required Integration Based on Shared resources in the Chemical Industries

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Abstract

One of the main themes in supply chain management is integration along the supply chain in order to improve performance. This paper contributes to a better understanding of what business conditions determine integrative practices. A framework is developed to investigate what level and scope of integration can be achieved in a supply chain dominated by shared resources, if the type and amount of uncertainty varies for different buyers. This framework is further explored in a case study of two colors manufacturing chemical industries and its six main buyers for one month through critical observations and interviewing techniques. Major findings obtained from the study are determining level of integration which is needed for different uncertainties for different buyer- supplier relationships based on hared resources of chemical industries.

Keywords: *Supply Chain, Integration, Buyer-supplier relationship, Shared resources, Uncertainty.*

1. Introduction

The fundamental value of supply chain management for business improvement is widely acknowledged [3], [2], [4]. In theory, SCM means a proactive relationship and integration among various tiers in the chain [5]. An important idea seems to be that integration within and across firms is a pivotal element of supply chain management [6], [1]. Shared network resources are resources (product or process oriented) that are used by a supplier in the network for more than one buyer. Here, buyers competing for the resources seem to be one of the main barriers in achieving integration. This paper focuses on the type and level of integration that is achievable with each buyer if the supplier's capacity is shared.

2. Literature Review

Integration and integrative practices

From the SCM literature, it is clear that integration is closely associated with performing activities in several areas in co-operation with other organizations in a chain. Joint activities can be developed in different areas. This is labeled as the scope of integration: the number of supply chain areas in which cooperation is developed. Furthermore, this paper distinguishes four logistical areas as separate dimensions of the scope: flow of goods, planning and control, organization, and flow of information (see Table 2.1) [9], [7], [8], [10].

Table 2.1 includes examples of Integrative practices within the four logistical areas.

Dimension	Examples of integrative practices
Flow of goods	Packaging customization, common containers, vendor managed inventories(VMI)
Planning & control	Joint forecasting and/or planning, multilevel supply control [11]
Organization	Partnership, quasi-firm [13], virtual firm [4],JIT II [12]
Flow of information	Sharing production plans, EDI, internet, barcoding

The level of integration can be described [14] as to what extent an integrative activity is developed. The level of integration applies to each of the areas presented under the scope.

Classification of Uncertainty

In order to distinguish between the different kinds of risks, the sources of uncertainty need to be separated into two different constructs:

1. Endogenous uncertainty: The source of uncertainty/risk is inside the SC and can lead to changing relationships between focal firm and suppliers, the most notable kinds are market and technology turbulence.

Market turbulence: Market turbulence is likely to arise from the hetero-genetic and rapid changes in the composition of customers in the market and their preferences [15]. Market turbulence can also be caused by mergers or acquisitions. If a supplier is acquired by another company or the divestiture of a certain division occurs, this can result in delivery or quality problems.

Technological turbulence: Technological turbulence refers to the degree to which technology changes over time within an industry and the effects of those changes on the industry [16]. Technological turbulence arises from changes in the underlying technologies of products or services and their rates of obsolescence [15].

Endogenous uncertainty can be reduced with a proper and proactive relationship with a supplier (using methods like information sharing, relationship development, joint reviews, etc.) [17].

2. Exogenous uncertainty: The source of uncertainty/risk is from outside the SC. Possible disruptions can be classified as long-term uncertainties (e.g. raw material/final product unit price fluctuations, seasonal demand variations) and short-term uncertainties (cancelled/rushed orders, equipment failure, etc.) [18], while those risks can be classified based on their likelihood and impact on business [19].

Our proposed classification of exogenous uncertainty is novel by virtue of its distribution of risk on the probability distribution of its impact:

1. Continuous risk: Events where the costs of potential changes are continuous in nature and relatively easy to predict (example: changes in raw material prices). For such risks, a calculation of the effect of a certain price increase on profit margins can be made and different insurance instruments can be arranged in advance [23].

2. Discrete events: This category consists of low-likelihood, high-impact events which can be classified as terrorism, the spread of diseases, natural disasters [20]. These are often hard to predict and their consequences can be large yet hard to measure.

While endogenous uncertainty can be measured with precise (and previously validated) questionnaires, the exogenous uncertainty is harder to estimate.

Uncertainty, shared resources and integration

A number of authors have explored the influence of uncertainty on integration in the supply chain. Three sources of uncertainty: customer demand, manufacturing and supply, control system [21], [10], [22].

The level of integration needed depends largely on the amount of uncertainty within the supply chain. In this paper, it is discussed the impact of the different kinds of uncertainty on the\allocation of capacity and the need for integration in a supply chain (see Table 2.3).

Table 2.3A framework for integration in case of shared resources and different levels of uncertainty

SC uncertainty	Impact	Integrative practices
Low-volume, low mix/specification	Necessity to integrate is absent	Simple ordering procedures (continuous replenishment, quick response), working together in optimizing the control of inventories (e.g. Vendor Managed Inventories), physical flow (e.g. Kanban).
High-volume, low mix/specification	Supplier has difficulty in capacity planning, buyers are reluctant to future commitments	Stocks, practices to improve physical flow
Low-volume, high mix/specification	High obsolete risks, capacity requirements stable, broad scope and high level of integration is necessary	Capacity reservation or buyer-focused operations enables broad scope and high level
High volume, high mix/specification	Stocks and capacity reservations are not feasible options, shared resources as important barrier	Information exchange crucial, supplier orchestrates the different links with buyers

However, it is important to know what products have to be produced (the specification and the mix) and how much capacity needs to be planned or reserved (volume).

3. Research Methodology

Introduction to the case study

The suppliers under study are relatively small part of two different large multinational color manufacturing companies named Berger paints and TAJ MG. Berger paints chemical industry which is situated in Savar, Dhaka and the Toyo Ink and Chemicals Bangladesh Limited is situated 83 Rajashan, Savar, and Dhaka-1340. The supplier was studied during a period of 1 month, with about two site visits. Both the length of the period and the use of different methods, interviews with different persons from various departments and the combination of qualitative and quantitative data made validation of data possible.

Supply characteristics

Raw materials are picked from the warehouse. These raw materials are mixed according to the recipe. Supply uncertainty is thus practically absent. Planning is based on monthly forecasts from sales (replenishment orders) and actual customer orders. Still, the delivery reliability is roughly 95%.Demand is lumpy and one-off for most buyers. Uncertainty comes into being through both the specification of the product, the moment of ordering and the amount asked for. For the purpose of clarity, it is restricted itself to the relationship of the pigment supplier and the six largest buyers of their pigments of two different color manufacturing industries. Table 4.1 contains a summary of their general characteristics.

4. Data Collection and Analysis

The supply chain uncertainty as experienced by the pigment supplier for each link is summarized in Table 4.2. The levels of uncertainty are based on the numbers in Table 4.1 and the regularity in orders as well as assessments from the planners and sales people.

Table 4.1 Characteristics of the six main buyers under two different paint industries

Name of industries	Berger Paints (Berger Chemical industries)			TAJ MG (Toyo Ink & Chemicals Bangladesh limited)		
Topics	Developers	Domestic Appliances	Compounding	Packaging I	Packaging II	Garment
Product life-cycle	3 years—10 years	3 months—few years	2.5–3 years	2.5–3 years	Long	Long
Order cycle	1 week-3 weeks	Few days' — 1.5 week	10 days	Project	<1 week	<1 week
Sourcing policy Relationships	Single More than 5 years	Single More than 5 years	Dual 2 years	Multiple More than 5 years	Single 10 years	Dual 10 years
Stocks Supplier	3 months	3 months	2 months	Varies per project (no inventory risk)	2 months	6 months
Upstream	limited	Very limited	Substantial	N/A	1 month	2 weeks
Obsolete stock	1%	6%	0%	0%	0%	0%
Customer-Order Decoupling-Point	Make-To-Order	Make-To-Stock (for most products)	Make-To-Order	Make-To-Order (delivery from stock)	Make-To-Order	Make-To-Order (delivery from stock)

Table 4.2 Levels of uncertainty across the six buyers

Name of industries	Berger Paints (Berger Chemical industries)			TAJ MG (Toyo Ink & Chemicals Bangladesh limited)		
Types of uncertainty	Developers	Domestic Appliances	Compounding	Packaging I	Packaging II	Garment
Uncertainty (short term)	Almost High	Almost high	Medium	Low	Almost medium	Almost medium
Mix/specification	Medium	High	Medium	Low	Low	Low
Volume	Medium	Medium	Medium	Low	Medium	Medium
Uncertainty (long term)	High	Medium	Medium	Very high	Medium	Medium

Analysis for Developers

Despite the experienced uncertainty (high in specification, medium in volume), the level of integration remains high and the scope is narrow. According to Table 2.3, information exchange is crucial to enable the supplier to orchestrate the shared resources' capacity for the different supply links.

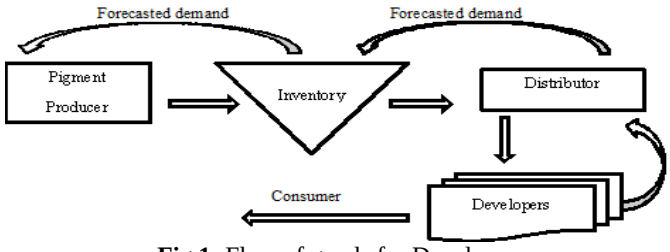

Fig.1: Flow of goods for Developers

Analysis for Domestic appliances

Despite the experienced uncertainty (high in specification, medium in volume), the level of integration remains high and the scope is narrow. According to Table 2.3, information exchange is crucial to enable the supplier to orchestrate the shared resources' capacity for the different supply links.

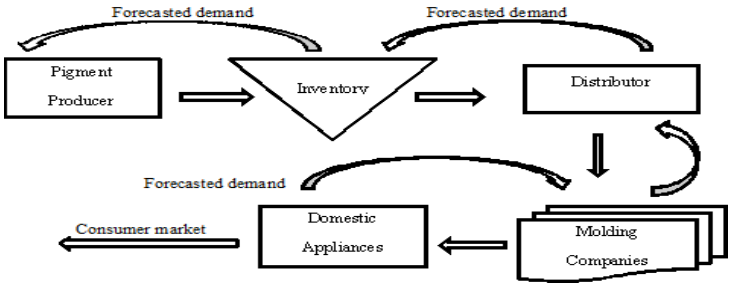

Fig.2: Flow of goods for Domestic Appliances

Analysis for Compounding

Given the medium level of uncertainty in volume and mix/specification, Table 2.3 suggests a somewhat higher level of integration. However, Compounding and the pigment producer both keep considerable stocks. Because of these stocks, uncertainty as experienced by the pigment producer is in fact low. Therefore, it is not surprising that the scope of integration is restricted (only exchange of information) and that the level of integration is not high. A better attuning of the level of stocks by means of an integrated planning and VMI is feasible in this situation and will reduce costs in the chain.

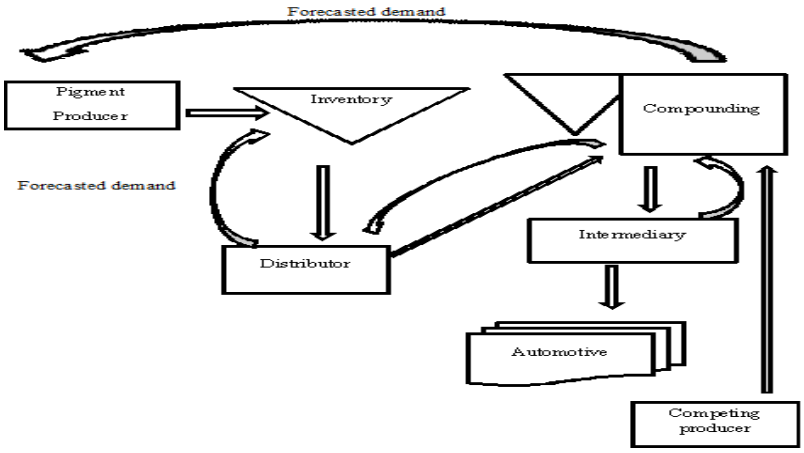

Fig.3: Flow of goods for Compounding

Analysis for Packaging I

This link can be characterized as high uncertainty in the longer run, but low uncertainty in the operational stage of a project in the short run. Within each project there is hardly any uncertainty and sale of stocked items is guaranteed. The number of projects varies each year and the timing of projects is difficult to predict. Therefore, integration of activities is restricted to the projects themselves. Given the level of uncertainty within the projects, the narrow scope and the low level of integration are in line with Table2.3.

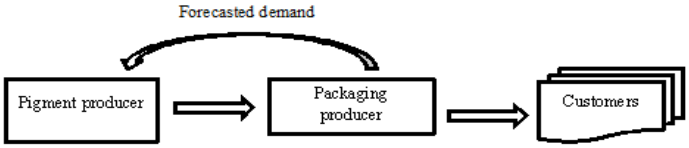

Fig.4: Flow of goods for Packaging I

Analysis for Packaging II

The activities of the pigment producer and Packaging II are not integrated at all. There is some uncertainty regarding the volume and timing of orders. If the buyer and supplier would decide to reduce their stocks, Table 2.3 suggests a higher level of integration to cope with the uncertainty in volume and timing. This reduction in stock levels might be achieved by sharing more information.

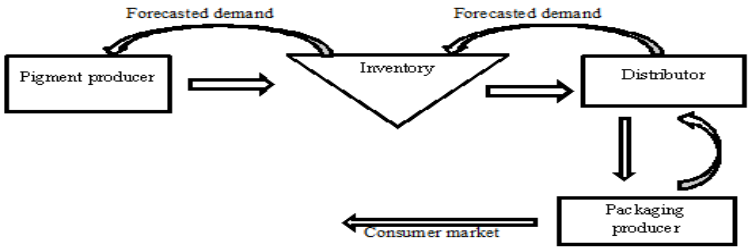

Fig.5: Flow of goods for Packaging II

Analysis for Garment

Garment uses a dual sourcing policy with our pigment producer supplying 66% (see Fig.6). Due to this sourcing policy, there is some uncertainty with respect to timing and volume. The colors, however, are not often subjected to changes. The low level of integration and narrow scope seems appropriate.

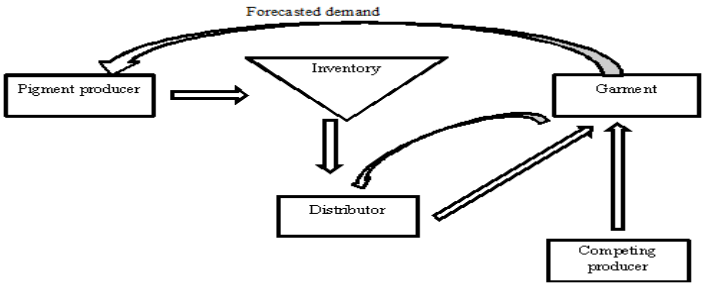

Fig.6: Flow of for goods garment

5. Discussion

Here, this paper concentrates on supply chains that are dominated by shared resources: common capacity used for different supply chains. The paper develops a framework for the influence of uncertainty on the level and scope of integration, in case of shared resources. The findings in the case study are in line with what is expected, but more research across more different cases in different industrial sectors need to be performed to limit possible biases from studying only six supplier–buyer relationships in the color manufacturing chemical industry. Another area for further research is the level of performance associated with different levels of integration.

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Development of Human Machine Interfacing (HMI) Software for Force Circulated Wood Pulp Digester

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Abstract

In this study an automated computer control small size force circulated pulp digester is designed and fabricated in BCSIR. Pressure and temperature sensors are used to read monitor and control the digestive system. A single parameter, H-Factor is used to control the pulp digestive process by measuring temperature and time. Depending on the properties of raw materials, H-Factor is set in the software. The analog values of temperature and pressure are being read by an analog programmable logic controller. These readings are then transferred to a computer using Visual Basic software. The temperature readings are then stored after every fifteen minutes and it is further proceed to calculate the H-Factor in the software itself. When the calculated H-Factor is less than that of set value, the heater and pump remains running condition. The heater, digester, pressure and temperature meters have been drawn and shown graphically on the monitor using this developed human machine interfacing (HMI) software.

Keywords: *H-factor, micrologix 1000 PLC, temperature and pressure transmitter, VB6 software*

Background

Forced circulated pulp digester is available in Canada, USA, EEC, Japan, Korea, Taiwan, China[6]. The digester vessel is designed and fabricated according to the codes of American Standard and Manufacturing Engineering (ASME) [1]. Nowadays this pulp digester is incorporated with full automatic computer controlled human machine interfacing software. As a result the price of pulp digester becomes very high. The cost of a ten liter capacity pulp digester including HMI software is about twenty lakh taka. Where as we designed and fabricated the same capacity pulp digester as per ASME code and developed HMI software for this digester at the cost of ten lakh taka. The international manufacturing companies design and develop the HMI software for their business purpose and sale only front edge software not the the back end software. As a result we are bound to buy their digester at higher cost. If we are capable to develop the back end program of HMI software, various types of digester, equipment and machine can be manufactured in Bangladesh in near future. With a view to this target, the HMI software is developed.

Introduction

This digester is a self-contained circulation type pulping pressure vessel system. The vessels are available in the standard ten liter size or sizes (ranging from one to twenty liters, with practically any size available). The vessels are designed, manufactured as per ASME Pressure Vessel Code Section VIII, Div 1. The vessels are easy to operate and maintenance. A reciprocating pump circulates the liquor through a 3 kW electric heater. The heated liquor returns to the top of the vessel where it is distributed over the pulp. The liquor return is directly over the center of the chip basket to assure even distribution of the liquor. The circulation flow is variable by means of a variable speed motor controller on each pump. An optional flow meter is available for indication of the actual circulation calibrated in liters per minute. The flow enters the vessel on top of a removable stainless steel basket in which the wood chips are placed. A perforated weight is supplied for placement on top of the wood chips to ensure chip packing and uniform distribution of the liquor. A valve in the top cover provides a means for application of steam or for the evacuation of air. The dual vessel system enables the user to generate steam or to preheat liquor in one vessel for use in cooking in the other vessel. One K type thermocouple sensor is used to measure the

temperature of the liquor in the vessel. A temperature transmitter (4 -20 mA) is also used to connect with an analog based PLC to control and interface data transfer to a computer. Visual Basic 6 is used to show temperature meter, pressure meter, electric heater and a pump. Cook programming and control is run by means of Windows compatible software. The software features graphical temperature and pressure indicators, Temperature vs. time graphing, Proportional, Integral and Derivative (PID) type control with and auto-tune feature, and H-factor cook control (the cook may be automatically terminated when a user defined H-factor is achieved[2].

H-factor- Time and Temperature

The delignification process is strongly depended on temperature. At low temperature, below140^{0}C, the delignification reactions are slow but increases fast in rate as the temperature rises. An increase in temperature with 10^{0}C results in a twofold increase in delignification rate. For this reason, it is difficult to judge how far the delignification has been preceded by the cooking time if the temperature has fluctuated. The time and temperature have therefore been combined in a single expression, the H-factor. This has been accomplished with the equation (1) $H = \int_0^t k_r \, dt$

$$\text{or } H = \int_0^t e^{(43.2 - \frac{16113}{T})} dt \qquad (1)$$

k_r is called the relative rate constant or comparison rate constant at a temperature to that at 100^{0}C[3]. Here temperature T must be at absolute temperature. H factor is different for different wood pulp. It varies from 500 to 2000 to be completed for the digestion of various wood pulps.

Determination of H-Factor

In order to determine H- factor, temperature readings are taken every 15 minutes of the cook and relative rate constants k_r determined. The k_r is plotted versus time. The area under the curve is equivalent to the H factor (Figure1). Sample calculations for the determination of the H factor can be found in figure2. The calculation method is given in table-1 for the determination of endpoint at 3 different temperatures. It needs to be stressed that this equation only estimates the effects of time and temperature and assumes constant effective alkali, sulfidity, liquor/wood, wood species, etc. The temperature is recorded every fifteen minutes and at same time relative reaction rate constant is also calculated for each temperature using equation (1). The area under the curve is determined by trapezium rule. The total area is segmented after each fifteen minutes (0.25 hr.). The relative constant rate k_r is determined at the temperature attained after each fifteen minutes. Then it is made average taking consecutive two respective values of k_r. The area of each segment is determined by multiplying this average k_r with time interval. Successively it is added and goes up to fixed value of H- factor that is previously set or given. In the following table and curves it is shown the relative constant rate (K_r) and H- factor. Considering the temperature 80^{0}C and its absolute temperature T = (80+273) K = 353 Kelvin. Putting this value in equation (1) , relative constant rate,

$$k_r = e^{43.2 - \frac{16113}{T}} = e^{43.2 - \frac{16113}{353}} = e^{43.2 - 45.65} = e^{-2.45} = 0.086 = 0.$$

Similarly, the relative constant rate is calculated for different temperature and shown in table 1.

Table 1: Calculation of H-factor when temperature rose to 170^0C within 3 hours

Start h	Temp ^{0}C	Relative Constant	Av. relative Constant	Multiply X	Time interval	=	H-factor
0.00	80	0	0	x	0.25	=	0
0.25	95	0	2	x	0.25	=	1
0.50	110	3	9	x	0.25	=	2
0.75	125	15	41	x	0.25	=	10
1.00	140	66	163	x	0.25	=	41
1.25	155	258	590	x	0.25	=	148
1.50	170	921	921	x	0.25	=	230
1.75	170	921	921	x	0.25	=	230
2.00	170	921	921	x	0.25	=	230
2.25	170	921	921	x	0.25	=	230
2.50	170	921	921	x	0.25	=	230
2.75	170	921	921	x	0.25	=	230
3.00	170	921	921	x	0.25	=	
Total							1582

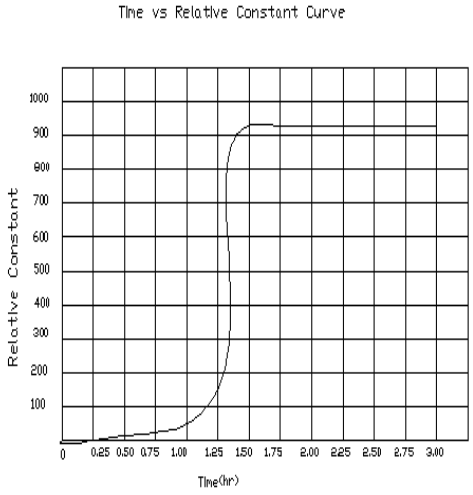

Fig.1

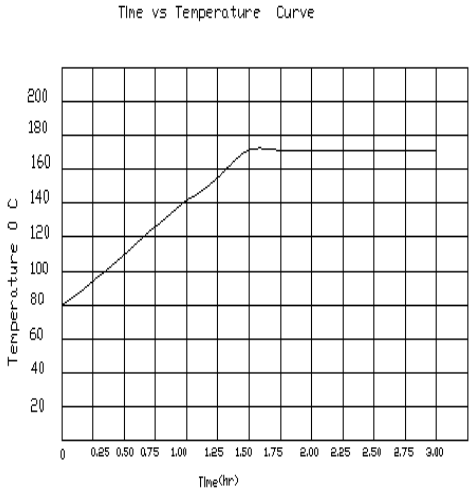

Fig.2

The area (A) under the time (t) vs relative constant rate (k_r) is defined as $A = f(t, k_r) = k_r \times t$. From figure-1 and figure-2, it is seen that temperature gradually raises and after certain period temperature is kept constant by using a thermocouple controller. The average (Av.) relative constant is determined by adding successive two k_r values and diving by two i.e. $(Av.\ k_r)i = \{(k_r)_i + (k_r)_{i+1}\}/2$. It is noticed that $k_r \geq 0.5$ is treated as 1. For example, at 95^0C, $(Av.\ k_r)_2 = (0+3)/2 = 1.5 \approx 2$.

Software Design and Analysis

To fabricate a forced circulated wood pulp digester, a strong pressure vessel is designed as per ASME pressure vessel code. To operate and control the digester an electric heater, a reciprocating pump, safety valve, K type thermocouple (0-650^0C), temperature and pressure transmitter (4-20 mA) and an analog based programmable logic controller (PLC) are used. At first electric heater and pump motor is being started and temperature rises gradually. The analog value of corresponding temperature is transmitted to the PLC by the transmitter and afterwards this value is interfacing to a computer through a serial port. The micrologix 1000 analog model of allenbradly PLC is operated on RSLogix500, Visual Basic ActiveX control and Visual Basic 6 (VB6) software[4]. These three software are used to develop to control and monitoring this forced circulated wood pulp digester. Grade-Industrial software built in VB6 is also used

to develop the human machine interfacing (HMI) of this digester. One temperature meter, one pressure gauge, one heater and a pump is chosen from the Grade Industrial software and placed on the VB6 display form. Ten text boxes are taken to show actual value of temperature, time, H-factor, set H-factor etc. The design of software display is shown below.

Graphical HMI Software

HMI Program in VB6, Active X control and Grade Industrial

```
Option Explicit
Dim i As Byte
Dim x As Byte
Dim y As Byte
Dim h As Integer
Dim m As Byte
Dim n As Integer
Dim p(10) As Long
Private Sub cmdRUN_Click()
GXLight1.LampOn = True
Gadget1.Discrete01 = True
```

```
Gadget2.Discrete01 = True
Gadget2.Discrete02 = True
End Sub
Private Sub cmdSTOP_Click()
Unload Me
End Sub
Private Sub Timer1_Timer()
Text11 = Val(Text11.Text)
Text9 = Val(Text9.Text)
Text9 = Val(p(0)) + Val(p(1)) + Val(p(2)) + Val(p(3)) + Val(p(4))+ Val(p(5))
If Text9 < Text11 Then GXLight1.LampOn = True
If Text9 < Text11 Then Gadget1.Discrete01 = True
If Text9 < Text11 Then Gadget2.Discrete01 = True
If Text9 < Text11 Then Gadget2.Discrete02 = True
n = n + 1
GXDisplay2.Text2 = Val(n)
Text12 = Val(n)
If n >= 15 Then
m = m + 1
n = 0
GXDisplay3.Text2 = Val(m)
Text13 = Val(m) '
End If
Text9 = Val(p(0)) + Val(p(1)) + Val(p(2)) + Val(p(3)) + Val(p(4))+ Val(p(5))
If Text9 < Text11 Then GXLight1.LampOn = True
If Text9 < Text11 Then Gadget1.Discrete01 = True
If Text9 < Text11 Then Gadget2.Discrete01 = True
If Text9 < Text11 Then Gadget2.Discrete02 = True
If m >= 5 Then
m = 0
Text6 = Val(Text16.Text)
GXDisplay1.Text2 = Val(Text16.Text)
GXDisplay10.Text2 = Val(Text16.Text) / 2 + Val(GXDisplay9.Text2) / 2
Text8 = Val(Text16.Text) / 2 + Val(Text7) / 2
Text7 = Text6
GXDisplay9.Text2 = Val(GXDisplay1.Text2)
p(i) = Val(Text8.Text)
GXDisplay6.Text2 = Val(p(0)) + Val(p(1)) + Val(p(2)) + Val(p(3)) + Val(p(4))
Text9 = Val(p(0)) + Val(p(1)) + Val(p(2)) + Val(p(3)) + Val(p(4))
i = i + 1
If i >= 5 Then i = 0
GXDisplay7.Text2 = Val(Text11.Text)
Text11 = Val(Text11.Text)
If Text9 < Text11 Then
GXLight1.LampOn = True
Gadget1.Discrete01 = True
Gadget2.Discrete01 = True
Gadget2.Discrete02 = True
Else
GXLight1.LampOn = False
Gadget1.Discrete01 = False
Gadget2.Discrete01 = False
Gadget2.Discrete02 = False
End If
End If
End Sub
Private Sub Timer2_Timer()
GXMeter1.Value = Val(Text16.Text)
GXLEDDisplay1.Value = Val(Text16.Text)
```

```
GXMeter2.Value = Val(Text17.Text)
GXLEDDisplay2.Value = Val(Text17.Text)
End Sub
```

Comparison between existing and developed one

HMI software can be developed by Java, Visual C++, Visual Basic language. It can also be developed by Labview or any other automation software. Siemens, Honeywell, Mitsubishi, Sony, Philips company use their own developed software. For example Siemens company use SIMATIC WINCC software which is very customized for only Siemens' product. Visual Basic software is used to create this HMI applications for several reasons[5]. Visual Basic language has some limitations to develop industrial HMI applications due to lack of tools for industrial applications such as control system hardware connectivity and data visualization. New technologies based on COM and grade industrial software have removed these barriers by extending the suite of tools and objects available to the Visual Basic developer. Engineers can utilize Visual Basic and quickly create simple HMI applications. From a budgetary standpoint, the potential savings are large. Developers creating applications in Visual Basic can distribute their compiled EXE applications at minimal cost. Per machine no licenses are required by the provider for the actual Visual Basic code. The developer creates or may use the built-in objects (text boxes, command buttons, etc). The Programmble logic controller or microcontroller can be used in this HMI software.

Discussion and Recommendations

The amount of lignin in different wood pulp depends on properties of wood. Therefore H-factor is not similar to all wood pulp. In table 1 it is shown that the general calculation method for finding H-factor. But in the software we can set the H-factor according to the required H-factor. Continuously the temperature and pressure is recorded in the software and calculated the relative constant rate, k_r every fifteen minutes and saves in another text. Timer1 is used to calculate every fifteen minutes and timer2 is used to read the temperature and pressure from the respective sensors through PLC to VB6 software that is developed for HMI monitoring and controlling the forced circulated wood pulp digester. There are many software available for developing human machine interfacing software. But the cost is too high. We have developed the HMI software using simple VB6 , active X control and RXlogix500 software. In this experiment we have used analog based alenbradly micrologix 1000. It is also possible to develop the HMI using microcontroller chip and hence cost will be lower.

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Application of Value Stream Mapping in Cement Industry's Supply Chain and Analyzing Results by Fuzzy Inference System

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Abstract

The purpose of this paper is to identify and address various wastes or non-value added activities in the supply chain of a cement industry using a value stream mapping (VSM) approach to improve productivity through reducing non-value added activities in a Bangladeshi context analyzing results by fuzzy inference system. Critical observations and interviewing techniques were used with open-ended questions to understand the processes involved in the value chain of the cement industry. Fuzzy inference system is applied to analyze results by showing rule and surface viewer through different inputs and outputs. Waste or non-value added activities removal from the cement-processing sector is one key to improving the productivity of the sector and showing the resultant output is changed by changing its corresponding inputs for various ranges by fuzzy inference system.

Keywords: *supply chain, value stream mapping, fuzzy inference system, Waste, cement industry.*

1. Introduction

The cement industry of Bangladesh is a rapidly developing sector of the economy Many countries cannot produce enough cement to meet their internal demand, and they depend on imports. Among local brands, Shah Cement, Meghna Cement, Crown Cement, Fresh Cement, Premier Cement and Seven Circle Cement are famous across the country. Despite the huge demand supply gap that persists for Bangladeshi cement industry, very little has been done for improvement in the productivity by reducing the processing waste of the industry. In this paper, an attempt is being made to apply value stream mapping (VSM) approach to address various wastes in the processing side supply chain of cement industry sector in Bangladeshi context and analyzing the corresponding results by fuzzy inference system.

2. Methodology

The data presented in this paper were obtained from a cement industry. Data about industry practices at large were collected over 1 month by conducting in-depth interviews with more than 25 practitioners working in various departments of cement industry (including supply chain engineers, warehouse operators, structural engineers, materials managers and expediters), raw material support suppliers (upper management as well a project managers and shop production managers). Interviews included an initial workshop and other face-to-face meetings, numerous telephone interviews with follow-up calls and e-mail exchanges.
Fuzzy sets can represent imprecise quantities as well as linguistic terms. Fuzzy inference system (FIS) is a method, based on the fuzzy theory, which maps the input values to the output values. The mapping mechanism is based on some set of rules, a list of if-then statements. In this research Mamdani fuzzy inference system is used to derive the overall output results when subjected to eight inputs and one output.

3. Waste Identification

Waste refers to all efforts that do not add value to the final product from the point of view of the customer. Reducing the share of non-value-adding activities is a tenet in process improvement. In the field of lean production, it is identified seven sources of waste [1]:

1. Defects in products
2. Overproduction of goods
3. Excess inventories
4. Unnecessary processing
5. Unnecessary movement of people
6. Unnecessary transport of goods
7. Waiting time

Womack and Jones [2] later recognized as an additional source of waste:

- Design of goods and services that fail to meet the user's needs

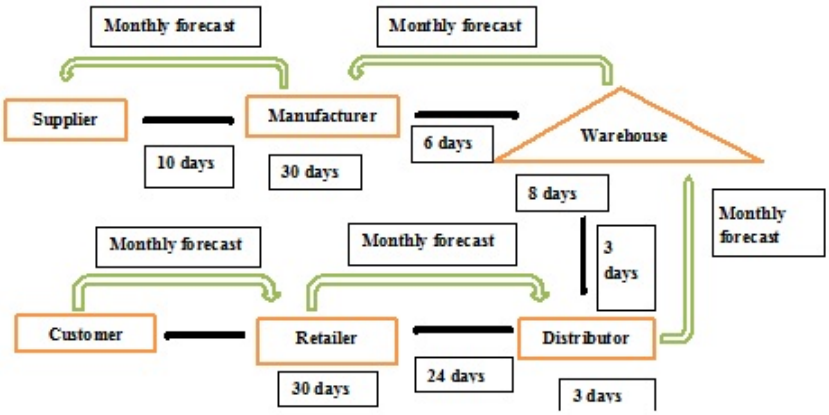
4. Case study: Application of value stream mapping in cement industry supply chain

Step 1: Agents identification

The manufacturer is Shah Cement industries limited, a local medium size company that acts in development and construction of residential and commercial buildings in all over the country. Now days, many cement industries are facing problems in terms of fixing up their incoming raw material sources. Shah Cement has however fixed two sources of clinker: Thailand and Malaysia. Clinker is brought to Bangladesh by using the company's own transportation. The company imports most of natural gypsum from India & rest of gypsum is imported locally (Bangladesh) as it provides it with more consistence of raw material. The fly ash is imported from India whereas the limestone is brought from Syhlet, a local region of Bangladesh.

Step 2: Current state mapping

In the current state of Shah Cement industry's supply chain network is followed by two different methods, at first raw materials are supplied to manufacturer, then after manufacturing and packaging the cement, then it is sent to different warehouses through different barges or ships and from the warehouse the fully packaged cements are sent to different distributors and then from distributors it is carried to retailers and from retailers it reaches to the hand of customers.50 percent of the total product follow the above network. Especially we are focusing on this above network which is shown in Fig.1



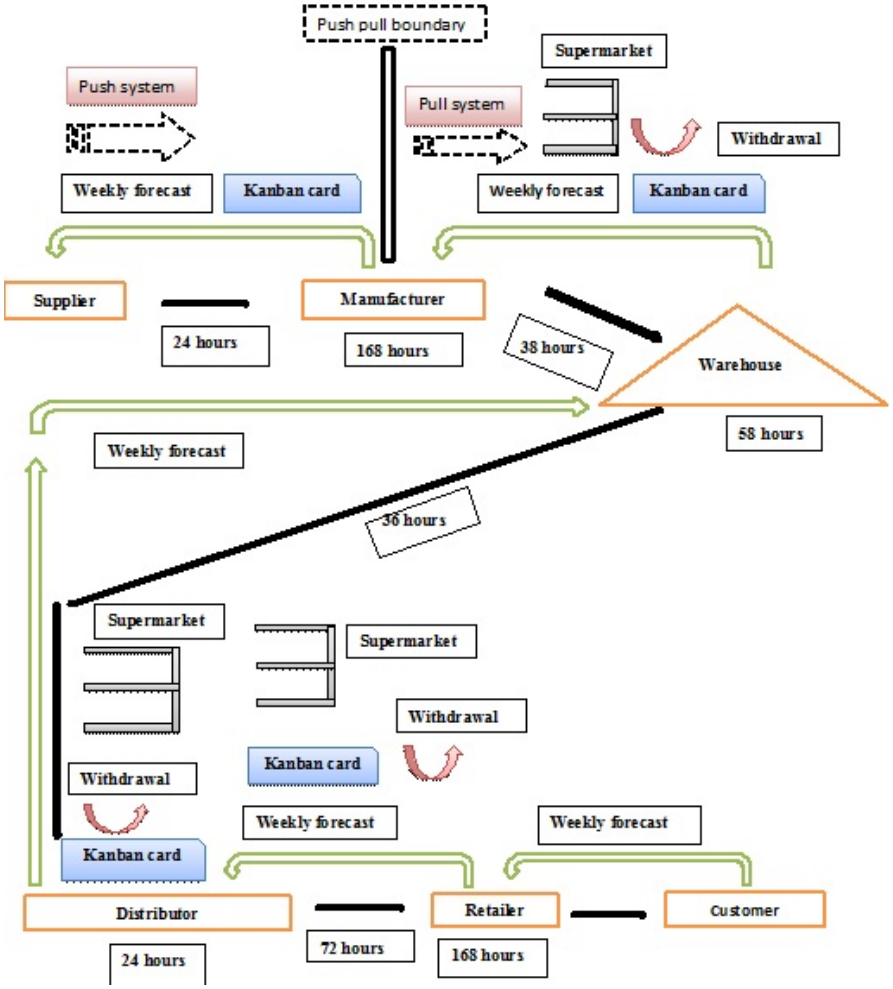
Time classification	Duration(days)	Percentage of time
Total value added time	30	26.31%
Total non- value added time	84	73.68%
Total processing time	114	100%

Figure.1 Current state mapping of supply chain network

Step-3: Future state mapping

Some proposed steps for future state mapping is suggested below. The first step is to waste elimination which can be the application of lean principles. With this improvement quality, productivity and lead time reduction can be achieved. The second step can be the development of pull system between supply chain agents. One potential suggestion is to implement Kanban Card system among supply chain agents. The Kanban Card system implementation implies significant changes in the supply chain network by adopting JIT (just –in-time) production, where each agent needs to produce what the customer demands actually. The Kanban Card system

is used to inform each company, the production necessity, changing the too each forecasts made with enormous forecasts antecedence for each agent. It is described some detail about Kanban Card system[3] and [4].By the implementation of pull production system through Kanban card system, supermarket and withdrawal, we have reduced non-value added activities or wastes from the supply chain network which is shown in the Fig.2



Time classification	Duration(hours)	Percentage of time
Total value added time	168	28.57%
Total non- value added time	420	71.42%
Total processing time	588	100%

Figure-2: Future state mapping of supply chain network

Step 4: creating action plans

Following suggestions or recommendations can be applied to improve the current state supply chain network of cement industry:

1. Adoption of pulled production through using supermarket and Kanban Card system in the supply chain network.
2. Stocks or inventory reduction inside the supply chain network by implementing JIT (just-in-time) methodology like warehouse, and distributor.
3. Minimizing the batch sizes or adaptation of small lots, it improves the communication between participants in the supply chain.
4. Fostering communication and co-ordination between supply chain participants It helps to increase flexibility and transparency that are needed to balance and synchronize flows in the supply chain network.
5. Creation of an integrated information system among all the supply chain agents.

6. Additionally, supply chain agents integration can be improved by means of period meetings, to discuss goals and strategies to reduce cost in the supply chain, to standardize the information flow, to warranty self-learning and to elaborate the action plans.
7. Resources must be dictated to particular tasks and have some excess capacity to buffer the anticipated variability in workload.

5. Analyzing results through fuzzy inference system

As In this research, the Fuzzy Logic Toolbox built on MATLAB is adapted. It provides tools to create and edit fuzzy inference systems within the framework of MATLAB. This toolbox also provides Graphical User Interface (GUI) tools to facilitate work, besides command line functions. Calculation method goes through the following steps:

- Expert knowledge is gathered and the suitable type of input variables and there range are selected. Mamdani type FIS is used for our research.
- For this work, for both the input and output, sigmoid membership function has been used. This is because it is a normal distribution curve.
- Rules are developed using MATLAB built in fuzzy inference toolbox.
- The surface viewer represents the relationship surface of result and two variables. The surface shows how result is changing with the changing of any two variables.
- By changing the value of the input factors, we can observe the effect on the output at rule viewer.

Some short specific features, which are mandatorily used for the simplification of this research, are following:

FIS Editor

Displaying general information about a fuzzy inference system is the main concern of FIS editor. The FIS Editor displays general information about a fuzzy inference system. There is a simple diagram at the top that shows the names of each input variable on the left, and those of each output variable on the right. The sample membership functions shown in the boxes are just icons and do not depict the actual shapes of the membership functions.

Membership Function Editor

Membership function is the mathematical function, which defines the degree of an element's membership in a fuzzy set. The Fuzzy Logic Toolbox includes 11 built-in membership function types. These functions are built from several basic functions:

1.Piecewise linear functions, The sigmoid distribution function,
2.The sigmoid curve and

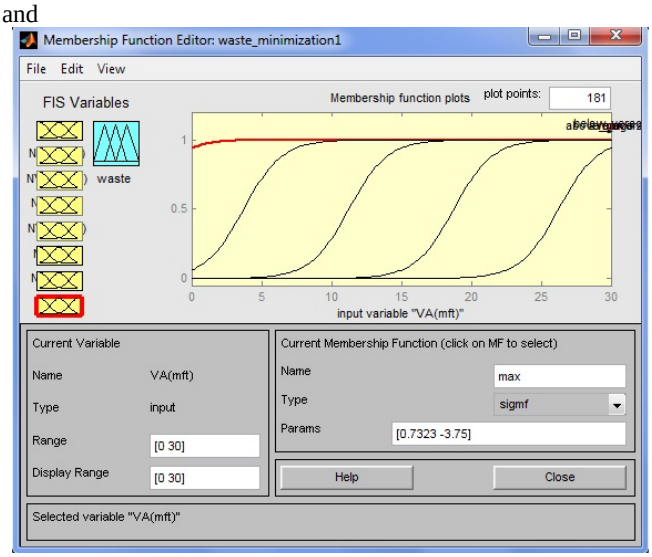


Fig 1: Membership Function Editor of FIS

Rule Editor

Constructing rules using the graphical Rule Editor interface is self-evident. Based on the descriptions of the input and output variables defined with the FIS Editor, the Rule Editor allows you to construct the rule statements automatically, by clicking on and selecting one item in each input variable box, one item in each output box, and one connection item. Choosing none as one of the variable qualities will exclude that variable from a given rule. Choosing not under any variable name will negate the associated quality. Rules may be changed, deleted, or added, by clicking on the appropriate button.

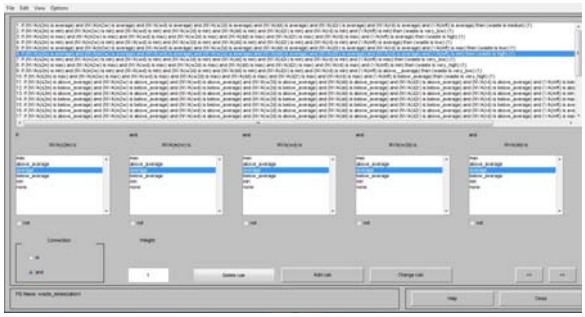


Fig 2: Rule Editor

Rule Viewer

The Rule Viewer displays a roadmap of the whole fuzzy inference process. It is based on the fuzzy inference diagram described in the previous section. You see a single figure window with 10 plots nested in it. The three plots across the top of the figure represent the antecedent and consequent of the first rule. Each rule is a row of plots, and each column is a variable. The rule numbers are displayed on the left of each row. You can click on a rule number to view the rule in the status line.

Fig 3: Rule Viewer

Surface Viewer

Upon opening the Surface Viewer, we are presented with a three-dimensional curve that represents the mapping from non-value added activity to value added activity and waste. Since this is a one-input one-output case, we can see the entire mapping in one plot. Two-input one-output systems also work well, as they generate three-dimensional plots that MATLAB can adeptly manage. When we move beyond three dimensions overall, we start to encounter trouble displaying the results. Accordingly, the Surface Viewer is equipped with pop-up menus that let you select any two inputs and any one output for plotting. Just below the pop-up menus are two-text inputs fields that let you determine how many x-axis and y-axis grid lines you want to include. This allows you to keep the calculation time reasonable for complex problems. Pushing the Evaluate button initiates the calculation, and the plot comes up soon after the calculation is complete. To change the x-axis or y-axis grid after the surface is in view, simply change the appropriate text field, and click either X- grids or Y-grids, according to which text field you changed, to redraw the plot.

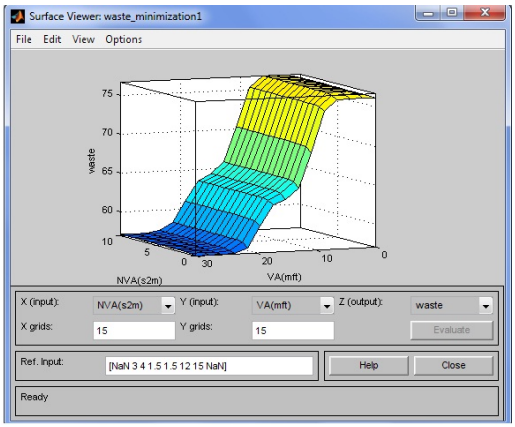


Fig 4: Surface Viewer

6. Discussion

Rother and Shook [5] rightly argue that whenever there is a product for a customer, there is a value stream. The challenge lies in seeing and working on it. VSM can be done in the same way for practically any business activity and expanded upstream or downstream. Cement Industry has a huge potential due to fast rising commercial and residential in Bangladesh. Use of inappropriate methods of processing, unorganized supply chain network and excess inventory is making the overall supply chain inefficient and is causing losses and wastes.

The manufacturing companies should use the optimal result which reduce the total waste and increase the overall profit. Fuzzy logic helps to find these optimal results if the company's expert provided data are available. In this research, using data of a cement manufacturing company the final result is obtained by which waste is minimized. Here, eight input variables are considered to find the variations in waste. For each input and output variable Sigmoid membership functions are considered to design the model.

7. Acknowledgements

A special thanks to Shah Cement industries limited that have collaborated information for the case study. Thanks are due to all the people interviewed, for the time they spent and knowledge they shared with us.

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Operation Management Techniques & Applications in Bangladeshi Industry

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Abstract

In developed countries, most of the industries use appropriate operation management techniques in production system. This is quite obvious that they posses high technology, skilled resources, and adequate raw materials. Unfortunately, Bangladesh has lack of high technology production plants and skilled manpower. Applying operation management techniques to improve production performance and limited resource and manpower utilization is one of the core techniques to overcome such issues. Previously, many attempts have been made to apply improvement techniques in various manufacturing industries. Under these circumstances, choosing the suitable operation management methods is quite important. In this paper, different operation techniques like, forecasting, inventory management techniques, aggregate planning, scheduling, CRP, MRP, ERP, time study, method study, work study and linear programming methods with applications in different manufacturing organizations are discussed. Findings suggest that forecasting techniques have been applied more frequently in recent times compare to twenty years ago. But forecasting accuracy has not improved much. The goal of aggregate planning is to achieve effective production planning with strategic decision and applications wherever, the effectiveness of using inventory management and scheduling is more important to run an optimal production system. All of these techniques can be used to improve production processes and can be benefited by using effectively and efficiently. Therefore, an attempt has been made to discuss appropriate use of operation management techniques and their applications in Bangladeshi industry.

Keywords: *Forecasting, Scheduling, Inventory management, Time study, Aggregate planning.*

1. Introduction

The economic environment of our country is very poor because of our industries have limited resources, raw materials, energy and technology. Moreover we have lack of knowledge on process improvement techniques, operation management techniques i.e., forecasting, inventory management, aggregate planning, MRP, CRP, scheduling, time study etc. whichare very necessary for effective productivity, increased efficiency. Many of our industries such as Garments, Textile, Automobile, chemical, Cement industries can boost up our economy and industrial sectors by applying these techniques. If manufacturing companies can potentially apply and get benefitted by these techniques, our industrial as well as service sectors will definitely have great impact on our economy as well as all over the world.

2. Background& Methodology

It has observed from previous statistics that Bangladeshi industries had changed a huge amount of its production capabilities compare to 20 years ago. Bangladesh has great opportunities to develop in industrial sector because of her sufficient amount of natural resources, available land and cheap labor. The key objective of this paper is to discuss the operation management techniques to industrial and related personnel in Bangladeshi industries. The major concern of this paper is to find suitable techniques for recent production problems and others activities of production system.We demonstrate the application of various techniques approach that how the use of operation management techniques could increase smoothproduction and profit line with optimum cost. This paper consists of some

necessary techniques, their purposes, scopes and opportunities in respect to our Bangladeshi industries. Information and data are collected from native source like,Meghna cement industry, Akiz Group, Navana Battery Ltd, BRAC Aarong, Epyllion Group etc. Beside the Industry sources, foreign journals and books are usedto solve some problems with examples.

3. Operation Management Techniques, scopes & applications

Operation management is a vast area in Industrial and Production Engineering where a large number of operation management techniques are used. This section will describe the nature and scope of operation management techniques and will present the issues of competition, strategy and productivity.

Forecasting

Forecast is an estimate of a production system that will happen in future. Forecasting is the process of estimating future demand in terms of the finance, timing, quantity, quality, and location for the desired products and service. An essential aspect of managing any organization is planning for the future. Organizations employ forecasting techniques to determine future inventory, costs, capacities, and interest rate changes.

Oppertunities & scopes

Forecasting is the powerful technique of making statements about future planning on production whose actual outcomes (typically) have not yet been observed. But it possible to meet the demand forecast. Some reputed industries applied this technique for future prediction. The key in forecasting nowadays is to understand the different forecasting methods and their relative merits and so be able to choose which method to apply. Defining a problem, products sales for a manufacturing company over the last 10 weeks are shown in Table 1, analyzed the data to see that linear trend equation is followed here. Calculation has followed trend line equation as well as predicted sales for 11 and 12 weeks.

Table 1. Forecasting data

Week(x)	Demand (y)	x*y	x^2
1	700	700	1
2	724	1448	4
3	720	2160	9
4	728	2912	16
5	740	3700	25
6	742	4452	36
7	758	5306	49
8	750	6000	64
9	770	6930	81
10	775	7750	100
∑x=55	∑y=7407	∑xy=41358	$\sum x^2$=385

Following the above values, a and b values have been calculated using following equations:

$$b = \frac{n(\sum xy)-(\sum x)(\sum y)}{n\sum x^2-(\sum x)^2} = \frac{10(41358)-55(7407)}{10(385)-55(55)} = 7.51$$

$$a = \frac{\sum y - b\sum x}{n} = \frac{7407-7.51(55)}{10} = 699.40$$

Following regression forecasting while the line equation is Y = a + b*x where, y=dependent variable, x=independent variable, a=intercept,b= the slope of the data line. For this problem, the regression line: y_x = 699.40 + 7.51*x. Now calculating the forecasted value of 11 and 12 periods,
F_{11}=699.40 + 7.51(11) =782.01
F_{12}=699.40 + 7.51(12)=789.52

Following different forecasting techniques, we can calculate future demand, lead time and quality of different product. This can be benefitted to increase productivity, scheduling, planning and production capacity estimation.

Aggregate production plan

Aggregate planning is an operational activity that does an aggregate plan for the production process in advance time to gain idea for management as to what quantity of materials and other resources are to be procured. For this reason, the total cost of operations of the organization is kept within budget over that period. It also determines the quantity and timing of resources that are required to match immediate periodic demand for all products. The aggregate planning usually helps to fulfill future demand by introducing modifications in the work force levels, overtime, vacation schedules, labor level, inventory levels, subcontracting, overtime, under time, and planned backlogs. Different strategies and techniques are used to balance the productivity. For example, the trial and error charting and graphic technique is easy to understand this technique that is also convenient to use and involves costing out various aggregate planning alternatives and selecting the optimum one for the production capacity.

Table 2. Summary of cost of alternating plan

Cost category	Pure chase strategy	Pure level strategy	Mixed strategy (mixed strategy work force=chase strategy work force)
Regular production	$340,296	$361,500	$347,147
Overtime production	$10,132	-	$9,600
Subcontracted production	$91,200	-	$73,960
Under time	$16,656	-	-
Inventory holding/ shortage	-	-	$11,420
Hiring / firing	$29,350	$1,514	$29,350
Total cost	$472,534	$560,453	$471,459

Scopes and Opportunity

Now a day, aggregate planning is significantly used in Garments, textile Industries, ceramics industry where Labor, Inventory levels, Overtime work, Subcontracting and Other controllable variables are utilized effectively. Various Automobile Industries i.e.,Aftab Automobiles Limited,Navana Group etc. usually apply pure strategies of aggregate planning. Companies can be benefitted by utilizing their capacity effectively (labor, plant, equipment etc.) through aggregate production plan.

Master production schedule

A master production schedule (MPS) is a plan for individual commodities to produce in each time period such as production, staffing, inventory.It is usually linked to production and manufacturing where the plan indicates when and how much of each product will be demanded.

Table 3. Customer order and MPS

Period	1	2	3	4
Customer orders	80	50	30	10

Period	(A) Inventory from previous period	(B) Requirements	(C=A-B) net inventory before MPS	MPS	(MPS+C) projected inventory
1	0	80	(80)	100	20
2	20	70	(50)	100	50
3	50	70	(20)	100	80
4	80	70	10	0	10

Starting Inventory =0	1	2	3	4
Forecast	70	70	70	70
Customer orders	80	50	30	10
Projected on-hand	20	50	80	10
MPS	100	100	100	0
ATP	20	50	60	0

This plan quantifies significant processes, parts, and other resources in order to optimize production cost, to identify bottlenecks, and to anticipate needs and completed goods. Since an MPS drives factory production activities, the accuracy and viability of using this technique dramatically affect profitability of the organization.

Typical MPS's are created by software with user tweaking.A typical MPS example is shown in Table 3. The forecast for each period is 70 units. The starting inventory is zero. The MPS rule is to schedule production if the projected inventory on hand is negative. The production lot size is 100 units.

Scopes and Opportunity

MPS is a business process design tool to balance and supply and in our country usually textile and clothing industries are benefitted by this technique. Demand management, material requirement planning, plant scheduling, supplier scheduling, financial planning activities are managed by this scheduling process. AbulKhair Group, Advanced Chemical Industries (ACI) etc. industry applying this to control their optimum production rate and productivity.

Time study

Time study is a work measurement technique for recording the time of performing a certain specific job or its element carried out under specific condition. Devices for example, stop watch ,taco meter, electronic timer are required for time study along with different other documents like, observation sheet ,observation board, job order or labor reporting data. Normally the cycle time is calculated for a certain work or task for further calculation of standard work time. An example is shown here.

Table 4. Normal and standard time calculation

Element No.	Cycle Time (min)				Avg. Cycle Time	Performance Rating	Normal Time
1	1.5	1.5	1.3	1.4	1.425	110%	1.568
2	2.6	2.7	2.4	2.6	2.575	110%	3.325
3	3.3	3.2	3.4	3.4	3.325	110%	3.658
4	1.2	1.2	1.1	1.2	1.175	110%	1.175
5	0.51	0.51	0.52	0.40	0.505	110%	0.555

PFD Allowance =15%
Normal time for the cycle = 1.568+3.325+3.658+1.175+0.555 = 9.531
Standard time = (9.531 + (0.15*9.531)) = 10.484 min

Opportunities of time study

Time study can eliminate insignificant task and nonproductive activities. It combines the sequence and layout of production and has been increased machine effectiveness. Scheduling and planning are properly maintained to determine the effective time. For that purposes reduces all type of timing waste, waiting time, processing waste, machine downtime. Time study can eventually increase performance or productivity that reduces all process waste or bottlenecks throughout the production. Batch or mass type production process normally follow the time study technique and can be benefitted.

Capacity Requirement Planning (CRP)

Capacity requirement planning is the process of determining the short term capacity requirements from MRP output. It is the process to give some necessary information to organizations on when planned order released, the current shop load, routing information job time and load report each work center. When variances are projected, the organization manager remedies such as alternating routing, changing or eliminating work size. CRP is the powerful technique that control plant capacity, changing demand, level production schedule; manage scheduling conflictsof an industry.

Table 5. CRP data for three departments

Process characteristics	Department		
	Grid casting	Pasting	Filling
Working hours per day	8	8	8
Processing time per battery, min	15	10	20
Average daily downtime, min	80	90	40
Average daily setup time, min	16	30	8
Defective time,%	6	4	9

Features and Benefits

CRP is the procedure that determines in detail the amount of labor and machinery resources required to accomplish the tasks of an operationplan. This tool is currently used widely in garment and textile industry. Beside that, food and beverage industry such as, Fu-Wang Group, Akiz Group of Industries and Automobile industry are also utilizing this technique to determine the amount of labors, number of equipment, machine efficiency, and production rate. Considering an example,Navana Battery Ltd. has signed a contract with Grameen Shakti for the delivery of 300 parts per year.Each battery is processed in three departments respectively grid casting, pasting, and filling shown in Table 5. The company operates 300days/yr.

Determination ofefficiency, (E) for each of the production stage,

Grid stage: $E_1 = 1 - \frac{DT-ST}{D} = 1 - \frac{80+16}{60*8} = 0.80$
Pasting stage: $E_2 = 1 - \frac{DT-ST}{D} = 1 - \frac{90+30}{60*8} = 0.75$
Filling stage: $E_1 = 1 - \frac{DT-ST}{D} = 1 - \frac{40+8}{60*8} = 0.90$

Determination of production rate (P) per stage,

Final demand, $P_{g.3}$=300 units/ yr.
Filling stage: $P_3 = \frac{Pg.3}{1-P}$ = 300/ (1-0.09) =329.67≈330 units
Pasting stage: $P_2 = \frac{Pg.2}{1-P}$ = 330/ (1-0.04) =343.75≈344 units
Grid stage: $P_1 = \frac{Pg.1}{1-P}$ = 344/ (1-0.06) =365.95≈366 units

Determination of equipment requirement(N):

Grid stage: $N_1 = \frac{T1}{60} * \frac{P1}{D*E1} = \frac{15*366}{60*8*.80}$ =14.3≈15 m/c
Pasting stage: $N_2 = \frac{T2}{60} * \frac{P2}{D*E2} = \frac{10*344}{60*8*0.75}$ =9.55≈10 m/c
Filling stage: $N_3 = \frac{T3}{60} * \frac{P3}{D*E3} = \frac{20*330}{60*8*0.90}$ =15.30≈16 m/c

Inventory Management

An inventory is a stock or store of goods. Manufacturing firm uses inventory management techniques to store raw materials, purchased parts, finished goods, machines, tools, and other supplies. Conventional inventory management follows different tools such as, ABC Analysis, EOQ, EPQ, Discount quantity, safety sock to determine the inventory costs that more important for every industry.

Scopes and Opportunity

Inventory management is an important technique of determining the quantity of products has stored, order cycle, length of order cycle, number of orders per years and annual total cost. It also determines the inventory cost and save a huge amount of money. For example, as a local distributor for automobile company expected to sell approximately 9,600 steel-belted radial tires of a certain size and tread design next year. Annual carrying cost is $16 per tire, ordering cost is $ 75. The distributor operates 288 days a year.

So, economic order quantity, $Q = \sqrt{\frac{2DS}{H}} = \sqrt{\frac{2(9600)75}{16}}$ =300 tires
Where H= Holding cost, S= Ordering cost, Q= Ordering quantity.

Then, number of order cycle: $D/Q = \frac{9600\ tires}{300\ tires}$ =32, Length of the order cycle = Q/D =300/9600=$\frac{1}{32}$ *288 =9 works day.
Total cost = holding cost + ordering cost= $(\frac{Q}{2})$*H + $(\frac{D}{Q})$ *S= (300/2)*16 + (9600/300)*75= 2400+2400=$4800.

4. Results & Discussions

The above discussion implies that a large number of manufacturing industries follow different operations management techniques and tools. The tools can improve productivity, efficiency and performance of the production and operation of the industry. An overview of different operation management techniques related to different manufacturing sectors and areas are listed in Table 6.

Table 6. Potential operation management techniques related to manufacturing sectors

Manufacturing sectors	Operation Management Techniques
1. Jute,cotton, textile and leather industries I. Cotton textile II. Jute textile III. Garments IV. Leather	a. Forecasting b. Aggregate production planning c. Inventory management
2.Manufacturing of food, beverage and tobacco industries. I. Tea and Sugar II. Soft drink III. Tobacco IV. Vegetable oil and soya-bean V. Flour milling.	a. Time study b. Method study c. Work study d. Supply chain management
3. Chemical, fertilizer, petroleum and rubber industries. I. Fertilizer II. Pharmaceuticals III. Insecticides IV. Paint and varnish V. Matches VI. Petroleum VII. Rubber footwear.	a. Linear Programming. b. Inventory Management. c. Transportation model.
4. Non metallic industry I. Glass industry II. Ceramics industry III. Cement industry	a. Material Requirement Planning. b. Forecasting.
5. Metallic industry I. Auto-mobile industry II. Furniture industry	a. Capacity Requirement Planning. b. Forecasting. c. Master Production Schedule(MPS)

5. Limitations &conclusion

Appropriate application and of different operation management techniques has become a major challenge in competitive industrial sectors. Although we have available human resources, we are running behind because of scarcity of skilled and technical human skill. From top management to worker, we have lack of knowledge on operation management techniques, improvement skills. It is recommended that to achieve the best possible output from operation management techniques; technical skill, human skill and conceptual skill must be employed in production and operation in manufacturing industry. By this, Bangladeshi industry can increased their productivity and efficiency.

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OpportunitiesforLean- Six Sigma (LSS) in Bangladeshi Industries

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Abstract

Companies around the globe are now suffering serious strategic plights by facing financial recession and huge competitive pressures. Countries in developing countries like, Bangladesh are also facing this issue and their manufacturing industries are not capable to compete others especially on waste reduction and quality problems. LSS is one of the most effective tools to overcome these problems and also improve the business process continuously. This approach is dynamic and synergistic force. Although this is a combined approach of reducing wastes and performance variations, the methodology is quite understandable. LSS is based on clear methodological principles and can be implemented on any process within any industry – in manufacturing and service, and in companies small to large. Lean and Six Sigma are collaborative and complementary in nature and when performed efficiently, represent a long term business practice that produces unparallel results. Lean accelerates Six Sigma and delivers greater results in terms of increased revenue, reduced costs and improved collaboration than what would typically be achieved by Lean or Six Sigma individually. Lean focuses on elimination of non value added steps in a process while Six Sigma focuses down its approach on reduction of variation over the remaining value added steps. This paper includes a methodology of LSS approach and presents how LSS improve the customer satisfaction, cost, quality and process speed. The paper also contains the basic principle of LSS and discusses why the use of LSS in manufacturing industry and service industry (hospital, HR administration) is so important. Main goal is to identify the opportunity of this mixed approach in various organizations. Finally, the overall execution process and value stream map show how LSS improve the process by bring a product (or transaction) though the main flows essential for every product/ service by discussing the opportunities of LSS for Bangladeshi industries.

Keywords: *Lean- Six Sigma, DMAIC, Value stream mapping.*

1. Introduction

Lean and Six Sigma are recent developments in continuous improvement methodology that have been popularized by several high-profile companies. The success and complementary nature of these methodologies has led to their combination into a single methodology, commonly called Lean Six Sigma or Lean Sigma. Lean Six Sigma has grown into a vital business discipline that was born of two individual methodologies--Lean and Six Sigma. Lean focuses on the elimination of waste from any and all business processes and centers around process flow and the separation of value-added and non-value-added. Six Sigma is a data driven approach for eliminating defective products. Lean and Six Sigma complement each other. Lean accelerates Six Sigma, delivering greater results than what would typically be achieved by Lean or Six Sigma individually. Combining these two methods gives your improvement team a comprehensive tool set to increase the speed and effectiveness of any process within your organization – resulting in increased revenue, reduced costs and improved collaboration. There are many ways that Lean Six Sigma can be applied to any type of company or organization. Lean Six Sigma more effective and different from its solitary isolated components is the fact that it optimizes the balance between "just quality" and " just speed". It is a balanced process that helps an organization with improving service quality, within a set time limit (DUSA, 2009) .You can readily start to apply it to your company. The LSS methodology integrates the human/customer elements like (culture change, customer focus, etc.) and process elements (process management, statistical analysis of data, measurement and system analysis, etc.) for improvement. Lean Six Sigma's growing popularity in the services industry masks a downside. Many organizations have trained and deployed legions of Lean Six Sigma experts—known as black belts—only to see little value result from their work. In a recent Bain & Company management survey of 184 companies, 80 percent say their Lean Six Sigma efforts are failing to drive the anticipated value, and 74 percent say they are

not gaining the expected competitive edge because they haven't achieved their savings targets. Not only service industry but also manufacturing industry has a vital role of LSS.It can be applied in garments manufacturing industry to minimize bottleneck, scrap product. The implementation of Lean and Six Sigma requires a systemic laid out plan that cannot be completed in a company board meeting in one day. This systemic plan of action is as crucial as the operating of the programs themselves. According to George (2003), failures occur most often in the execution of implementing of Lean and Six Sigma. The components of successful implementation and the creating of a Lean/Six Sigma culture will be introduced and discussed in great detail.

2. Literature Review

Overview of LSS

Lean Six Sigma (LSS) is a powerful, flexible and proven cost and waste elimination method that has been used successfully in both private and public organizations. It is applicable equally to both industrial/manufacturing processes and transactional/customer service processes. In other words Lean Six Sigma is a synergized managerial concept of Lean and Six Sigma that results in the elimination of the seven kinds of wastes (classified as Transportation, Inventory, Motion, Waiting, Overproduction, Over-Processing, and Defects,) and provision of goods and service at a rate of 3.4 defects per million opportunities. In order to understand the power of LSS methodology it is important to know about lean and six sigma.

Lean is an approach to organizational improvement that focuses on process speed and efficiency. It does this by a relentless search for all kinds of waste in the functions the organization performs. This waste is generally identified as non-value-add tasks, process steps, review cycles, reporting requirements and personnel practices that distract and take away from the absolutely essential functions the organization must perform. By identifying and eliminating these non-value-add activities, the organization decreases costs and shortens the time required to deliver goods and services to its customers (either customers in the traditional commercial sense of the word or citizens under the authority of a government entity.

Six Sigma is a set of tools and strategies for process improvement originally developed by Motorola in 1986. In other words, Six Sigma is a disciplined, data-driven approach and methodology for eliminating defects (driving toward six standard deviations between the mean and the nearest specification limit) in any process – from manufacturing to transactional and from product to service. Six Sigma also created a generalized problem solving methodology called DMAIC (Define, Measure, Analyze, Improve, and Control). In the first step, **Define,** you must talk to the user of your output to understand what they would like to see improved. In the **Measure** phase, you collect data to verify the users' issues. The **Analyze** and **improve** phases use the Statistical Process Control tool to reduce variation. Finally, the **Control** phase requires the owners of the process to sustain the benefits achieved.

Common LSS Terms

I. Common cause variation: Variation where the root cause is known or easily understood without advanced statistical analysis. For example, if different workers perform the same task in significantly different amounts of time, one obvious root cause would be lack of standard work, training, and best practices.

II. Non-common cause variation: Variation where the root cause is not readily evident and in which statistical analysis (e.g., DOE or ANOVA) must be performed to determine the root cause of the responsible independent variables. For example, a manufacturing defect may require quantitative analysis to determine which combination of variables is significant.

III. Tact time: Available time divided by customer demand. This produces a value in units of time per good or service. If tact time is five minutes, a value stream or cell should produce a good or service every five minutes.

IV. Value stream: All the actions, value-added and non-value-added, required to bring a product or service from raw material through to the customer.

Lean and Six Sigma make such a powerful combination because Lean maximizes value stream velocity and Six Sigma minimizes value stream variation. Without the combination, companies might fall into the trap of increasing value stream velocity alone; in that case, the quality of the end product may degrade because the firm produces more flawed product per unit of time.

LSS Principles

In lean Six Sigma, there are five principles that are used:

I. The first of these is the **law of the market**. This signifies that the customer is always to be put first. The company must implement this immediately and make sure that all employees adhere to it. The company wants the employees to understand that without the customers, there would be no business.

II. The second of these principles is the **law of flexibility**. If a process is easily maneuverable, it is easier to work with. A method of business that cannot be changed for any reason can cause problems.

III. The third principle is the **law of focus**. This is meant to keep the focus on the problems within the company and not the entire company itself. Executives and employees should concentrate on just the portions of the company that are causing problems and fixing those problems, dismissing distractions by other areas of the business that are not having problems.

IV. The fourth principle is the **law of velocity**. This means that if a process has many, many details that have to be performed, it may be slowing down the process. The work put into the process should be proportional to the results the company sees.

V. The fifth principle in lean Six Sigma is the **law of complexity**. Simply put, keep it simple. When a process is complex and difficult, it may have elements that are not necessary. More complexity does not necessarily mean more valuable or more important. In fact, it could mean just the opposite.

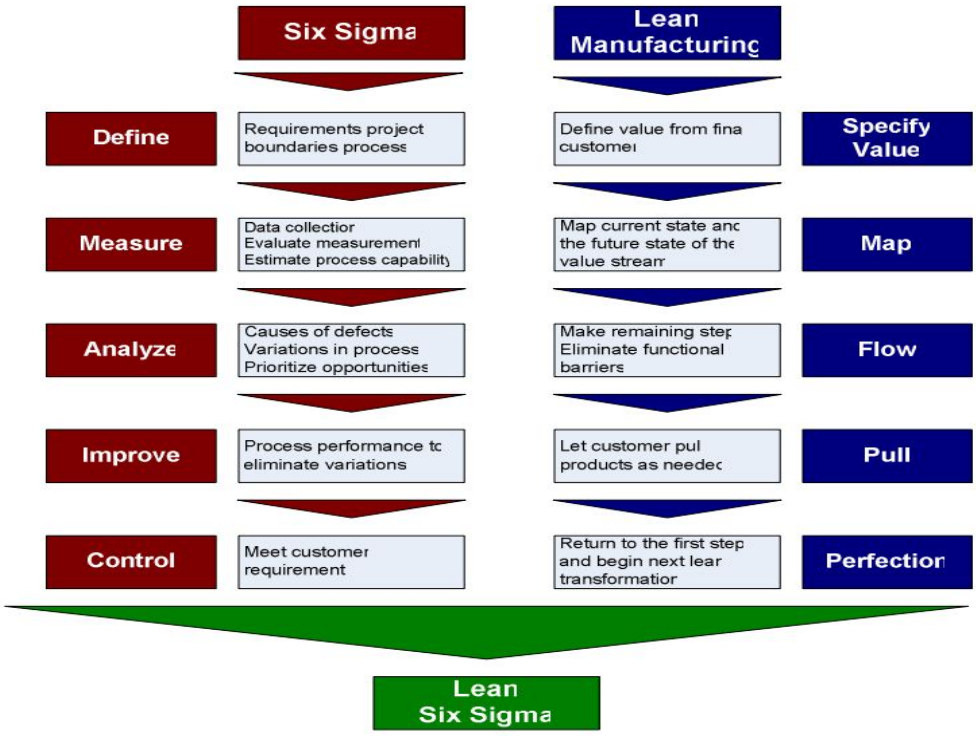

Fig.1. Combined Lean Six Sigma principles

General Applications

I. Lean Six Sigma can be applied to finance and accounting by reducing the time it takes to close the monthly accounting, controlling spending, improving the process to pay vendors, reducing the time it takes to complete payroll processing, improving payment receipts from accounts receivable and improving the forecasting process.

II. Use Lean Six Sigma in sales and marketing for improving time required to enter sales orders, reducing errors on sales orders, increasing the repeat orders process, reducing the time it takes to approve a new customer's credit line, reducing the time spent on bad deals or no sales, improving the cycle time from invoicing to receiving payment and improving client management processes.

III. Apply Lean Six Sigma to shipping and receiving by improving delivery time to customers, improving the documentation processes, improving inventory control and rotation and improving the inspection process.

IV. Implement Lean Six Sigma in information technology by finding ways to reduce network and server downtime, improve help desk processes, improve system reliability, improve technical support calls and responses and improve software and hardware upgrading processes.
V. Apply the process to call center departments by increasing or decreasing talk time on calls, improving employee knowledge and communication skills and reducing customer on-hold time.
VI. Apply Lean Six Sigma to product or service design by reducing the time it takes to complete designs, reducing the number and severity of design errors and reducing design testing time.
VII. Healthcare facilities can apply Lean Six Sigma in several ways including improving patient satisfaction and care, improving physician satisfaction, reducing costs and increasing savings, reducing time patients spend in the emergency room and eliminating system redundancies, bottlenecks and waste.
VIII. Education facilities can apply Lean Six Sigma by improving student satisfaction, teacher satisfaction, the registration process, the grade reporting process, the communications process from student to teacher to administrator, the teacher evaluation process, reducing waste and costs, improving all processes from handling student and teacher records to purchasing, information technology, bus routing and upkeep and building maintenance.

3. Methodology

The theoretical implementation of lean six sigma strategy is based on the following steps-

First step

Need to look at the "3 Real Things" in every operation.

I. Material Flow or Business Steps (i.e. transactional processes)
II. Information Flow (data)
III. Work-in-process

Second step

Need to answer the following questions.

I. Ask what?i.e., what is the operation doing?
II. Ask why?i.e., why is the operation necessary?

Anything which does not add value is waste. Once the function of the process is known, waste can then be identified.

An improvement plan can be achieved by asking how. For example: how the production process run?

Third step

Finally, major contributors need to be checked out.

I. Overburden/ overdoing (or called, MURI)
- Waste caused by how work and tasks are designed

II. Unevenness (or called, MURA)
- Waste caused by poor quality (process unpredictability)

III. Process methods (MUDA)

For overall implementation of lean with six sigma perfection, the process then need to be examined through DMAIC' (Define, Measure, Analyze, Improve and Control). The details of DMAIC process are as follows:

Define	Define the requirements and expectations of the customers Define the project boundaries Define the process by mapping the business flow
Measure	Measure the process to satisfy customers Develop a data collection plan Collect and compare data to determine issues and shortfalls
Analyze	Analyze the causes of defects and sources of variations Determine variations in the process Prioritize opportunities for future improvements
Improve	Improve the process to eliminate variations Create alternatives and implement enhanced plan
Control	Control process variations to meet customer requirements Develop a strategy to monitor and control the improved process Implement the improvement of the systems and structures

4. Theoretical Implementation of LSS

The execution of a Lean Six Sigma initiative includes three streams of activities:

I. Initiation
II. Resource allocation and project selection, and
III. Implementation&sustainability.

The Initiation stream includes the steps that are necessary to successfully execute Lean Six Sigma. These activities are conducted by the leader of an organization or company. The activitiesneed to be done by the CEO and those who directly report to CEO to implement and support the LSS initiative. These activities lay the foundation for a successful implementation. For this research effort the Initiation stream will be considered "deployment." CEO involvement is widely believed by most professional implementers to be a vital factor to LSS implementation. Lean Six Sigma expert Michael George states, "Over the past dozen years in working with both successful and failed continuous improvement initiatives, my colleagues and I have learned one hard-and-fast lesson: the Lean Six Sigma effort will succeed or fail based on the engagement and buy-in of the CEO and executives with P&L (Profit and Loss statement) responsibility" (George, 2002). This anecdotal evidence suggests that without the support and engagement of the top-level management of an organization it is impossible to organize and utilize the energy of the entire organization. This lack of support appears to doom a Lean Six Sigma or any quality improvement initiative to failure. The leadership support of Lean Six Sigma includes three specific activities performed by the CEO in coordination with the executive leadership.First is "CEO/executive engagement, as demonstrated initially by his or her active involvement in the upfront decisions about "where," "how," and "who" of Lean Six Sigma" which is followed by the second leadership activity "setting long-term (two- to five-year) fiscal and performance goals for the organization. The third and final leadership activity is, "commissioning a design/deployment team to champion the design of the Lean Six Sigma policies and architecture for the company" (George, 2002). The George Group's implementation model describes the design and deployment team's initial responsibilities are to "determine the gaps between current and desired performance, determine how Lean Six Sigma can close the gap, and develop a preliminary design for the implementation of Lean Six Sigma".

The implementation team's mission is to use the gap analysis to design the Lean Six Sigma plan to address the changes required to meet the desired performance levels. Once the theoretical issues have been addressed, the team then moves on to developing the infrastructure that will support the Lean Six Sigma implementation. With the CEO approval of the goals and the general deployment plan, the design team then sets about to develop a detailed deployment plan. According to George, "Meticulous planning for the first 100 days of implementation is a prime determinant of the ultimate success of a Lean Six Sigma launch and of your organization's ability to achieve major cost and lead time reductions and quality improvements in one year". According to George (2002) the detailed deployment plan should include the following components:

I. Process: Designing the critical Lean Six Sigma sustaining processes to be part of the normal business mode of operations.
II. Organization: Fleshing out the organizational structure by determiningthe roles, responsibilities, and reporting structures. Developing the criteria and selecting the champions and black belts. Identifying what training will be given to which groups of people.
III. Measures: Determining the measures of success.
IV. Rewards: Establishing mechanisms for collection of information and methods for providing rewards and recognition.
V. Tools: Determining requirements for supporting software tools.

Value stream mapping

A value streamis all the actions (both value added and non-value-added) required to bring a product (or transaction) though the main flows essential for every product/ service: from raw material/(customer need), through all the required steps, then – back to the arms of the customer. An example of typical value stream mapping for a manufacturing Industry is plotted here.

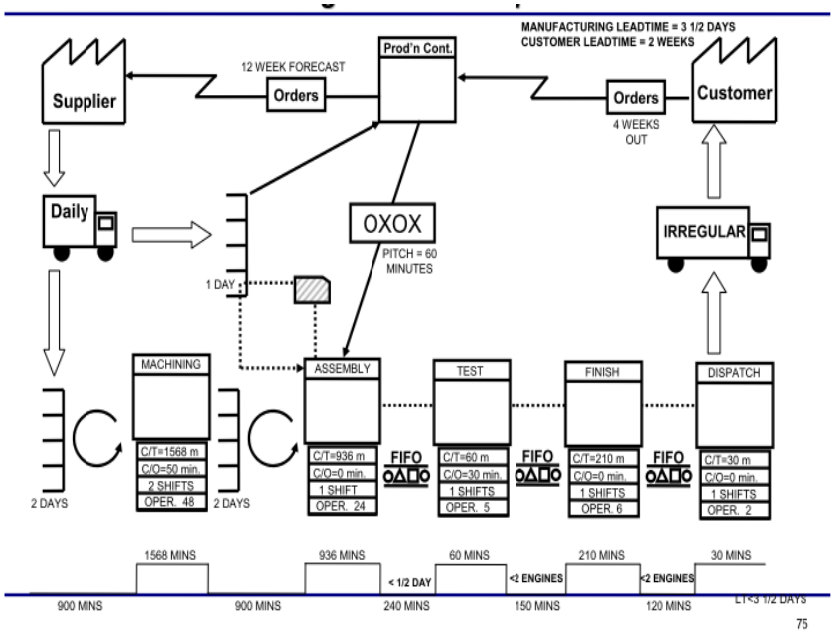

Fig.2. Value stream mapping

5. Limitations, Recommendations &Conclusion

The problems and challenges faced by an organization are gathering quality data, effective communications etc. significantly in between processes where no primary or metadata is available to begin with (Antony, 2008). The effective analysis, selection and prioritization of organization's projects can be one of the most critical factors for success of a Lean Six Sigma program. Many organizations still base the prioritization of programs, on a purely subjective basis, which often leads to program or project failure million opportunities. Lean Six Sigma implementation is most vulnerable to digress into a mere bureaucratic exercise if the project focus shifts on things such as the number of trained Black and Green Belts, etc. instead of bottom line organizational savings.This paper introduces the opportunities of Lean Six Sigma process, which combines the bests of Six Sigma and Lean. As a combined approach, it uses the strongest parts of each and reduces the limitations of each approach when they are used in isolation. The Lean Six Sigma process is extremely useful for those service companies and manufacturing industries that want to gain the benefits of Six Sigma while increasing customer satisfaction. Lean Six Sigma principles-based methods will change how you manage your business and sustain positive change into the future. The data based structure drives how management will make reality-based decisions and govern day-to-day employee performance. The suggested management strategy can provides an opportunities of reduce costs, improve quality, develop better schedules and time lines, increase speed and efficiency and reduce customer delivery time which have sealed its place as a leading methodology for improvement of our business in the present and hopefully in future for manufacturing industries in Bangladesh.

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Recent Trends and Issues of Sustainability in Battery Manufacturing Industries of Bangladesh

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Abstract

In recent times, sustainability is an important phenomenon for manufacturing industries. Sustainable manufacturing and recycling process can be applied in different manufacturing industries especially, battery industries to produce green product as well as process. Most industrial/automobile batteries contains hazardous components such as lead, bitumen, nickel etc. where lead is very harmful to human health and environment. This project is aimed at identifying the method of producing green lead-acid industrial/automobile battery and to study recent trends and advancements of the battery manufacturing industries in Bangladesh regarding sustainability. To accomplish this goal, green test of different parts contained by an industrial/automobile battery, various methods of making pure/green lead, reverse logistics and transportation of industrial battery, recycling of the battery, industrial battery manufacturing companies in Bangladesh and their sustainability has been studied. It is observed that only few battery industries in Bangladesh apply sustainable technologies and there is obvious scope of applying sustainable manufacturing among all the battery industries which will make the environment healthy, green and sound. Finally, this paper suggests various techniques and opportunities of sustainability in manufacturing industries as future recommendations.

Keywords: *Sustainability, Battery Industry, Reverse logistics.*

1. Introduction

Battery technology has already changed our lifestyles. In near future batteries are going to have even bigger effect on earth and human mankind. This research is to study the environmental impact of battery and its manufacturing process on earth, its recent trends if those are sustainable or not and the future possibilities. Our primary objective is also to collect information about manufacturing procedures from different battery industries existing in Bangladesh. How battery technologies can be improved referring to recycling, battery alternatives as well as correct battery handling, use and disposal are also discussed here. In this purpose, we selected lead acid battery to get relative information. In most countries, nowadays lead-acid batteries are used and returned for lead recycling. However, considering a normal battery, which contains sulfuric acid and several kinds of plastics, the recycling process may be a potentially dangerous process if it is not properly controlled. These technical guidelines are, therefore, meant to provide guidance to those manufacturers whom are planning to build their capacity in order to manage the used lead-acid battery wastes. A comprehensive approach is adopted and clear information is provided on these mentioned issues and it is expected that by using these guidelines country will be able to improve its actions in relation to the following aspects:

I. Protection and improvement of its environmental quality;
II. Protection of its population health;
III. Adoption of clean technologies in order to minimize waste generation;
IV. Adoption of reuse and recycle as means to protect non-renewable natural resources and reduce energy consumption;
V. Adoption the environmentally sound management of used lead-acid batteries;
VI. Creation of a sustainable and regulated system of lead utilization;
VII. Adoption of management plans for lead wastes;
VIII. Generation of social, economic and environmental benefits through the environmentally sound management of lead wastes.

2. Literature Review

Sustainability

Sustainability is based on a simple principle: Everything that we need for our survival and greater interests depend either directly or indirectly on natural environment. Sustainability creates and maintains the conditions under which human and nature can exist in productive harmony that permits fulfilling the social, economic and other requirements of present and future generations. Sustainability is important to make sure that we have and will continue to have, the water, materials, and resources to protect human health and our environment. A typical sustainable design cycle is drawn here. Any manufacturing process design should possesses green option or sustainability from raw material extraction to end of its product.

Fig. 1. Typical sustainable design cycle

Recycling

The recycling process is very essential for sustainable development that provides rational uses for scarce, or potentially scarce, natural resources such as lead. Some potential advantages of recycling process are as follows:

I. Extension of natural resources lifetime– although there are undiscovered ore deposits all over the world, they are all ultimately finite and this limit is linked to its usage rate. Therefore, recycling processes extend the lifetime of these deposits;

II. Reduced monetary costs– secondary materials provide means of monetary economy by: (a) being cheaper processes than primary minerals recovery, (b)reducing the dependence on imported materials; (c) reducing the investment cost of equipment; and (d) reducing the waste production, specially the primary extraction waste;

III. Energy conservation– since few metals occur in nature as readily usable forms, the recycling processes allow the production of metals with about 25% or less1 of the energy used in the primary processes. Furthermore, since most of the primary metal processes require energy-expensive procedures which usually depend on fossil fuels, as in furnaces for example, the recycling processes provide means of pollution reduction;

IV. Toxicity toward the environment and human health– it is well known the consequences of lead exposure, being it human or environmental exposure. Thus, it is reasonable to think that a lack of a lead recycling system would increase dramatically the risk of exposure since the lead waste would have to have environmentally unsound destinations;

V. Large recyclability– the fact that lead has a low melting point and it is easily refined from scrap increases its recyclability, i.e. the relatively technical ease or feasibility of lead isolation from scrap and reintroduction into the raw material stream;
VI. Large market– lead enjoys a large market and, depending on the country of course, a reasonably well-organized collection system of up to 96% from one predominant product which has a short and predictable lifetime: the SLI battery.

Lead acid industrial battery

Industrial batteries are very useful for large and medium industry power and energy usage. It directly affects environment and hazardous issues. So sustainable battery manufacturing is recent demand. There are different types of these batteries i.e., lead acid, nickel cadmium battery, solar battery, flooded solar battery, integrated battery, tubular batteryetc. where lead acid is mostly used in industry purpose. In lead acid industrial battery, around 96% lead is used which is highly toxic and produces a range of adverse health effects particularly in young children. Exposure to excessive levels of lead can cause damage to brain and kidney, impair hearing; and lead to numerous other associated problems. Therefore, it is necessary to ensure its proper collection and eco-friendly recycling.
Lead acid industrial batteries have numerous applications that may employ different voltages, sizes and weights, ranging from 2kg no-break batteries to industrial batteries that may weight more than 2.000kg or more.Normally lead acid battery has more than ten parts such as, plates, separator, hard rubber container, lead, bitumen, battery cap, cork, connectors, electrolyte, electrical accumulator, negative plate or anodepositive plate or cathode, sealant and chemical compound: CFCs, carbon tetrachloride, halons, methyl chloroform, lead, Sulphuric acid.

3. Theoretical Analysis

Sustainable battery manufacturing process follows lead acid recycling since 96% of lead is used in general battery manufacturing. Lead is dangerously toxic to environment as well as hazardous for human being that should be removed or controlled for sustainable practices by recycling process. Recycling process for lead acid battery manufacturing is as follows:

Pre recycling process

Before reaching into the recycle stage, used batteries must be collected, transported and stored with proper care, in order to avoid adverse health effects and environmental contamination.

Recycling process

The pre recycling process finishes when the used batteries are again received and properly stored at the storage place in the recycling plant. After this, the used batteries enter into the recycling process that could ideally be divided in three major processes:
I. Battery breaking or breakage;
II. Lead reduction;
III. Lead refining.
Battery breakage process increases the possibility of soft lead production and polypropylene recovery. The battery scrap obtained from the breaking process is a mixture of several substances: metallic lead, lead oxide (PbO), lead sulfate (PbSO4) and other metals such as calcium (Ca), copper (Cu), antimony (Sb), and arsenic (As), tin (Sn) and sometimes silver (Ag). In order to isolate the metallic lead from this mixture, two methods may be applied: pyro-metallurgical processes, also known as fusion-reduction methods, and hydro-metallurgical processes, or electrolytic methods.As indicated earlier, if a smelting plant stops at the stage of the fusion-reduction plant, it will produce what is known as hard or antimonial lead. If the plant is meant to produce soft lead, the crude lead bullion must undergo a refining process. The objective of the refining process is to remove almost all Cu, Sb, As and Sn; since the soft lead standard does not allow more than 10g per ton of these metals.

Environmental control measures

Sustainable technologies require permanent monitoringand control even after implementing the best available technologies. Environmental monitoring correctly identifies the defective steps in the recycling chain as well as provides concrete data in order to improve the process, and increase the degree of environmental and human

health protection. Ultimately, the environmental monitoring ensures the environmental friendly recycling process.Control measures provide a simple set of instructions that, if followed, decrease significantly the risk of environmental contamination.

I. Personal protection equipment (PPE)
II. Green work practices
III. Dust filtering system
IV. Internal transports should be in the form of enclosed conveyers
V. Slag storage
VI. Air filtering system
VII. Coal storages should be protected
VIII. Rainwater must be collected

Health control measures

Lead is, and always has been, naturally present and quite abundant not only in the environment and but also in human body. Natural mobilization of lead occurs by weathering of mineral deposits and gaseous emissions and it has been estimated that together these two mechanisms release about 210.000 tons of lead into the environment each year. So, the lead acid battery recycling processes may be considered as a potential and powerful magnifier of the natural lead sources if the proper controls are not taken. Lead is absorbed by human being through inhalation, ingestion and skin. Basically, the lead absorption depends on individual characteristics such as physiological state and tissue integrity, both related to age and other factors such as nutritional, metabolic and anatomic conditions. The most affected human body systems by lead exposure are:Hematopoietic System, Central Nervous System (CNS), Peripheral Nervous System (PNS), urinary system, gastrointestinal system, cardiovascular system, reproductive system, endocrine system and joints. From health point of view, the proposed prevention measures are activities that should be observed in the occupational environment in order to prevent human exposure to lead from suffering adverse effects of lead contamination.

I. Consider every material containing lead as a possible source of environmental and human contamination;
II. Keep the work environment in compliance with the national regulations for industrial safety;
III. Prohibit eating and smoking inside the working areas;
IV. Prohibit children and pregnant women from working in lead recycling facilities;
V. Undertake the development of educational and informative programs;
VI. Ensure the use of personal protection equipment in working places containing at least:
    (a) Effectively protective cloth;
    (b) Daily clean the used cloths;
    (c) Protective masks which may vary in accordance of the average lead concentration in air;
VII. Control the lead concentrations in the working environment;
VIII. Demand periodical medical control of lead exposed workers.

Reverse logistics

The process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal. More precisely, reverse logistics is the process of moving goods from their typical final destination for the purpose of capturing value, or proper disposal. Normally, logistics deal with events that bring the product towards the customer. In the case of reverse logistics, the resource goes at least one step back in the supply chain. For instance, goods move from the customer to the distributor or to the manufacturer.Reverse logistics offers the concept of goods return from manufacturing to end consumers in order to reuse or proper disposal. This research concerns to management of used batteries that contains a hazardous material/chemicals and creates a problem of environmental inputs if it is not properly treated in disposal area. In order to gain economic value, this reverse logistics model accommodate an objective not only to minimize the total cost, but also consider the other objective based on the multi criteria analysis. The reverse logistics model developed is goal programming model, which take into account 3 objectives in optimization process namely to minimize the total reverse logistics cost, to minimize the environmental impact and to maximize the number of quantity used batteries collected.

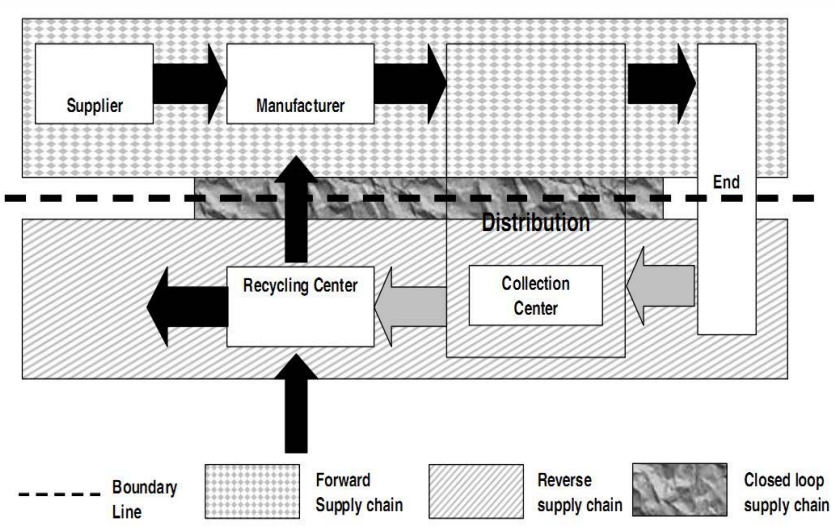

Fig. 2. Reverse logistic model for lead acid battery

4. Result & Discussion

In Bangladesh there are almost 40 industrial battery-manufacturing companies. Among them only 3 or 4 use sustainable manufacturing technologies while 10 to12 use recycling process. The technologies discussed in this paper such as reverse logistics, pure lead manufacturing process, recycling process can be used easily in these industries with minimum establishment cost. Bangladesh is an environmentally polluted country. Pollution due to adopting hazardous technologies and unsustainable practices are causing various harmful effects environment. This paper discusses various sustainable options and possibilities for battery manufacturing companies and ranks the battery manufacturing companies in Bangladeshi with satisfactory sustainable practices.

Table 1. Bangladeshi industrial battery manufacturing companies

Name	Location	Green/Sustainable Practice
AFTAB AUTOMOBILES LTD.	Dhaka	Satisfactory
EASTERN BATTERIES LTD.	Dhaka	Semi- Satisfactory
HAMKO	Dhaka	Satisfactory
HAQUE BROTHERS (CARBIDE) LTD.	Dhaka	Semi- Satisfactory
JEWEL MOTORS	Dhaka	
MULTI POWER LTD.	Dhaka	
OLYMPIC INDUSTRY LTD.	Dhaka	Semi- Satisfactory
P.K. INDUSTRIES LTD	Dhaka	
POWER DISTRIBUTION (TROKEN)	Dhaka	
QUASEM DRYCELL LTD.	Dhaka	
RAHIM AFROOZ BATTERY LTD.	Dhaka	
RELIANCE ELECTRONICS	Dhaka	Satisfactory
TYRE & BATTERY BAZAR	Dhaka	
UTTARA MOTORS LTD.	Dhaka	
VISION BATTERY INDUSTRY LTD	Dhaka	
NEW DUNLOP BATTERY CO.	Dhaka	
PANDA BATTERY CO. LTD.	Dhaka	
R.B.C. BATTERY	Dhaka	

REGNANT TECHNOLOGIES	Chittagong	
S.R. BATTERY	Dhaka	
PANNA BATTERY LTD.	Dhaka	
BELL CORPORATION LTD.	Dhaka	
MOTI BATTERY	Dhaka	
ROLEX BATTERY CO.	Dhaka	Satisfactory
SAFAT MOTORS LTD.	Dhaka	
URMI TYRE & BATTERY CENTRE	Dhaka	
PLATINUM POWER TRADING	Dhaka	
BATTERY PLUS	Dhaka	

- Based on available data

5. Recommendations &Conclusion

Several important issues related to the recycling of used lead acid batteries were considered along with other aspects such as, technical aspects, recycling process overview, monitoring and control measures, health issues, status of green lead acid battery in Bangladesh etc. However, a complete survey on the lead recycling processes would require a much deeper incursion on industrial processes, economic factors, social aspects and other, which is out of the scope of this technical guideline. Other performance indicators, such as Technology Assessments (TA), Life Cycle Analysis (LCA), Risk Assessment (RA), Environmental Auditing (EA) and Environmental Manage System (EMS), should be adopted and used in order to improve the environmental and health protection.Therefore, a specific contextual map should be generated, encompassing local politics, economical aspects, social aspects, local and international market aspects, etc., and the lead recycling plant inserted into this context.

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Paper ID: IE-P16

Development of adjustable pattern for foundry shop

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Abstract

In foundry shop orders come for making products are different in dimension for the same kind of products. So it is necessary to make one pattern for every product of different dimension although these are of same kind. So it consumes a large amount of cost. To minimize this cost an adjustable pattern has been developed. This paper will introduce the criteria of making adjustable pattern, its feasibility and economic aspect. This pattern can be adjusted according to the expected dimensions ordered. But it has some limitations of dimension range. In this dimension range product of various dimensions can be made easily. Another adjustable pattern of same kind of product yields another range of dimension. More of pattern can be made for having wide range of dimension. It is seen that one or two adjustable patterns can fulfill all of the requirements. After all, from economic calculation it is found that this adjustable pattern reduces around 50% cost for only five products.

Keywords: *pattern, drag, allowance.*

1. Introduction

In casting, a pattern is a replica of the object to be cast, used to prepare the cavity into which molten material will be poured during the casting process.

Patterns used in sand casting may be made of wood, metal, plastics or other materials. Patterns are made to exacting standards of construction, so that they can last for a reasonable length of time, according to the quality grade of the pattern being built, and so that they will repeatedly provide a dimensionally acceptable casting[1].

2. Design Procedure

Pattern making procedure is divided into two parts
1. Inner part
2. Outer part

2.1 Inner part:

- In the figure 2.1 second image is the inner part of flywheel. For various diameter of wheel like diameter 12 inch 3 parts (red colored in the figure) can be attached with the inner part of 10 inch diameter wheel to make inner part of 12 inch diameter wheel.
- Same as to 14 inch diameter wheel.

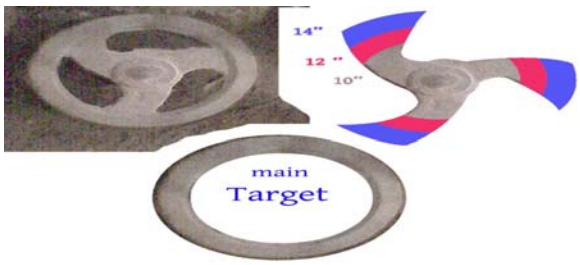

Fig. 2.1. Inner part and outer part (main target) of the Pattern

2.2 Outer part:

There is developed a criteria for making this part adjustable. This criteria has been discussed below for various diameter (10" and 14" for example) of wheel.

2.2.1 Pattern with diameter 12 inch:

- A circular part of 12 diameter is divided on its periphery into eight
- Another same part(extra part that is not used for 12" wheel) has been made
- All of the parts(8) are connected with plates and nuts

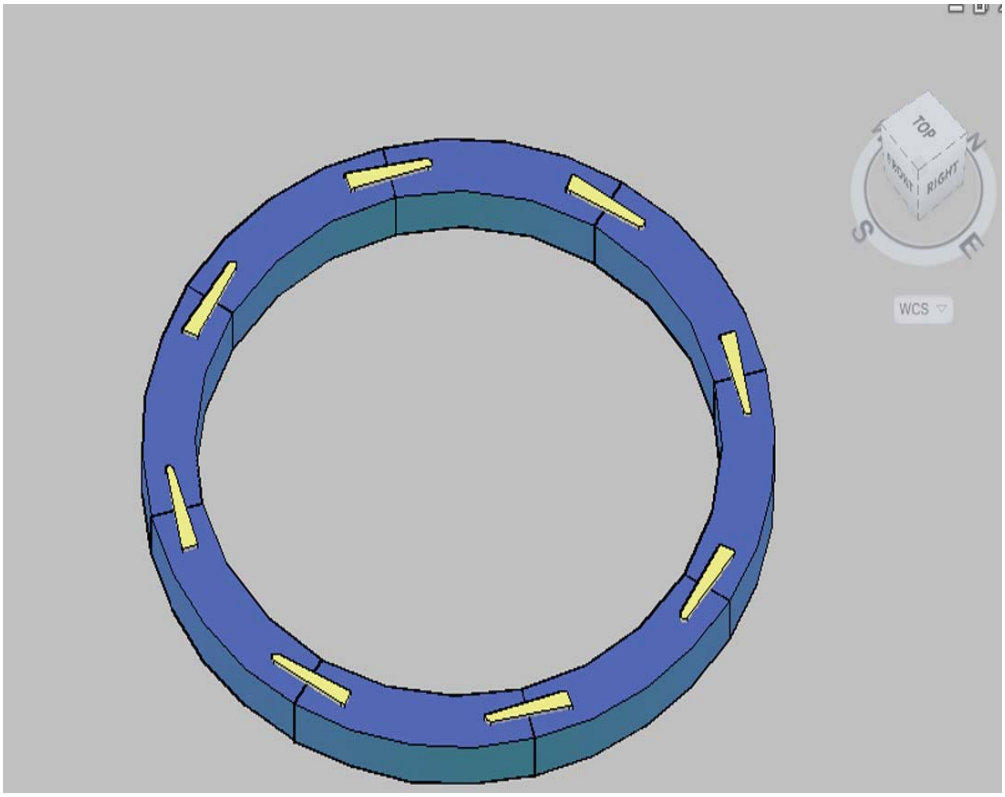

Fig. 2.2. Pattern with diameter 12 inch

2.2.2: Pattern with diameter 10 inch

- Six parts are attached with their inner corner point
- Another small part between first and last parts is added
- All of them are connected with plates and nuts**.**

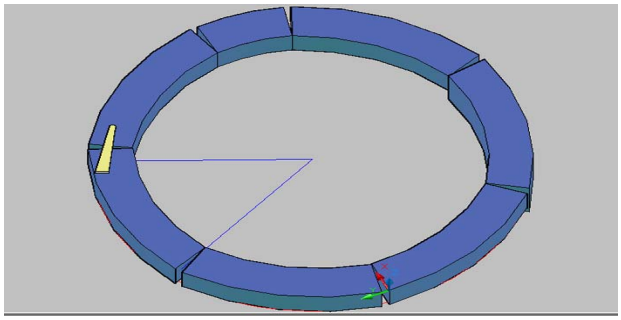

Fig. 2.3. Pattern with diameter 10 inch

2.2.3: Pattern with diameter 14 inch:

- Nine parts has been attached with their inner corner point
- Another small part between first and last parts is added
- All of them are connected with plates and nuts.

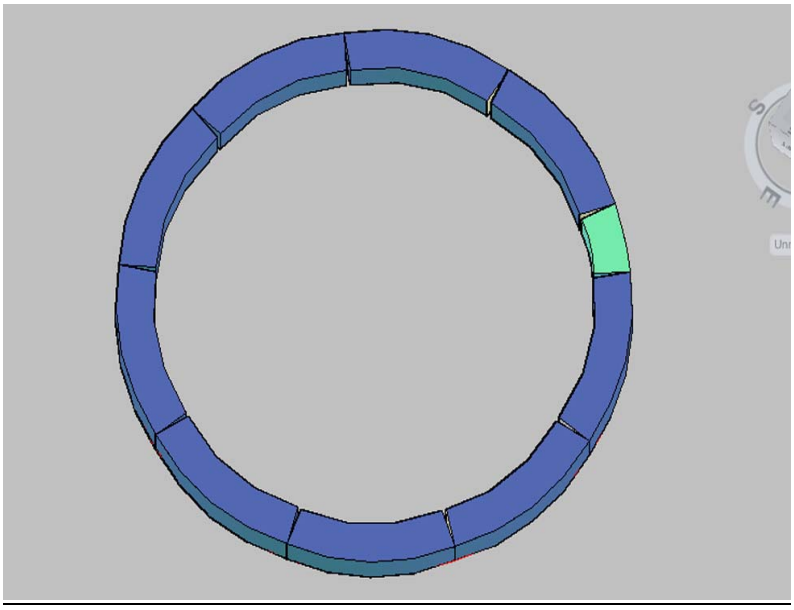

Fig. 2.4. Pattern with diameter 10 inch

3. Feasibility Analysis

- ❖ There will form some small sand stakes for gap between the two parts. From the figure 3 it is seen that there will be only .19" and .11" of extra sand stack for 10" and 14" diameter wheel successively. These can be removed easily with air flow.
- ❖ As two steel plate and nuts are used in every two pattern parts, all of the pattern parts are well tighten
- ❖ Extra allowance is very small

So making this type of pattern is highly feasible.

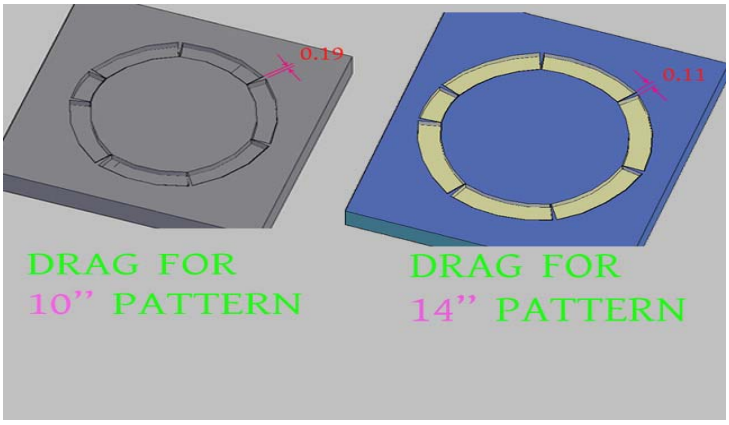

Fig. 3. Drags showing the amount of extra stack of

4. Economic analysis

Table 4.1. Data table for conventional and adjustable pattern

Conventional Pattern cost		Cost of adjustable pattern			
Number of pattern	Cost(TK)	Name of component	Cost(TK)	Extra cost(TK)	Total cost (TK)
1	200	Wood	230		
5	**1000**	Plate	200	40	**500**
		Nut-bolt	30		

In this table 'Extra cost' means cost of melting of extra material, extra machining cost and extra labour cost.

From table 4.1 we find the ratio between adjustable and conventional pattern costs is
= 460/1000
= 0.46
So cost reduction is = (1-0.46)
= 0.54
= **54%**

9. Advantages and Limitations of the system

The advantages of flexible pattern are given below:

- Yield to have many patterns from it
- Decrease overall production cost
- Minimize overall production time
- Urgent order can be taken very easily
- Increase good will of company
- Skilled operator is not necessary

Besides the advantages it has some limitations also which are given below:

- Initial pattern making time is comparatively high
- If the number of manufacturing products > (cost of conventional pattern) /(Extra operating cost), this flexible pattern is not economically feasible
- It is not possible to make feasible pattern for all types of products

11. Conclusions

The system is a cost effective system. The setup cost is only one thousand taka which can be reduced at a substantial extent. There is no maintenance cost related with the system and no electrical bill related here. Changing the setup different patterns can be made with required shape.

The operating process is very easy and also the buildup process is very easy. So the system is very much helpful as well as advantageous for light machine shop for normal operation. The low cost and easy using can be helpful for foundry shop for adopting this system.

In this project we have establish an optimized system for making product with the help of pattern. Most of the cases in foundry shop different patterns are used to make different material; it is also an expensive process. So we have made a system which can be used for making different size of part by using only one pattern. This is economical and efficient for a limited number of parts.

12. References

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Paper ID: IE-P25

Recycle of waste polythene and use this recycled polythene to produce construction block

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Abstract

Waste polythene is one of the hazards which pollute environment extensively. Recycle of waste polythene would help in two ways- first it will clean environment and secondly recycled material can be used as a raw material for other products. Now a days, bricks or construction blocks are produced through conventional procedure. This procedure causes erosion and destruction of fertile land surface all over the country and as a result reducing the crops production area. Other adverse effects of these brick production procedure are that it causes deforestation and air pollution. To avoid these types of environment pollution, a new energy efficient and pollution free process has been developed to produce construction blocks by using sands of different mesh sizes and other ingredients. Use of sands, on the other hand helps to renovate the river bed. The strength of the produced construction blocks has been measured and compared to that of the conventional product.

Keywords: Polythene, recycle, environment, construction block.

1. Introduction

In Bangladesh, now a day's polythene bags (or shopping bags) and other polythene products are used extensively. After using these polythene products, users through it in the environment. These waste materials [1] are not bio-degradable and causes harm for environment. We can easily use this waste material for producing construction block [2] or a product substitute of conventional fire burn bricks. To use these waste material, at first we need to recycle it and then use the recycled material to produce construction blocks. Other ingredients for producing construction blocks are sand of different mesh sizes, water, cement and binder. The production procedure does not require any heating of the ingredients and as a result the procedure is not energy consumable.

The production process of these blocks is also pollution free. The traditional fixed chimney kiln brick production process causes severe and long term replenish able environmental pollution and destruction. This type of environmental pollution sometimes causes threat to human health and also animal health where brick kilns are near to their residence or habitat. Such as skin diseases, diseases of respiratory organs, hearing organ etc of human. Animals also suffer from different diseases.

In present, there are about 1250 traditional brick fields in and around Dhaka city. Each brick field produces almost 6 to 10 million bricks per year. Total production of bricks in Bangladesh is 15 billion bricks per year and this production increasing 5 to 6 % per year.

15 billion clay bricks per year consumes topsoil of 1,00,000 acres of land which can produce 5,00,000 metric ton of rice.

To produce this big number of bricks per year, total carbon emission is 8.75 million tones of CO_2 equivalent per year.

So, it is very essential to save our environment and substitute the traditional brick producing procedure by the present one.

2. Materials and equipments used

Materials and equipments used to produce construction blocks in the present procedure are easily available and equipments or machinery can be fabricated / produced (or erected) locally using local technology. Materials whose chemical properties are very close to that of polythene, can also be recycled and used in the same procedure.

Among the raw materials, sand of different mesh sizes are used in large quantities, which is easily available and is the main component to produce construction block in cold process.

According to the capacity of the plant, raw materials and equipments / machinery used for production of construction block in the present energy efficient and environment friendly procedure are -

A. Raw materials used:

The raw materials used in the project are

a) Waste polythene
b) Coarse sand, mesh size 40, commercial grade
c) Fine sand, mesh size 60, commercial grade
d) Cement, commercial grade
e) Water
f) Binder (Ad-mixture)

B. Machinery used:

a) Heat gun (3000W) (or any other available technique to melt polythene)
b) Grinding machine (220V, 300W, 2800 rpm)
c) Weighing balance
d) Sieve (different mesh sizes, such as 40, 60, 100 mesh sizes)
e) Hydraulic press machine with mold to produce construction block.

INDEX

SL NO	ITEMS	DIMENSIONS	MATERIALS	QUANTITY
1	Hydralic press (1)	Shown in fig.	ASTM A-36G60	1
2	Top house	Shown in fig.	ASTM A-36G60	1
3	Bottom house	Shown in fig.	ASTM A-36G60	1
4	Bush base plate	76X460Xt12	ASTM A-36G60	1
5	Guid plate	228X460Xt12	ASTM A-36G60	2
6	Spandle holder ring	Ø76Xt16	ASTM A-36G60	1
7	Spandle holder plate	305X305Xt12	ASTM A-36G60	1
8	Stay bar	435X51Xt10	ASTM A-36G60	1
9	Pressure gauge nozel	Ø10	ASTM A-36G60	1
10	Hydralic press (2)	Shown in fig.	ASTM A-36G60	1
11	Hydralic press base plate	228X406Xt32	ASTM A-36G60	1
12	Guid stick	Ø38XL576	ASTM A-36G60	2
13	Bush	Ø76XL76	ASTM A-36G60	1
14	Pin holder plate	203X203Xt25	ASTM A-36G60	1
15	Pin	Ø25XL101	ASTM A-36G60	4
16	Punch plate	119X240Xt12	ASTM A-36G60	2
17	Die shifting bar	25X976Xt5	ASTM A-36G60	4
18	Brick die	Shown in fig.	ASTM A-36G60	2
19	Ruber foot	Ø63XL56	Ruber	4
20	Hydralic oil control valve	-	-	1

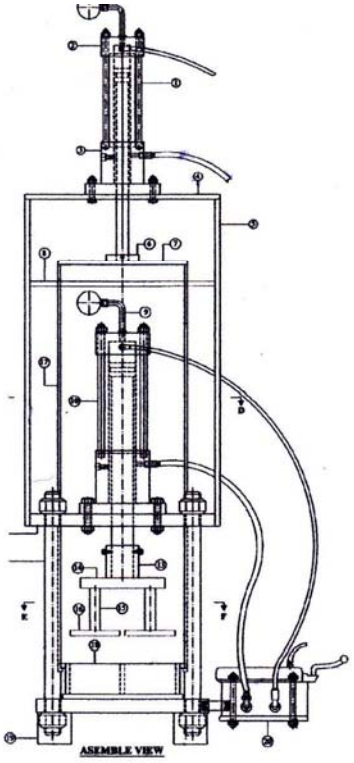

Fig 2(a): Hydraulic press machine for producing construction blocks.

3. Production process

The production process of the construction block followed through the following steps-

a) At first waste polythene of different colour, thickness, size and shapes were collected. This waste polythene has some foreign materials or dirt with them when collected. Wash this waste polythene with plenty of water to get clean material. Dry this material in open air (or in a dryer if possible)

and form solid lump/ball/cube (approximately $\frac{3}{4} x \frac{3}{4} x \frac{3}{4}$ to 1 x1 x1 or with diameter $\frac{3}{4}$ to 1) or any other size by heating the clean waste polythene with the heat gun. Grind these solid lumps in a grinding machine up to 100 mesh sizes or near sizes.

b) Sand of 40 mesh size and 60 mesh size were collected and separated from pebbles or any other substances like straw etc. if required. Take weight of coarse sand (40 mesh size) 40%, fine sand (60 mesh size) 40%, cement 10% and waste polythene 10%.
c) In the next step, mix the above materials with water (add 4 cc binder /Ad-mixture with 1 liter water). The amount of water depends on moisture content of the ingredients. If sand is comparatively moist, it needs to add less amount of water in comparison to the sand which is not so moist.
d) Load the mixed materials in the mold of the machine.
e) Press the mixed raw materials up to 1700 to 2000 psi, hold this pressure for certain time and then release pressure.
f) Collect the wet product from the mold and keep it to dry at NTP.
g) After 6 to 12 hour (depending on proportion of ingredients used) dip the product in water for approximately 2(two) weeks so that it can attain its strength after proper setting.
h) Collect the construction block from water and keep it at NTP. These blocks are ready for use.

4. Results and discussion

Test of several parameters of the produced construction block have been performed. Based on these test results, we can take the decision as bellow.
Compressive strength of the construction blocks is a major test parameter. Compressive strength is directly depends on amount of cement used, pressure applied during production, quality of the sand used and also the amount of ad-mixture used.
Effect of ad-mixture and hydraulic pressure used during production, on compressive strength of the product is illustrated in figure 4(a) and figure 4(b).
a) From figure 4(a) it is clear that compressive strength of the product increases with the increase of amount of ad-mixture in one liter of water which is used for preparing the mixture to produce construction blocks. Addition of ad-mixture causes increase of compressive strength of the product because it helps to make proper bonding between the ingredients used for producing construction blocks. Ad-mixture also helps to attain strength of the product.
b) From figure 4(b) we can say that, compressive strength of the construction block also increases with increase of hydraulic pressure which is given to the product during production. The cause of increasing compressive strength in this case is that this hydraulic pressure makes to dense or come close of the ingredients. As a result compressive strength of the products increases.

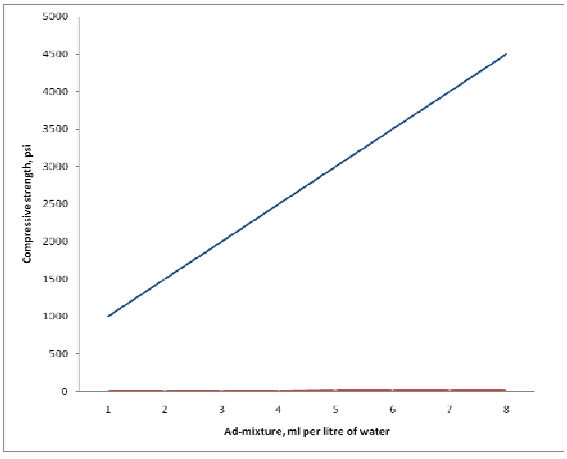

Fig. 4(a): Effect of ad-mixture on strength.

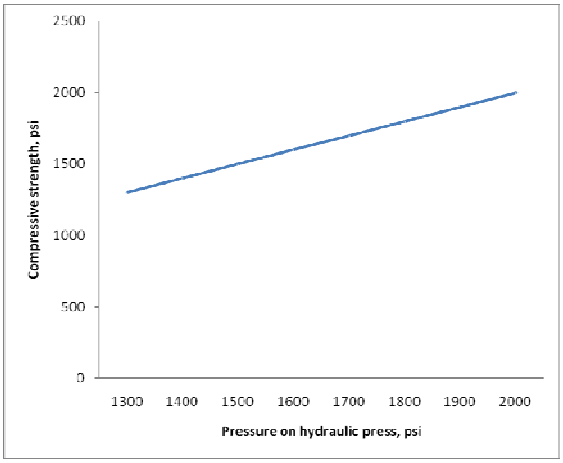

Fig. 4(b): Effect of hydraulic pressure on strength

c) Compressive strength of the construction blocks also depends on moisture content and water absorption. At higher moisture content of the product compressive strength is comparatively lower. On the other hand, as the compressive strength increases, water absorption tendency of the product reduces.

d) Thermal conductivity of a typical product is 0.2535 W/(m^oK) at 85^oC.
e) Expansibility of the product is $4.80X10^{-7}/^oC$ (0-100^oC).
f) Weight comparison with traditional clay fired brick for same dimension of the brick/construction block.
Cold process or present process construction block: 3.175 kg
Traditional clay fired brick: 3.060 Kg

5. Conclusion and recommendation

Conclusion and recommendation of the work can be drawn as follow-
Conclusion:
a) Waste polythene is recycled and the material after recycle is used to produce construction blocks.
b) The production procedure does not follow conventional one and also energy efficient.
c) The machinery used for producing the product can be fabricated locally using local and simple technology and the fabrication materials are available in the local market.
d) The production procedure has not any adverse effect on environment and it is environment friendly.
e) Also production procedure is not threatening for the health of the worker who are associated with the production of construction block or collection / transportation of the raw materials which are required to produce the construction blocks.
f) Compressive strength of the construction block depends on the quality of the ingredient used specially the quality of the sand and cement used.
g) Compressive strength of the construction blocks can be achieved according to need by selecting raw materials proportion and applied hydraulic pressure.
h) This production procedure eventually save agricultural top soil, help to protect environment from pollution and save greeneries from deforestation.
Recommendations:
a) Further work can be done to produce different shape and size of the product, together with producing hollow shape inside the brick. Test results can be achieved of these products.
b) These construction blocks can be used first experimentally and then commercially for construction of pavements, boundaries or walls of a house or building.
b) One can repeat the procedure to produce construction blocks by using other ingredients such as rice husk ash, fly ash or any other industrial or agricultural waste materials in certain percentage as a filler material.
c) Total production procedure can be atomized.
d) Commercial production can be started as SME which will save agricultural land and help to renovate river bed all over the country.
e) Saving of energy can be calculated.
f) Benefit regarding consumption of soil and environmental pollution can be measured.
g) An assessment regarding protection of agricultural land and trees can be made.

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Paper ID: *IE-P36*

ASSESSMENT OF ENVIRONMENTAL POLLUTION OF GASEOUS EMISSIONS OF CHEMICAL PLANTS BY MATHEMATICAL MODELING

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Abstract

Mathematical modeling of an environmental pollution by emissions of an industrial enterprise has been spent with using empiric model of Pasquille-Gifford. Spatial distribution of the aerosols in the near surface layer of the atmosphere was determined. Scattering of pollutants in the atmosphere with the indication of spray concentration were obtained..

Keywords: *mathematical modeling, pollution, aerosols, maximum permissible concentration, industrial emissions.*

1. Introduction

At present all labor processes cause anthropogenic change of nature. Notwithstanding the variety of anthropogenic processes in different countries and on different continents, differentiated man – induced flows integrate finally in the objects of geo- and biosphere causing global-scale ecological risks. Pollution and contamination of atmosphere, waters, soils, caused by industrial wastes and other substances and followed by changes of ecological balance present an enormous threat. Occasionally air pollution leads to disasters similar to large-scale natural ones. The total capacity of anthropogenic of real ecological situations on the basis of the data of control of the man-induced changes of the environment present one of the main tasks of engineering-ecological analysis of nature-technical geological systems [1-5].
There is no generally accepted method of evaluation of impact on the environment which allows characterization of an enterprise construction project as well as an enterprise activity in the period of operation. An unbiased evaluation of the system state rests on the group of indices, having a different physical nature and basing on different methods of measurements and control.

2. Materials and methods

Original statistical material for the mathematical modeling were data obtained during normal operation of industrial processing enterprise phosphorous rocks of Kazakhstan. In this study we used the model Paskuill-Gifford, as it is simple and has the official status (it is a working model of the International Atomic Energy Agency, IAEA). It is useful to realize, even if you plan to create more advanced models.

3. Results and discussion

Evaluation through mathematical modeling of an environmental pollution by aerosols caused by the industrial enterprise manufacture of thermal phosphoric acid is given in the present article.

In the present time in the Republic of Kazakhstan for calculation the air pollution are mainly use methods of numerical modeling devoted to the dispersion of contaminants in the atmospheric boundary layer [6-8]. In conditions of changing climatic indicators, of using of new laws and regulations environmental documents and fundamentally new approaches to the protection of the environment and, in particular, to the protection of the atmosphere, it is necessary to use in the Republic of Kazakhstan mathematical modeling that dominate in almost all developed countries and have official status.

With the aim of quantitative evaluation of atmosphere pollution by aerosols we have used Pasquille-Gifford empiric model based on the assumption of constant interference-free point source of a definite capacity having homogenous characteristics of atmospheric dispersion (equation number 1). This model is based upon the conception of concentration of admixture emitted by a constant point source into atmosphere as of a stream with vertical Gaussian distributions and transverse to wind:

$$q(x,y,z)=\frac{Q}{2\pi\sigma_y(x)\sigma_z(x)u}\times f_F f_W\times\exp(-\frac{y^2}{2\sigma_y^{\,2}(x)})\times(\exp(-\frac{(z-h)^2}{2\sigma_z^{\,2}(x)})+\exp(-\frac{(z-h)^{\,2}}{2\sigma_z^{\,2}(x)})) \quad (1)$$

where q – admixture concentration in the given point of space, mg/m^3; *x,v,z* – Cartesian coordinates, axis *z* – up -, axis *x* – downwind; Q - source of emission capacity, g/c; $\sigma_y(x)\sigma_z(x)$ - vertical and transverse dispersions of admixture cloud; *u* – wind velocity averaged for the layer of mixing, m/c; f_f and f_w – deduction for cloud depletion at the expense of dry deposition of admixture and its scavenging h - effective altitude of the source, m (i.e. altitude with consideration of the original rise of the overheated stream). Exponents sum in this formula corresponds to the ground surface not absorbing the admixture, in case of absolute absorption exponents the difference is observed. The main content of the model is presented by numerous summarizing experimental data, specific functions $\sigma_y(x)$ and $\sigma_z(x)$ and expressions for h, f_f and f_w.

Actually sources of emission are not exactly point sources, but for the purposes of simplification of mathematical description it is possible to assume they are. The nature of specification of the chosen model allows taking into consideration the peculiarities of local meteorological conditions and calculate the distribution of the pollutants concentration in current meteorological conditions at various values of emission capacity [9, 10].

In this work we have used the data on technical characteristics of the emission sources and averaged value of aerosols in the conditions of its actual operation. Calculations were made by means of universal integrated suite MATLAB [11].

As the emissions contain simultaneously several substances having their own corresponding maximum concentration limits values (MCL) with concentration C_i ($i=1,2,3\ldots n$), it seems necessary to determine the distribution of the total concentration of aerosols of pollution agents emitted by the enterprise.

Total dimensionless spray concentration (*q*) is determined by the following formula ‘(equation number 2):

$$q=\frac{c_1}{MCL_1}+\frac{C_2}{MCL_2}+\frac{C_3}{MCL_3}+\ldots+\frac{C_n}{MCL_n}, \quad (2)$$

where C_1, C_2, …, C_n are harmful substances concentrations in the atmospheric air in one and the same point of the area, mg/m^3 ; MCL_1, MCL_2, …, MCL_n are corresponding maximum concentration limits of harmful substances in the atmospheric air, mg/m^3 [12].

As the maximum environmental pollution takes place in the conditions of calm, we calculated for the wind velocity of 0.1 m/s, i.e. in conditions close to calm.

Fig. 1 demonstrates spatial dispersion of polluting agents in the atmosphere. Emission source point corresponds to the coordinates $x = 0$, $y = 0$. Wind direction is aligned with the direction of axis *x*. It is shown that the aerosols is distributed over the whole territory adjacent to the plant gradually decreasing with the distance from the source of emission down to 0,05-0,1 fractions of MCL at the range of 20 km.

The model allows prediction of the degree of atmospheric air pollution at different emission capacities and to obtain the data on the distribution of polluting aerosols and determine the zones of danger for human beings. Calculations for the emission capacity in the outlet of the conventional source equaling to 8,5 fractions of MCL demonstrated, that in the situation, close to calm, the aerosols concentration no exceeds MCL and in the residential area makes 0.16 fractions of MCL (Fig. 2).

Thus, the presented results of the calculation of the spray dispersion in the near-surface layer of the atmosphere using the empiric model of Pasquille- Gifford allows prediction the distribution of toxic substances concentration within the area, i.e. allows to single out the most dangerous sites of the contaminated area. The feasibility of singling out the areas most harmful for human health is realized.

4. Conclusions

1. Evaluation of the degree of the atmospheric pollution by emissions of aerosols caused by emissions of industrial enterprise in the near surface layer of the atmosphere was determined with using empiric model of Pasquille-Gifford

2. The opportunity to predict the pollution of surface air at various degrees of intensity of polluting agents emissions is shown.

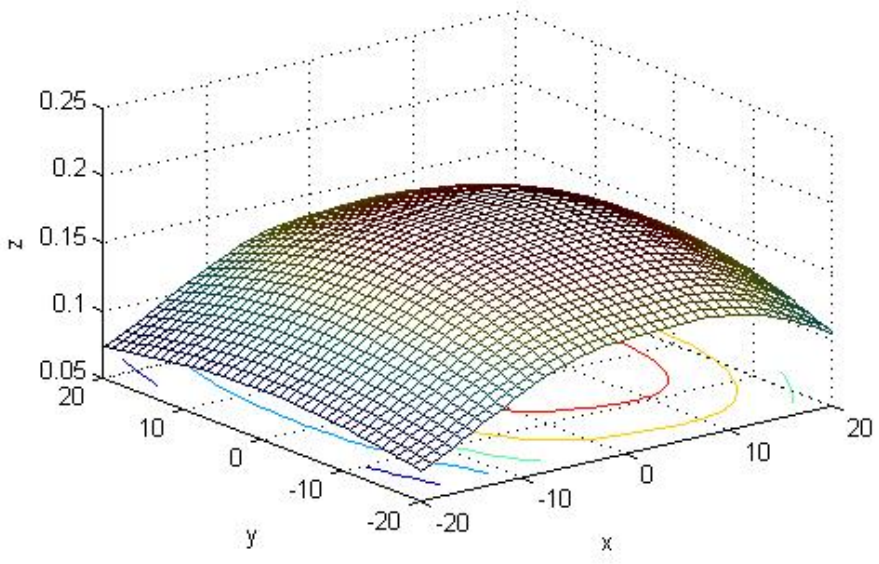

Fig.1. Spatial distribution of the aerosols in the near surface layer of the atmosphere. Axes *x* and y - distances, kms; axis *z* – concentration, fractions of MCL. Conventional point source of emission corresponds to coordinates x =0, y =0.

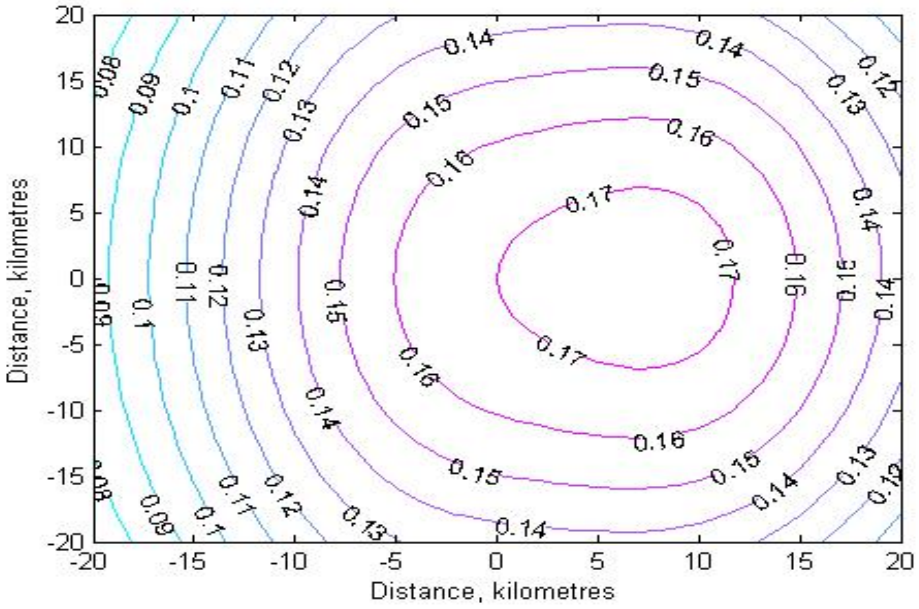

Fig.2. Aerosols distribution in the near-surface layer of the atmosphere with the indication of areas of danger. On the curves the values of dimensionless total concentration of spray in the fractions of MCL are shown.

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Quantification and Physical Categorization of Waste Generated by Different Healthcare Entities in Chittagong Metropolitan Area, Bangladesh

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Abstract

Quantification of healthcare waste (HCW) generated by healthcare entities (HCEs), especially in municipal areas, is important in order to assess the potential risks associated with HCW handling and management besides guiding the policy makers in developing HCW management guidelines. In Bangladesh, research to this end is scanty and non-coordinated. This research - based on primary data from 300 public, autonomous and private HCEs in Chittagong City Corporation (CCC) - aimed at obtaining HCW categorization data. We used both questionnaire survey and actual weight measurements of waste samples in this study. The spatial distribution HCEs in the city is not even, rather the map we prepared based on GPS locations indicated three clusters of HCEs - KB Fazlul Kader road, Panchlaish residential area and Jamal Khan. HCEs increased in number noticeably within three consecutive decades since 1991. The city generates 15 to18 tons of HCW every day which includes respective contributions from hospitals, clinics, diagnostics, maternity, diabetics, eye and dispensaries as 6,7.2,4,1.6,0.15,0.42 and 0.25 tons/day which is equivalent to 1.45,2.25,0.13,1.82,0.26,0.12 and 0.01 kg/patient/day containing 20,30,18,55,13,10,48 and 50 percent hazardous wastes respectively. Color coding at temporary storage for source segregation was found only in public hospitals. Overall, situation of healthcare waste management in CCC is not satisfactory and we need stringent policy and guideline for HCW management with strong enforcement.

Key words: *Healthcare waste, categorization, generation, quantity, management, composition and environment.*

1.0 Introduction

Hazardous wastes are the materials which contain germs and sharp substances, if managed improperly, inflict losses of varying magnitudes to the environment while affecting human health [1]. Common sources of hazardous wastes include industries, healthcare entities, research labs and to a lesser extent households [17; 24]. Among different categories of hazardous wastes, health care wastes (HCW) are a grave concern in developing countries like Bangladesh which lack in proper statistics, technology and environmental management credentials [19]. Traditionally, HCW or medical waste or hospital waste are defined as wastes generated from diagnosis, monitoring and preventive, curative and palliative, immunization and research activities in field of the veterinary and human medicine [8]. It is worrying that the rapid and unplanned urbanization in developing countries pushed ahead by high population growth lead to rapidly increasing number of healthcare entities (HCEs) and intensification of HCW quantities and diversities [5]. HCWs are usually categorized into *non-hazardous* items including packaging materials, waste from administrative activities, foods etc., and *hazardous* items including infectious, sharp, pharmaceuticals, genotoxic chemicals, heavy metals and pressurized wastes etc [7]. On the other hand, HCWs can be subdivided into pathological, sharp, infectious, chemical, radioactive and liquid wastes [7; 15] which may contain toxic, reactive, radioactive, poisonous, carcinogenic, irritant, mutagenic, teratogenic, corrosive, explosive and flammable ingredients [18] requiring special attention due to their toxic nature [16; 1] and infection potential [10; 22; 20; 9]. The quantity of healthcare wastes generated by different categories of HCEs varies, and the composition of HCW varies between and within countries. These variations are attributed to the size of HCEs, proportion of in and out patients, type of HCEs and specialization, adopted waste segregation options, proportion and use of reusable items, and above all the prosperity of the

country [23]. HCW in China, as shown by Li Rundong [14] contained 53%, 17%, 15%, 3% and 12% paper, organic, plastic, metals and others categories respectively. In Sri Lanka, as reported by Haniffa [12] from 538 hospitals with 52702 beds, the daily generation of HCW ranged from 76623 kg to 170789 kg. In Bangladesh, according to 2011 records of Directorate General of Health Services [11], there are 583 primary, secondary and tertiary public HCEs with 65,470 beds while the number of registered private HCEs was 7,623 of which 2,501 were hospitals and clinics and the rest were diagnostic centres. All these had 42,237 total installed beds. Prism Bangladesh [17] showed that in Dhaka Medical College and Hospital (DMCH) – one of the biggest teaching hospitals, alone generates about 3609 kg HCW per day at 2.65-0.67 kg/patient/day waste generation rate with 19.8% of it being hazardous. In Rajshahi, a study encompassing 44 HCEs reported generation of 22 kg pathological waste, 30 kg plastic waste, 20 kg soft waste, 7 kg sharp waste, and 320 kg general waste per day [2]. However, this baseline survey measured 349 kg medical waste per day from the mentioned hospitals/clinics/diagnostic centers with when Rajshahi Medical College Hospital (RMCH) as the largest single contributor. On the other hand, in a study in Chittagong – the second largest city of Bangladesh, showed generation of 0.57 kg HCW /patient/day segregable into eight categories [6]. According to our calculations Chittagong Medical College Hospital (CMCH) generated 0.94 kg/bed/day of HCWs which was 0.48 for Chittagong General Hospital, 1.13 for Memon Maternity Hospital [4]). Different scenario of HCW generation was found for private HCEs, for example, at the private teaching hospital – the Bangabandhu Memorial Hospital, it was 1.52 kg/bed/day which were 1.79, 1.56, 0.9 and 2.4 kg/bed/day respectively for National Hospital (private hospital) Chittagong Diabetic Hospital ; Chittagong Eye Infirmary Hospital and Surjer Hasi Clinic (Private maternity). Besides, Metro Diagnostic center produced 0.08 kg HCW/test/day. A study in Khulna city reported 0.15 kg/bed/day HCW generation rate based on data from 8 hospitals/clinics [19]. For this city, another study reported average waste generation rate for hospitals and clinics to be 0.934 kg/bed/day - much higher than 0.0414 kg/person/day for diagnostic centers and outdoor clinics [21]. However, in from the aforementioned literature, the lack in data became evident on detailed categorization of solid wastes including all the different categories of HCEs in Chittagong. Alam et al. [6] worked only on wastes from CMCH. However, such category wise waste generation scenario and waste generation rates are very important for comprehensive HCW management, especially in a scenario when private HCW management entities like Innovation Sheba Sangstha (ISS) are entering into business. Also, we hypothesized that such study is very relevant to the accurate estimation of potential risks from HCW and HCEs, for the formulation of law and policy on HCW management besides providing information to HCW management organizations. Therefore, we undertook this study within CCC and accomplished it between January and July, 2012. We used semi-structured questionnaire, GPS device, digital camera and measuring instruments for waste categorization and weight measurement.

2.0 Methodology

2.1 Study area selection

We included the entire Chittagong Metropolitan Area for the purpose of this study. The city is located between 22˚14’ to 22˚-24’-30” N Latitude 91˚46’ to 91˚53’ E Longitude. The river Karnafully (Hossain, and Alam, 2012) runs along the north border of the city and on its west side lies the Bay of Bengal. However, we included only the HCEs which are clustered into some certain zones of the city hence, in strict sense; the whole city was not needed to be surveyed.

2.2 Reconnaissance survey and questionnaire survey

In order to facilitate the entire process, we conducted few reconnaissance surveys within the study area. Based on the results we fine tuned our survey plan, the questionnaire and the mode of waste collection and measurements. We conducted questionnaire survey in all pre-target HCEs within metropolitan area by taking into consideration all the different categories of healthcare establishments.

2.3 Field visit and data collection

We visited many times the HCEs to judge the most suitable time for taking images and talking waste sample and quantify the wastes. We took official permissions from all HCEs for survey, waste collection and measurements as well as for taking photographs using digital camera. We availed the experiences of workers and nurses.

2.4 Mapping

GPS locations (latitude and longitude) were collected for all the HCEs included into our survey who are known to discharge their HCWs into the dustbins within the metropolitan area. Then we compiled all the collected readings in MS excel sheet and using the online GPS visualize tool online, we placed the location points on the map of Chittagong city (Figure 1).

2.5 Data analysis

All our gathered data we compiled into MS word and MS excels, version 2007. We analyzed the data by using MS excel and SPSS V16.0 (Statistical Package for Social Sciences) software.

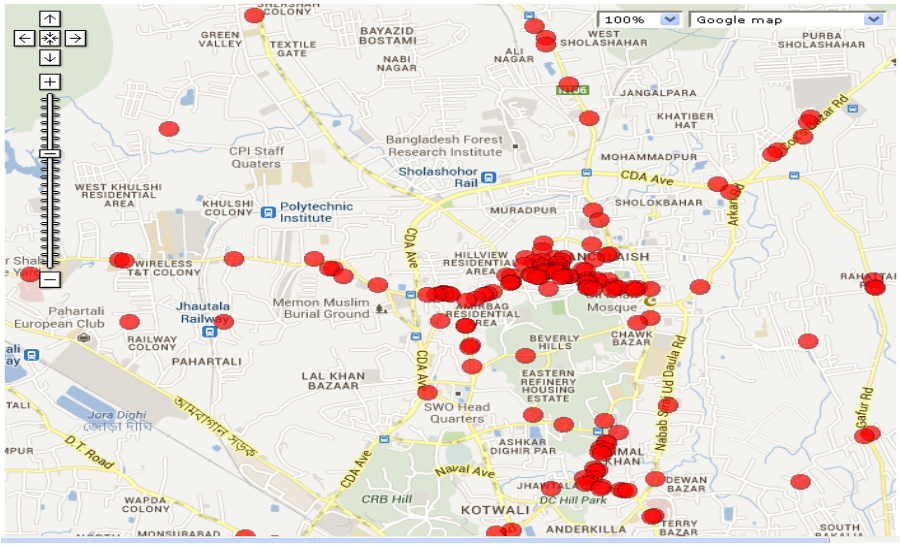

Figure: 2.1: Location map of surveyed HCEs in Chittagong city area.

3.0 FINDINGS AND DISCUSSION

3.1 Temporal trend of HCE numbers

Chittagong, being the expanding commercial capital and the second largest city in Bangladesh, is home to an increasing population of about 5 million. The rapid growth of population and associated urban sprawl led to the rapid rise in the number of HCEs which in turns responsible for the generation of large quantity of HCW. The total number of different category of HCEs in Chittagong was quite small at the time of the liberation war in 1971. From figure 3.1 we can see noticeable increase in the numbers of different categories of HCEs between time intervals 1991-2000, 2001-2010 and 2011-2012.

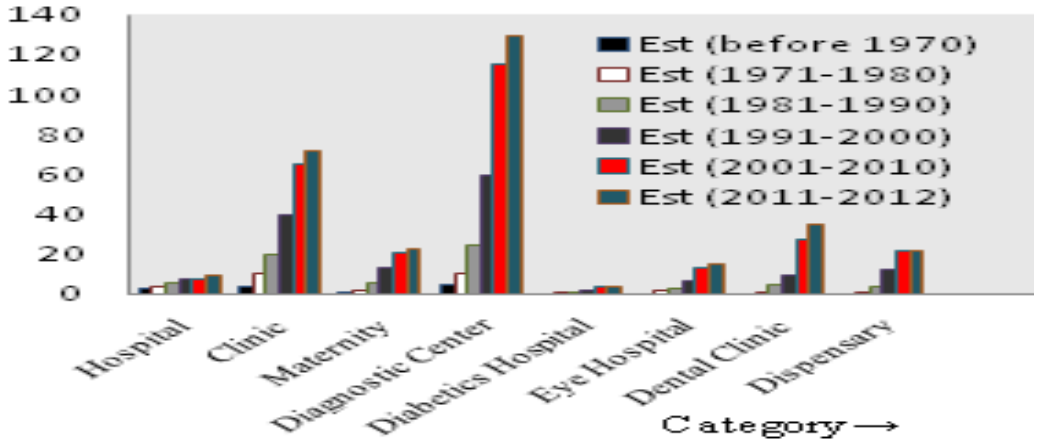

Figure 3.1: Different category of HCEs increase in different time interval

But in 2011-2012 time intervals total number of each category of HCEs increase is low because duration is short than other intervals. For example, from figure 3.1 we can see that before 1970 there were no maternity, eye hospital and dental clinic in CCC and only three hospitals and four clinics existed. Also, during 2001-2010 times interval there was no increase in the number of hospitals while the clinics which are private HCEs increased rapidly between all time intervals studied. This finding is indicative of a poor non-centralized HCW management scenario as we have observed since HCEs are smaller in size but many in numbers. In addition, figure 3.1 indicated the absence of diabetics hospitals, eye hospitals and dental clinics in CCC before 1970 and dental clinics were also absent between 1971-1980 time interval as well. Diabetics' hospitals, eye hospitals and dental clinics increased in number between 1991 and 2010 which indicated a relatively recent trend of building specialized HCEs in CCC. On the other hand, total number of private physicians' chambers, dispensaries and diagnostic centres in CCC increased noticeably over the last two decades in CCC.

3.2 Different categories of HCEs in CCC

Among the HCEs found in CCC area, there were different categories including hospitals, clinics, maternity centres, dispensaries, diagnostic centers, eye hospitals, diabetic hospitals, dental clinics and regional office of pharmaceutical companies in CCC. The respective numbers of HCEs under each category in CCC are 7, 72, 23, 22, 130, 15, 3, 30 and 65 (Fig 3.2). Hospitals are large in size and handles majority of the patients but these are smaller in number. Diagnostic were comprises the highest in number among HCEs in CCC and clinics were next to them. Diabetics hospitals, eye hospitals and maternities were very few in numbers compared to population size of CCC.

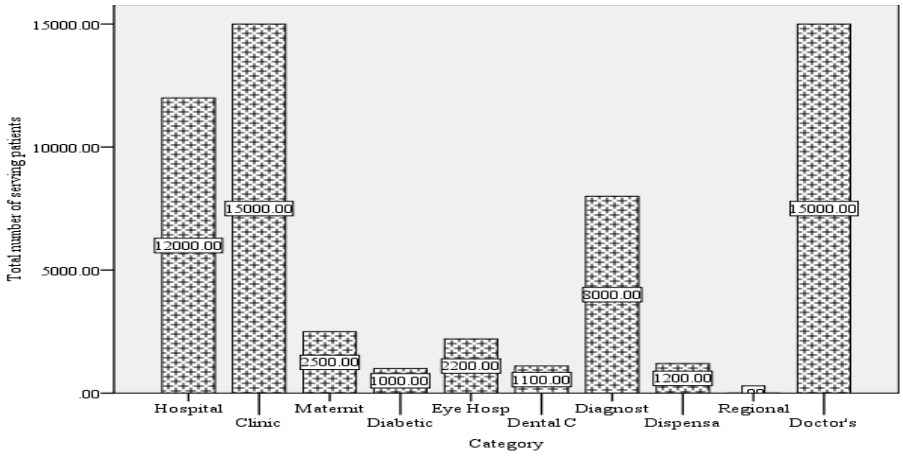

Figure 3.2: Total number of different category of HCEs in CCC

3.3 Patients served by different HCEs in CCC

Compared to the size of population in CCC, the numbers of HCEs are insufficient. Since the private HCEs are costly, the majority of poor patients in CCC rely on public hospitals which are smaller in numbers. Affluent patients usually generate larger quantity of HCW than poor patients. With the increasing number of HCEs, the total number of patients getting healthcare services also increases. The total number of patients served by different category of HCEs every day in CCC are 12000, 15000, 2500, 1200, 8000, 2200, 1000, 1100 and 15000 respectively by hospitals, clinics, maternities, dispensaries, diagnostic centers, eye hospitals, diabetic hospitals, dental clinics and private physicians' chambers (Fig 3.3). Hospitals, clinics and private physicians' chambers are the major source of healthcare services in CCC. It was found that, in CCC maternity related services are mainly provided by different NGOs such as Niskrithe, Mariestopes, Red-Crescent and BRAC.

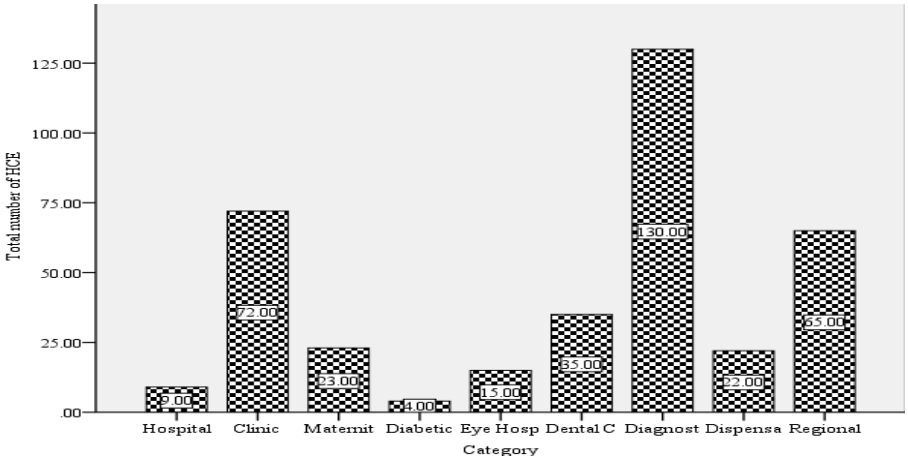

Figure 3.3: Total number of serving patients/day by different category of HCEs in CCC

3.4 HCW generation by different categories of HCEs

The total HCW generation in CCC was 15 to 18 tons/day from all categories of HCEs. But quantity of waste generated by different HCEs depended mainly on their sizes, service facilities and the number of patients served as well as the social and economic status of their patients. We found that the total HCW generated from each category of HCEs are 6, 7.2, 1.6, 0.25, 4, 0.42, 0.15, 0.35, 0.65 and 0.15 tons/day respectively from hospitals, clinics, maternities, dispensaries, diagnostic centers, eye hospitals, diabetic hospitals, dental clinics, regional office of pharmaceutical companies and private physicians' chambers (Fig 3.4). When brought down to kg/patient/day, HCW generation from respective HCEs stood at 1.45, 2.25, 1.82, 0.01, 0.13, 0.12, 0.26, 0.32 and 0.01. Due to their bigger sizes and whopping patients' numbers, hospitals generated the largest quantity of HCW. Though each clinic generates smaller quantity, their number is more and their HCW footprint per patient is large; hence in total their contribution to HCW is large. Diagnostic centers also generates considerable amount of HCW due to their large number though their rate of waste generation per patient is lower. Both local government- and NGO-ran maternities generated similar amount of HCW. Eye hospitals, diabetic hospitals, dental clinics, dispensaries and private physicians'chambers were found to generate very small quantity of HCW but as their number is high, the total amount was large. Therefore all category of HCEs contribute little or more HCW into total MSW stream ultimate result of which is conversion of non-hazardous waste to hazardous if not managed separately and properly. So it requires special attention for HCW handling and management which we found not adequate in CCC.

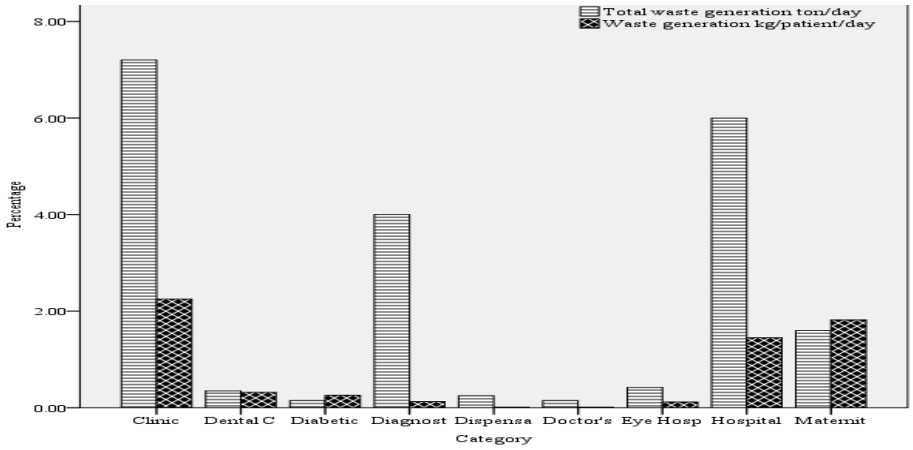

Figure 3.4: Total HCW generation rate tons/day and kg/patient/day by different category of HCEs in CCC

3.5 Physical categorization of HCW from HCEs in CCC

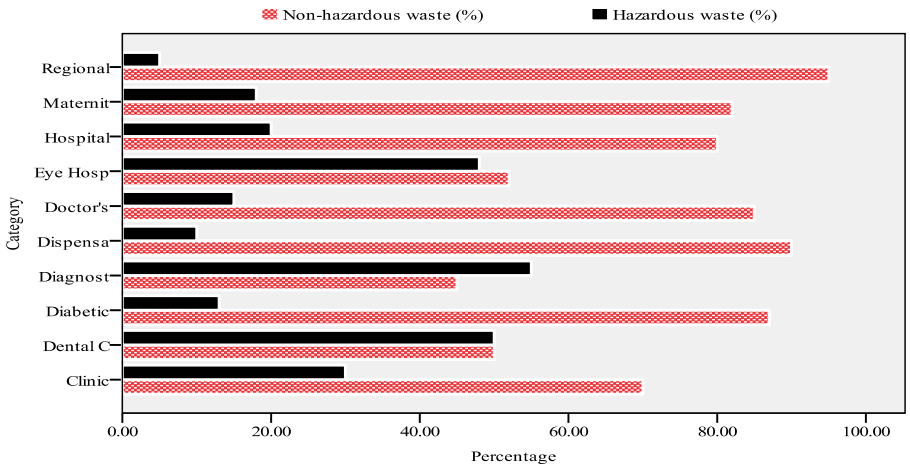

Figure 3.5: Percentage of hazardous and no-hazardous HCW generated by different category of HCE

Hospital – Figure 3.5 shows that the HCWs from hospitals comprises of 20% hazardous and 80% non-hazardous wastes. However, more verities of HCW were observed to be generated from hospitals as they serve varieties of patients. Only in two public hospitals were found to follow color coding system for temporary storage of HCW within the hospital premises. Others do not follow color coding, rather they use different sorts, shape and strength drums for HCW collection. Compared to public hospitals, private hospitals use strong drums and their surrounding environment is cleaner. Workers collecting HCW were not found to wear any protective gear which was a worrying finding.

Clinics – Clinics also generate similar varieties of HCW in smaller quantity compared to hospitals. However, they generate comparatively more hazardous HCW than hospitals. Figure 3.5 indicates that the HCW from clinics contain 30% hazardous and 70% non-hazardous wastes. Alike hospitals, clinics also do not follow color coding system but they use comparatively strong drums and some are contracted with private company for managing their HCW. But many of them directly discharge their HCW to municipal dustbins or open road and create an unhygienic environment.

Maternities – Maternities generate less quantity of hazardous HCW compared to hospitals and clinics with 18% of its wastes being hazardous (Fig 3.5). Their entire HCW handling and management system is comparatively better than others but they don't follow any color coding system for temporary storage of HCW.

Eye hospitals – Eye hospitals or clinics generate small quantity of HCW but their wastes contained 48% hazardous items (Fig 3.5). It was also noticed that they burn their major part of their hazardous HCW by them.

Similar to others, they were also found not to follow a clear color coding system for temporary storage of HCW and most of their wastes are thrown to municipal dustbins.

Dental clinic – There is only one dental hospital in CCC but many dental clinics are there where patients are not admitted rather treated as and when arrived. They generate very little quantity of HCW but with 50% hazardous content. They mainly generate some infectious HCW. They mix up all categories of wastes they generated to discharge them to nearby municipal dustbins.

Diabetic's hospitals – Diabetic hospitals generated similar quantity of HCW as clinics but with less hazardous content which was only 13%. They also do not follow color coding system and release their wastes into municipal dustbins.

Diagnostics centers – Though total number of diagnostic centers in CCC is more but they generate smaller quantity of HCW including fewer categories than clinics and hospitals. However, their hazardous content is high (55%). Though they don't follow any color coding, they usually segregate sharp HCW before releasing into municipal dustbins.

Dispensaries – Dispensaries generate only little quantity of sharp hazardous waste (10%) and others wastes are non-hazardous (90%). They mix up all of their generated HCW and then discharge to municipal nearby dustbins.

Regional office of pharmaceutical companies and doctor's private chamber – Regional office of pharmaceutical companies generates mainly non-hazardous paper wastes from packaging materials and product flyers. In contrary, private physicians' chamber generates small quantity of sharp HCW such as syringes, saline bags, blades and gauges etc. The hazardous content in wastes from these two sources is 5% and 10% respectively. All of their generated HCW are disposed to municipal dustbins mixing up.

3.6 Discussion

Their overall environment of HCW management was not satisfactory at all in CCC. Therefore, it is necessary to form monitoring body by hospitals to plan and implement proper HCW handling system. Only Chittagong Medical College Hospital and Chittagong General Hospital were found to follow color coding system in CCC which was also not proper and regular. All other HCEs in CCC use different sorts and strength drums, basket, box and bowl for collecting HCW without following any standard collection bin. Some of them little quantity of sharp HCW segregates but finally discharge to municipal dustbins without any treatment which converts harmless MSW to hazardous waste. Comparatively better HCW handling and management system was found in NGO running maternities which can be used as initial model for HCW handling. Since the major portion of generated HCW is non-hazardous, they can be recycled or safely managed if strict color coding system is adopted for them for the purpose of source reduction and re-utilization. Nevertheless, government and concerning authorities should monitor HCEs and implement related regulations strictly to improve current condition.

4.0 Conclusion

Rapid and unplanned urbanization is responsible for large quantity of MSW generation in urban areas as well as HCW. Though HCW contributes only 1% to the total MSW streams, it is important because when it gets mixed with MSW convert them to hazardous. Hospitals and clinics contribute major quantity of HCW to MSW stream while total HCW contribution of diagnostic centers is also noticeable. In contrary, the rest category of HCEs in CCC generates less quantity of HCW. This study reveals that total HCW generation of CCC is 15-18 tons/day. Compared to public, HCWM scenario in NGO-run HCEs and private HCEs is slightly better. In conclusion we can say that HCW management related rules and regulations should strengthen and strictly enforced. Considering field observation and secondary data, we felt the need to deeper investigation into HCW situation to find out acceptable a model for CCC to manage its HCW environmentally friendly manner.

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An Overview of Control Systems Applied to a Gas Process Plant

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Abstract

This paper outlines the control engineering methods and principles applied to a gas process plant. The discussion is divided into some engineering aspects—needs analysis, methods, specifications and requirements of a control system. The various control modes(proportional, derivative, integral and PID) are discussed as these are most commonly used in oil and gas production plants. Specifications of different control systems and HART principles are mentioned. This will bridge the gap between theoretical study and application of control system courses at undergraduate level. Most of the students frustrate that the courses they studied have no practical use. This article will enhance their method of learning and will be a tool for connecting students and professionals in process engineering fields.

***Key-words**: PID Control, SISO, PLC, Servo-mechanism, HART.*

1.Introduction(Overview of UG Courses on Control Systems):

The standard course on control system at undergraduate level deals with introductory concepts such as open- loop versus closed- loop feedback system, input-output relationship, transfer function, DC machine dynamics, performance criteria, sensitivity and accuracy, analysis of control systems—time and frequency domain. Moreover, stability of control system deals with bode plot, Nyquist and root-locus technique, frequency response analysis, non-linear control system, controllability etc. Some pre-requisite courses on Mathematics such as Laplace transforms, Matrices etc. are studied. The subject matter included in the course are useful to design and analysis of control systems or devices/equipments used in a process plant. While analyzing the performance of a system or it's parameters by using programming tools, we've to know the ins and outs of the system. The study of automatic control is a complex subject. Exact solutions to particular control problems require detail process knowledge, not only of the physical and chemical characteristics of the fluids, but also of the mechanical aspects of the process—equipments (pumps, heat exchangers etc.), piping systems and the control loop itself. Mixed control modes are used in the process plant to control different valves(level control valves, pressure control valves), to control temperature and flow by electronic indicator(indicating controllers) situated in the control room and pneumatic sensing or measuring element in the process field area. Remote analogue control loops generally employ electronic single loop controllers, local level control loops employ pneumatic controllers, and all switching logic and ESD functions are accomplished with a Programmable Logic Controller(PLC). One thing to mention here, this is an introduction into the complex field on control system keeping in mind that once basic principles are sufficiently clear, it will be relatively simple to understand and operate more complex systems. However, details of PLC functions is beyond the scope of this article.

2. Process Description:

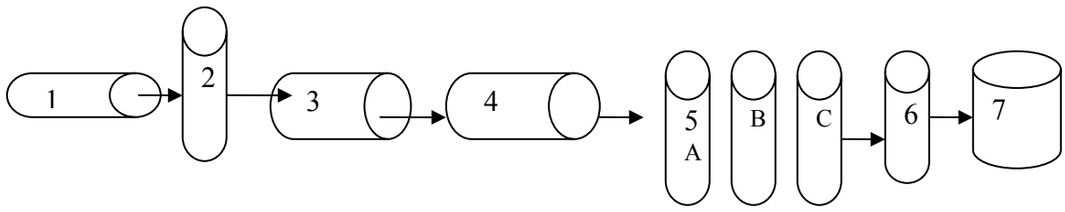

Fig.1 Gas dehydration and condensate recovery process : 1-Inlet knock-out separator
2-inlet separator, 3-regen heater, 4-heat exchanger ,5-desiccant towers, 6-regen scrubber, 7-tank

Before describing how the control engineering is applied to the gas process plant, let us describe the process first, in brief. The complete process plant consists of four basic steps: inlet gas treatment, gas dehydration, regeneration gas treatment and cooling gas treatment

Inlet Gas Treatment

The inlet gas is drawn from various wells. After passing the flow lines, the gas flows via ESD valves into knock-out separators where water, condensate and solid material(if any) are separated out from the gas. Because the pressure of the gas in the knock-out separators is higher than in the production manifold, the gas must be throttled which is achieved in the flow control valves. Then the gas first passes to the inlet separator, and then, before it flows to the desiccant towers, is filtered in the filter separator to remove any solids and entrained liquids-particularly, water which can affect the silica gel desiccant performance. Then it passes to the plant associated (heavy) condensate separator.

Gas dehydration

The three desiccant towers operate in different modes at any given time. Thus, while the first tower is in the drying mode, the second is in the regeneration mode and the third is in the cooling mode. The operating mode for the towers change with an approximate ½ hour interval cycle. The operating mode switch-over of the towers is controlled by a timer-activated automatic sequential control system programmed in a PLC. The filtered gas is routed to the desiccant towers and enters the tower in the drying mode from the top. The towers contain a bed of silica gel –based desiccant and , while passing through the bed, the water and C5-plus the heavier hydrocarbon components present in the gas stream, get adsorbed onto the desiccant. The contact with the desiccant bed renders the gas stream sufficiently dry to meet the dew point specifications (both water and hydrocarbon) required for the pipeline quality. The dried gas flows out from the bottom of the tower and is routed to the dust gas filter.

Regeneration Gas Treatment

The tower in the regeneration mode undergoes heating of the desiccant bed with hot regeneration gas. This gas is a side stream of approx.30% of the feed gas to the desiccant towers and heated in the regeneration gas heater to a certain temperature. The hot gas, while passing over the desiccant bed, vaporizes the adsorbed water and hydrocarbons from the bed. From the tower, the regeneration gas flows through the gas-gas exchanger, regeneration gas cooler in series to cool it down to a designated temperature.

Cooling Gas Treatment

The cooling gas treatment is performed in a similar manner to that of regeneration gas using cooler fans etc.

3. Needs Analysis

Before selecting or choosing a controller type or mode, we have to analyze the characteristics of the complete process, the individual process variables or parameters and other factors including ambient conditions(dew point, humidity), instrumentation and measurement philosophy etc. From this analysis or simulation by using software, we can decide whether it will be an electronic integrator, totalizer, counter, recorder or other type of electronic indicator. We first look at the parameters to be controlled from the control room. For information, this is notable here that this is not the exact designing approach , only for illustration.

Major process variables/parameters affecting the performance of solid desiccant: feed gas temperature, feed gas specific gravity, cycle time, outlet gas dew point, desiccant capacity, desiccant bed pressure drop.

Pressure: individual well pressure(inlet knock-out separator), manifold pressure, heat-exchanger shell out pressure.

Differential pressure: of individual desiccant towers, heat exchanger.
Temperature: individual well temp., outlet temperature of knock-out separators, water bath(inlet heater) temperature, regen gas temp., sales gas temp.
Level: level glasses used for related equipments in the process area.
Flow: plant inlet flow, regen gas flow(quantity), cooling gas flow etc.

4. Automatic, Closed loop versus Open loop Control System

An Automatic Control System comprises of an arrangement of elements which are inter-connected and interact such that some controlled condition (e.g. temperature, flow or pressure) forming part of the system is maintained in a prescribed manner. The important elements of a process-control loop are the process, measurement, evaluation, and the control element.

If this system was to be controlled manually by an operator, the system in block form would work as shown in Fig. which becomes a 'closed loop' in the sense that any disturbance to the temperature will pass round the loop from element to element until the human brain compares the desired temperature with the temperature as indicated, and corrective action is applied manually.
To control temperature at near about set value without much offshoot, operator action would be as follows : Whenever he finds any difference between measured and set value, he would open or close the valve initially by an amount proportional to the error by his experience. He would then wait for the response or its effect.

This is because system has some capacity and resistance which take time in transferring the cause to effect. After sometime he would again open/close the valve by lesser amount and again wait for the effect and repeat such action with smaller and smaller opening /closing subsequently till the desired value is reached.

Since operator can't do such a function continuously and correctly due to his limitations, an automatic closed control loop has to be employed which would be doing exactly similar functions continuously and endlessly. The closed control loop is also known as servo mechanism and the various elements are process itself, sensor, settler, controller, power amplifying device, and regulating device such as control valve. Regardless of the number of elements used, the loop will contain at least four basic elements : (a) detecting, (b) measuring, (c) Controlling and (d) final control element. Often, a transmitting element is added to these

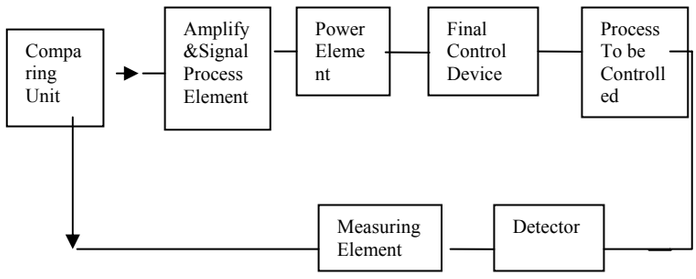

Fig.2 Single Loop Feedback Control System

In the closed control loop the controller mechanism takes the place of the human eye and the correcting unit is substituted for the human hand. Fig.1 shows in block schematic form the closed control loop. It would be noted that the command signal θi generated by the setter is applied to the controller and compared with the instantaneous value of the process parameter to be controlled(θo). The output of the comparing unit represents the difference of θi and θo known as error which is amplified and processed by the controller as per its settings. The output of the controller is fed to a power element/motor element. The motor element is the correcting unit which adjusts the final controlling device in response to a signal from the controller and thus amplifies it to a level sufficient to actuate the final controlling device which adjusts the output to match with set value.

Open Loop Control System : Control without feedback is called an open loop system. It is many times advantageous to make use of an open loop to give an approximate correction for changes which will ultimately affect the true controlled variable.

5. Methods/Modes of Control System

There are five main modes of control which can be used to control the process at the desired value despite the difficulties, occasioned by the characteristics of the plant and process.

(i) Two step or on/off
(ii) Proportional
(iii) integral
(iv) Derivative
(v) Proportional plus Integral plus Derivative (PID)

Two step/On-Off : The simplest form of automatic control used is the two-position or on-off type control. Two position control is normally used when the controlled process variables need not be maintained at precise values. This type of control action regulates the flow of input energy by either fully opening or fully closing the valve. The controller operates the valve when the controlled variable rises or falls above or below the set point. In on-off control, the output is dependent on the error. An example is alarm and shut down functions.

Proportional: It's name is derived from the fact that controller output is proportional to the difference between the measured variable and the set point, i.e. the error signal. In proportional mode of control, the control valve or regulating unit can take up any position right from fully open to fully closed, which results in a stable control. Proportional control produces an overshoot followed by an oscillatory response, which levels out at a value that does not equal the set point ; this ultimate displacement from the set point is the offset.

Integral : Integral or reset action is defined as a controller response which is proportional to the extent and duration of a signal deviation. In the proportional control, valve begins to move as soon as there is a deviation and will come to rest after traveling a distance, proportional to deviation. Further, the speed of valve travel is proportional to the rate at which the deviation is increasing or decreasing. In integral action, the valve speed changes continuously depending upon the error. With this control, the valve is only at rest when the control variable is at the set point.

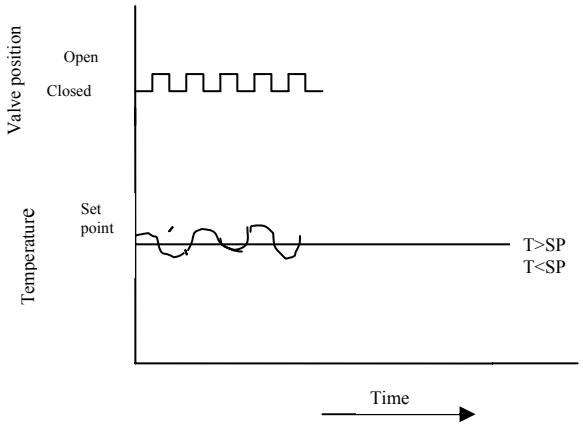

Fig.3 Simple two-position (On-Off) Control System

Derivative Control: It is defined as that part of a controller response which is proportional to the rate of change of input. If, during control the variable rapidly approaches the set point, it is bound to result in a large overshoot. Accordingly, a large movement of valve in opposite direction is essential to reduce the overshoot. In derivative control, the valve is no way concerned with the set point, but moves an amount purely according to the direction and the rate of change of deviation. If the variable makes a sudden step movement, its rate of change is infinitely fast and the valve will, therefore, travel at once to its full travel position. If, on the other hand, the variable moves gradually at a constant rate, the valve will move on an amount proportional to that rate and will not move again until the rate of change of deviation alters. Derivative control is never used alone, but normally in conjunction with proportional or proportional plus integral control.

PID : The proportional-integral-derivative(PID) controller is by far the most commonly used controller. About 90 to 95% of all control problems are solved by this controller, which comes in many forms. It is packaged in standard boxes for process control and simpler version for temperature control. It is a key component of all distributed systems for process control. Specialized controllers for many different applications are also based on PID control. The PID controller can thus be regarded as the "bread and butter" of control engineering. It has gone through many changes in technology. The early controllers were based on relays and synchronous electric motors or pneumatic or hydraulic systems. These systems were then replaced by electronics and, lately, microprocessors.

6. Specifications of Control System : Generally, control system specifications can be divided into two categories : performance specifications and robustness specifications. All though the boundaries between the two can be fuzzy, the performance specifications describe the desired response of the nominal system to command inputs. The robustness specifications limit the degradation in performance due to variations in the systems and disturbances.

Performance specifications for SISO LTI systems :

Transient Response Specifications : In many practical cases, the desired performance characteristics of control systems are specified in terms of time-domain quantities, and frequently, in terms of the transient and steady-state response to a unit-step input.. The unit step signal, one of the three most commonly used test signals(the other two are ramp and parabolic signals), is often used because there is a close co-relation between a system response to a unit step input and the system's ability to perform under normal operating conditions. And many control systems experience input signals very similar to the standard test signals. If the response to a unit step input is known, then it is mathematically possible to compute the response to any input. Both the transient and steady-state specifications require that the closed-loop system is stable.

The transient response of a controlled system often exhibits damped oscillations before reaching steady-state. In specifying the transient response characteristics, it is common to specify the following quantities : (a)Rise time (b)Percent overshoot (c)Peak time (d)Settling time (e)Delay time

Frequency –Domain Performance Specifications

In control system design by means of frequency-domain methods, the following specifications are often used in practice : (a)Resonant peak (b)Bandwidth (c)Cut-off rate.

Robustness Specifications for SISO LTI Systems:

(a)Relative Stability –Gain and Phase Margins (b)Sensitivity to Parameters (c)Disturbance rejection and Noise Suppression

Miscellaneous Specifications : There are many other aspects of a control system that are often specified. There are usually constraints on the allowable cost of the controller. In some applications, the size, weight and power required for the controller's operation are restricted. Control system reliability is also often specified. The simplest such specification is the life expectancy of the controller. The allowable ways in which a controller may fail are also often specified, especially in applications involving humans.

7. Analyzing Control Problems

The proper solutions to control problems are not always obvious. Solutions that seem obvious are not always the best. In order to evaluate the various alternatives, some pertinent questions may furnish clues to proper applications. Among the questions that need answering are these:

1. Which variable should be controlled?
2. Which detection method should be used for that variable?
3. Where should the detector be located?
4. How should system cost versus system efficiency be evaluated?

8. Requirements of a Control System /Performance Criteria

The essential conditions for a good control are : small deviation from set value after a disturbance, high sensitivity, narrow proportional band, minimum offset, quick return to set value after a disturbance. These conditions can be achieved by proper study and analysis of plant and process.

9. HART Communication

The HART (Highway Addressable Remote Transducer) protocol gives field devices the capability of communicating instrument and process data digitally. This digital communications occurs over the same two-wire loop that provides the 4--20 mA process control signal, without disrupting the process signal. In this way, the analog process signal, with its faster upgrade rate, can be used for control. At the same time, the HART protocol allows access to digital diagnostic, maintenance, and additional process data. The protocol provides total system integration via a host device.
The HART protocol uses the frequency shift keying (FSK) technique based on the Bell 202 communication standard. By superimposing a frequency signal over the 4-20mA current, digital communication is attained. Two individual frequencies of 1200 and 2200Hz are superimposed as a sine wave over the 4-20mA current loop. These frequencies represent the digits 1 and 0 . The average value of this sine wave is zero, therefore no dc value is added to the 4-20mA signal. Thus, true simultaneous communication is achieved without interrupting the process signal.

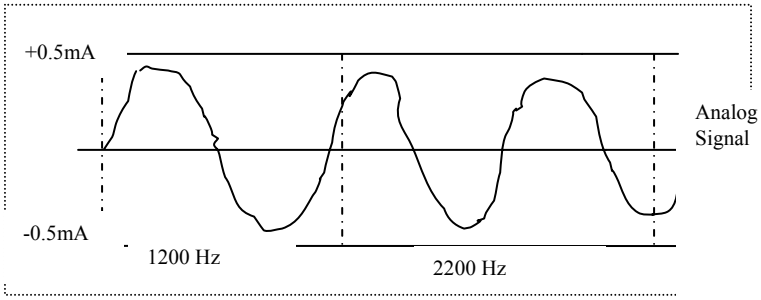

Fig. 3 HART FSK Technique

10. Conclusion

In this article, five types of control, HART, specifications and requirements of control system have been discussed. Once the control system methods and principles are properly understood, attention may be paid to control circuit design by using electronic devices or microprocessor as per need. To do so, control system requirements, specifications and standards currently used must be known. Many computer software packages are available for use in solving problems in process dynamics and control. Some are : TUTSIM, Program CC, ACSL, SIMNON etc.

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A Comparative Study of Instrumentation Systems of a Gas Process Plant

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Abstract

The Challenges of 21st century are basically centralized to the proper utilization of energies, especially the natural resources. Natural gas (methane) is one of the most important sources of energy upon which other systems are dependent, e.g. power generation system as well as the economic or industrial development. The successful exploration of natural gas with other hydrocarbon components (petrol, diesel, octane etc.) depends on proper instrumentation and control. Inaccurate instrumentation may cause inefficient production or severe damage of the total system; consequently, economic losses. This paper outlines some practical aspects(electrical and electronic) of instrumentation system applied for a silica-gel based gas gathering system. This will connect the students who are studying courses on and the professionals in the field of instrumentation and control engineering.

Keywords*: Transducer, Signal conditioning, Calibration.*

1. Introduction

An instrumentation system is an aggregation or assembly of devices united by some form of regular interaction of an interdependence. It is a group of diverse units or devices so combined by nature or by a n art to form an integral whole, and to function, operate or move in unison, and often in obedience to some form of control. Electrical and electronic instrumentation for a natural gas process(silica-gel based) plant may be consists of both analog and digital types of instruments. Analog systems deal with information in analog form. An analog signal may be defined as continuous function such as a plot of voltage versus time or displacement versus force. On the contrary, digital instrumentation systems deal with information in digital form. A digital quantity may consists of a number of discrete or discontinuous pulses whose time relationship contains information about the magnitude and the nature of the quantity under measurement.
An analog system typically consists of some or all of the following elements: (a) Transducers: Thermocouples, Strain gauge bridges, piezo-electric devices (b) Signal Conditioning Equipment: devices for amplifying, refining or filtering, isolation, linearization or selecting certain positions of signals (c) Multiplexer (d) Calibrating equipment (e) Integrating equipment (f) Visual display devices (g) Analog recorders (h) Analog computers.
A digital system typically consists of some or all of the following elements: (a) Transducers (b) Signal conditioning equipment (c) Multiplexer (d) Signal converter (e) Analog to digital (A/D) Converter (f) Auxiliary equipment (g)Digital recorder (h) Digital Printer.

2. Needs Analysis

An instrumentation system in industrial applications measures quantities such as temperature, pressure, force, flow, humidity, light intensity, etc., and controls certain elements in the system to maintain the measured quantity at some desired value. By a proper instrumentation system we want to control the operating conditions of the gas process plant as per requirements such as: the ratio of material flows, the correct temperatures (heaters, dehydration towers), pressures (inlet and outlet temperatures of separators, well head pressures), fluid levels. The prime element (mechanical, electrical, magnetic or a combination of two or more of these devices)of a measurement system is a sensor. Sensors producing electrical outputs in the form of voltage, current, charge, resistance or capacitance are most commonly used because the electrical outputs can be easily amplified, conditioned, modified, processed and recorded. Electrical signals enable remote measurement too. However, we can classify our needs for instrumentation into the following categories:
Measurement: measures and detects various parameters in the field area

Control/Switching: how much to open/close the valves or to control the operating conditions
Indication: in the control panel, starting from inlet (wellhead) values to the sales condition
Alarming/Shutdown: in the annunciator panel, any unusual/abnormal condition.

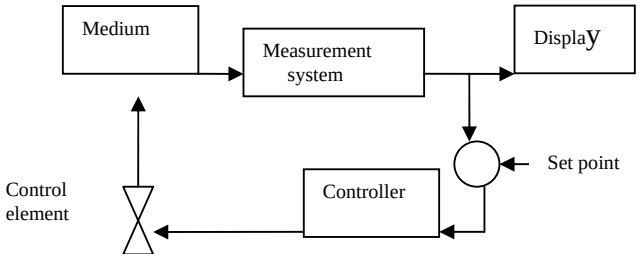

Fig.1 Block diagram of a generalized instrumentation system.

3. Pressure and DP Measuring Device

Electrical type pressure sensors use elastic elements to sense pressure and use different types of sensors to measure changes occurring in sensing elements. Pressure and differential pressure devices are so constructed that increasing or decreasing pressures produce linear movements on pointers or dials which move over calibrated scales. At the same time that they provide a local indication, they may also provide a movement to a flapper in a flapper-nozzle relationship to give a proportional output signal for remote use. The same principle applies to filled temperature systems where the pressure of constant volume systems changes with the contraction and expansion of the fluid in the system. Indication or transmission of these measured values is accomplished primarily by balancing systems commonly referred to as motion-balance or force-balance systems.

Electronic Force-balance Transmitter

The electronic force-balance transmitter is similar to its pneumatic counterpart. The flapper and nozzle arrangement is replaced with some type of electrical detector, often a coil whose inductive reactance is modified by the proximity of the beam. Electronic amplifiers (normally transistorized or with integrated circuits) convert the detected signal to a DC current which serves as the transmitted signal. The feedback force generated by the process variable (as in the pneumatic system) is provided by the output signal and is used to counterbalance the force generated by the process variable. The span of the transmitter is changed by simply adjusting the position of the beams fulcrum. Range adjustments of 10:1 are typical for force balance transmitters. The level gauges attached with various separators (inlet separator) are designed in accordance with the principle of force balance.

4. Flow Measurement

Positive displacement meter or turbine flow meter can be used as volumetric measuring flow meter. The flow of fluid engages the blades of the rotor, causing the rotor to rotate at an angular velocity directly proportional to the velocity of the fluid. Because the meter has a finite volume, the angular velocity is directly proportional to volume flow rate. As the rotor blades pass beneath the pickup coil, the change in magnetic flux causes an AC electrical signal to be generated. The frequency of the sinusoidal waveform generated is directly proportional to total volume throughput. Positive displacement meters or turbine flow meters can be converted to mass flow meters using a gas density transducer and a simple readout system (e.g. flow computer). Since both the flow meter and density sensor signals are in frequency form, the readout system need use only digital techniques.

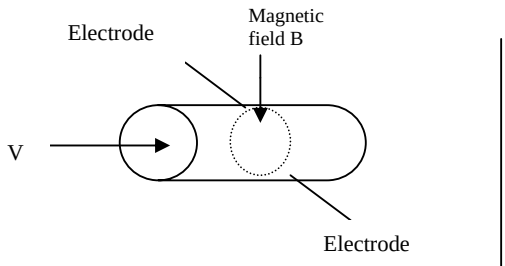

Fig.2 Electromagnetic flowmeter--Principles

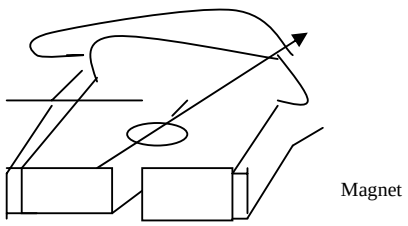

Fig.3 D'Arsonval Galvanometer to Calibrate DP & PT

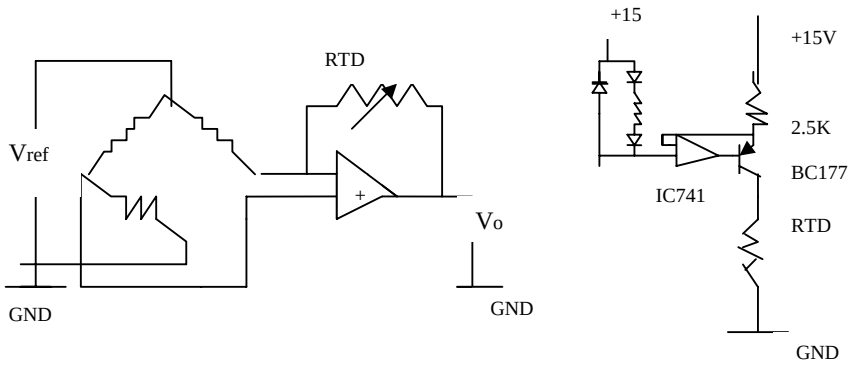

Fig. 4 Temperature Measurement Circuit using RTD: (a) Bridge Circuit (b)Current Source

5. Temperature Measurement and Signal Conditioning

Several types of temperature sensors are available to measure temperature. The thermocouple, resistance temperature detector (RTD), and thermistor are a few widely used types. The RTD changes its resistance with temperature. By measuring the change in resistance exhibited by the RTD, the temperature of a medium is measured. RTD is used in gas process and condensate recovery plant for measuring the temperature of inlet heater, regeneration gas heater (hot oil temperature) etc. Somewhere bi-metallic thermometer is used (desiccant tower outlet temp.). Signal-conditioning provides operations necessary to transform a sensor output into a form and level necessary to interface with other modules of the measurement system. The output signal from sensor is usually very low in level, weak in power, and easily susceptible to electromagnetic noise. It requires amplification with large gain and little noise and distortion. Common signal-conditioning operations are: amplification, isolation, filtering, scaling, attenuation, current to voltage /voltage to current conversion. Signal conditioner for RTD or thermistor uses a simple bridge amplifier to convert the change in resistance to a proportional voltage. The signal- conditioner for the RTD and thermistor, supply the required ac/dc voltage /current excitation for the bridge circuit.

Signal Processing Simple signal-conditioning is not sufficient in many measurements. In addition to signal conditioning, further processing by signal processing circuits such as modifiers, detectors or demodulators are needed before they are displayed. Phase sensitive detectors, peak detectors, RMS converters, comparators, voltage to current converters, current to voltage converters, voltage to frequency converters, frequency to voltage converters, and logarithmic amplifiers are a few signal processing circuits that are built-in in a measurement system.

6. Calibrating Equipment

Analogue indication of electrical parameters such as current, voltage, resistance (converted to current or voltage by a bridge or other such circuits), etc. is carried out by an appropriate adaptive version of D'Arsonval Galvanometer—so named after its inventor. The aluminium frame is pivoted and provided with spiral suspension and control springs. A pointer is attached to the coil. The current passing through the coil produces a rotating movement of the coil and this angular deflection of the coil is directly proportional to the current. As the electric signals used on the plant are limited to 4--20mA, this meter can measure current within the range of 4—20mA. The flow is cut before calibration of transmitters. Then pressure input is arranged by using a calibrator which is converted into current signal within the range. By comparing the spot response with the remote (control room) response, necessary change is performed and accuracy is made.

7. Other Instruments

So far the fundamental functions of any control loop have been listed and discussed. In almost all control loops, one or several other functions are used. These include recorders, indicators, transducers or converters, integrators, alarm and shut down functions.

Indicators: These are electronic indicators observed from the control room. For monitoring various parameters of the process, these electronic indicators are used that present measured variables in numerical form, bar-graphical form etc.

Recorders provide continuous records of measured variables with respect to time. For recording the temperature or other parameters of the desiccant towers, electronic recorders are used. Most charts are driven electrically, but mechanically and pneumatically driven charts are also available.

Transducers or Converters: The development of miniature electronic controllers in the early 1950's created a need for a group of instrument devices –transducers or converters—whose use continues to grow. Their main purpose is to convert signals from one energy form to another or from one signal level to another. Gas density transducer, displacement transducer, and many other types of transducers may be used in a gas process plant.

Electronic Transmitters and controllers were introduced about the same time. Because at that time there were no electronically actuated valves (final control element) available, a transducer was necessary to convert the electronic signal to the pneumatic signal needed at the valve.

Integrators are instruments that receive continuous rate signals (either pneumatic or electronic) and automatically provide running totals or integrated values of these rates. They are used primarily for flow measurement. Units are available with six-digit or eight-digit counters normally and may or may not have reset functions. Integrators may also be provided with other functions such as switching so that when a pre-determined value is reached, initiation of appropriate actions occur (such as valve closures or pump shutdowns).

8. Alarm and/or Shutdown Functions

Ordinarily an alarm condition is one that warns that a shutdown may be imminent. Conversely, a shutdown is a situation in which an alarm condition existed that was so serious that no time was available for remedial action. There are instances when time existed for remedial action, but some reason the action is not taken. In either case, a switching action occurs to initiate the alarm or shutdown. The switch, in this case, is a device which "measures " the variable at a particular value and operates(opens or closes) when the preset value is reached.

Switches which actuate alarms or shutdowns may be piped directly to the process (process actuated), or they may be actuated by transmitted signals. Many companies insist that shutdown functions be initiated directly by process mounted devices rather than secondary (transmitted signal) devices. A typical application of pressure switch used on pneumatic signal lines and is applicable to whatever variable the system is measuring—flow, pressure, level or other.

Alarms units which provide the visual alarm indication include units such as light or it may be part or a multi unit system. The devices and equipment that may be shutdown include pumps, compressors and other types of rotating machinery that could be damaged under adverse operating conditions. Solenoid valves may be operated to open or close piping and equipment systems for safety precautions, for material conservation, to maintain product quality or for some other economic consideration.

9. Effectiveness Influenced by Electric Instrumentation

It is important to make a comprehensive survey to ascertain the types of measurements and learn the good and bad features of each of these types. Only then will one be aware of the best method for a particular application. For measuring flow, positive displacement meter method provides continuous measurement, high accuracy and resolution, fast response and intrinsically safe etc. advantages. On the other hand, for economy, for product quality, for equipment and personnel safety and for the reduction of losses, the best level measuring technique is essential. Furthermore, for remote indication, recording or control, electrical type level measurement method is preferred. Pressure transducers are mechanical, electrical or electronic types. Electrical type pressure sensors use elastic elements to sense pressure and use different types of sensors to measure changes occurring in sensing elements. Thus electrical instrumentation is more advantageous than the others.

10. Conclusion

This article provides a general discussion on instrumentation for a natural gas process plant. However, this is an introduction to the complex field of instrumentation engineering keeping in mind that once the fundamental concept is properly understood, a student or a fresh graduate will be able to understand and operate more complex system; therefore, find out the update technology and improve where necessary.

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Effect of Climate Change on The Coastal Area in Bangladesh

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Abstract

Bangladesh is likely to be one of the most vulnerable countries in the world to climate change. Climate change is an important issue now a days. Various human activities are making the world hot to hotter. The ultimate result is global warming, i.e. climate change. Rising temperature in the atmosphere causes sea level rise and affects low lying coastal areas and deltas of the world. Possible loss of land through beach erosion due to sea level rise on the eastern coast of Bangladesh is examined. Some discussions are also made on the impacts of back water effect due to sea level rise on flood situations in the country. Finally, a few remarks are made on the adaptation options for Bangladesh in the event of climate change It is very essential to have sufficient water supply and sanitation in all over the world. This study includes an outlook of remedial measurements that can be considered for sustaining the water supply and sanitation due to climate change in coastal belt of Bangladesh. The coastal area affected by severe weather condition which hampers the existing water supply and sanitation facilities. The aims to contribute the trend of environmental changes in the coastal areas of Bangladesh and to identify the major forces responsible for causing these changes , to investigate the coverage of safe water supply services and sanitation facilities in southern zone and to recommend or suggest alternatives adaptation strategies for promoting community-led water supply and sanitation. The country is already beset with many problems like high population density (120 million people living in an area of 144000 km2), shortage of land to accommodate the people, food security, human health, illiteracy, and so forth. The above mentioned types of disasters make the problems all them.

Keywords: *Climate change · Impacts · Erosion · Back water effect ·*

1. Introduction

Climate change is global phenomenon and caused by the accumulation of greenhouse gases in the lower atmosphere. The main sources of greenhouse gases are due to human activities. Rising temperature in the atmosphere causes sea level rise and affects low lying coastal areas and deltas of the world. In 1990, Intergovernmental panel on Climate Change estimates that with a business-as-usual scenario of greenhouse emission, the world would be 3.3^0 C warmer by the end of next century, with a range of uncertainty of 2.2 to 4.9 ^{0} C (Warrick et al., 1993). With the rise of temperature, sea level will rise because of thermal expansion and ice melt. Sea level rise has various impacts on Bangladesh, a coastal country facing 710 km long coast to the Bay of Bengal. It already has affected Bangladesh by land erosion, salinity intrusion and loss in biodiversity. Its potential threats are coming even strongly in the future. Sea level rise will cause river bank erosion, salinity intrusion, flood, damage to infrastructures, crop failure, fisheries destruction, loss of biodiversity, etc. along this coast. But, there is still a lack of awareness among the public about climate change and also, little consensus among the concerned bodies about the existence and the types of environmental effects of climate change and the numbers of environmental displacements. Lack of coordination among the organizations makes the situation even more difficult to tackle. It is very essential to have sufficient water supply and sanitation in all over the world. In Bangladesh most of the people live in coastal area are affected with salinity problem and scarce pure drinking water. In every year many people die due to various types of water borne diseases like diarrhea, cholera etc. which is certainly related with the insufficient sanitation system.In coastal areas of Bangladesh which are frequently affected by various natural calamities, there is no sufficient water supply or sanitation system. Thus they are always in want of pure water for drinking, cooking, washing etc. Though Public Health Department and different NGOs install deep and shallow tube-wells, shallow shrouded tube-wells (SST), very shallow shrouded

tube-wells (VSST), pond sand filter (PSF) and rainwater harvesting equipments, it seems inadequate to meet their need. Climate includes patterns of temperature, precipitation, humidity, wind and seasons. "Climate change" affects more than just a change in the weather; it refers to seasonal changes over a long period of time. These climate patterns play a fundamental role in shaping natural ecosystems, and the human economies and cultures that depend on them.

Because so many systems are tied to climate, a change in climate can affect many related aspects of where and how people, plants and animals live, such as food production, availability and use of water, and health risks.

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2. Experimental Details

Location of the Study Area

The field study is related with the present situation of water supply and sanitation in coastal area. For this purpose, Shyamnagar Upazila of Satkhira District in the Division of Khulna was selected. Shyamnagar Upazila is bounded by Kaliganj (Satkhira) and Assasuni upazilas on the north, Sundarbans and Bay of Bengal on the south, Koyra and Assasuni upazilas on the east, West Bengal of India on the west. The main rivers here are: Raymangal, Kalindi, Kobadak, Mother Kholpetua, Arpangachia, Malancha Hariabhanga and Chuna. South Talpatti Island at the estuary of the Hariabhanga is notable places. Shyamnagar has 12 Unions/Wards, 127 Mauzas/Mahallas, and 216 villages. The unions are 1. Vurulia. 2. Shyamnagar Sadar. 3. Munsigong. 4. Horinagor. 5. Koikhali. 6. Ramjan nagor. 7. Nurnagar. 8. Chondipur. 9. Isharipur. 10. Atulia. 11. Podmopukur. 12. Kshimari.

Shyamnagar has a population of 1949899. Males constitute are 1004415 of the population, and females 8945024. This Upazila's eighteen up population is 132516. Shyamnagar has an average literacy rate of 53.32% (7+ years).

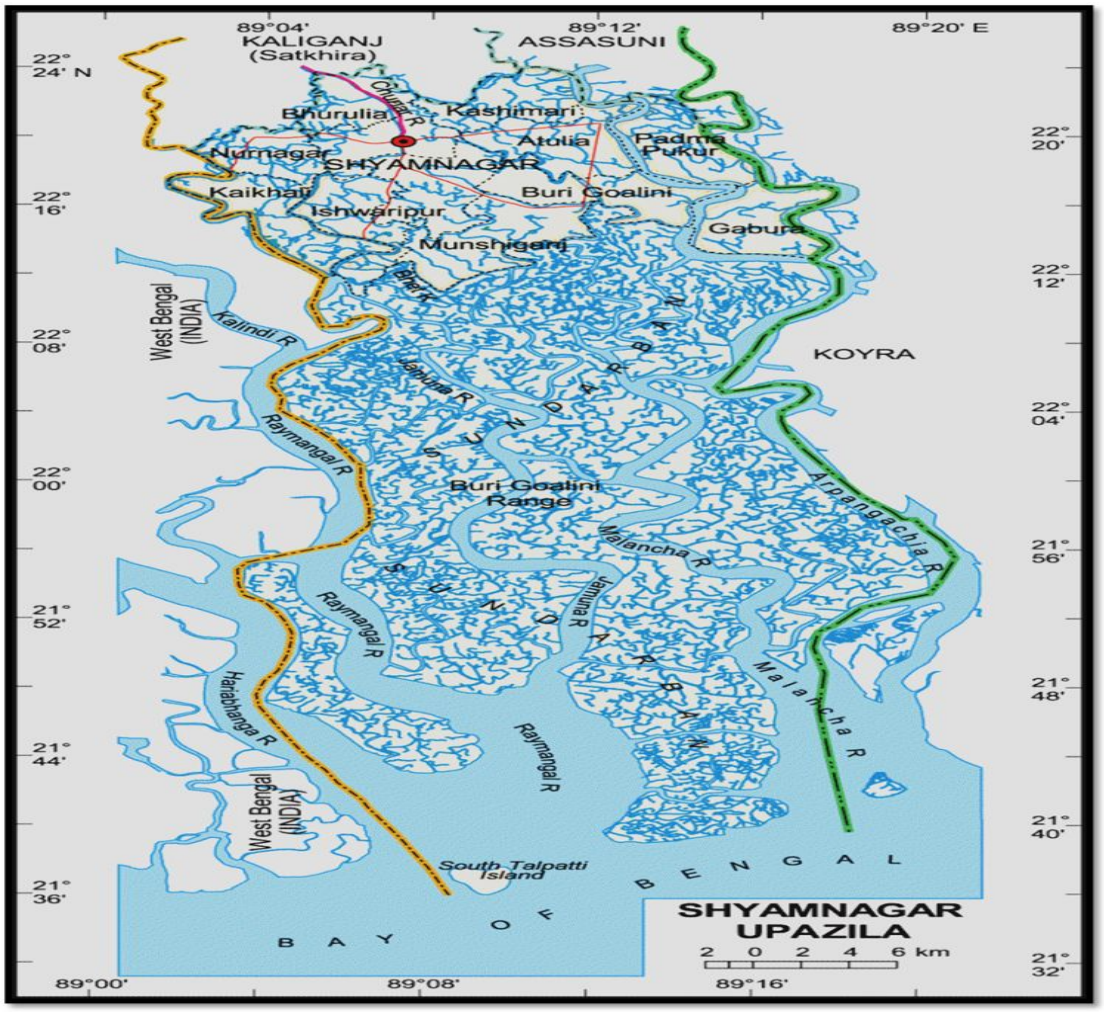

Figure 1: Map of Shyamnagar Upazila

3. Methodology

An elaborated literature study on the related topic was carried out for the better understanding and representation of the problem. To identify the technical and social problems of existing water supply and sanitation situation a questioner survey was conducted among the inhabitants the selected area. Pictorial references of the existing water supply and sanitation facilities were also taken. Raw water and filtered water samples were collected from selected PSFs that were tested in the laboratory for water quality investigation. Important parameters like total colliform (TC), faecal colliform (FC), turbidity, salinity and color were tested for raw water and treated water. After that, suitable adoptive measurements are suggested considering the available facts like available source of water, production cost, accessibility etc.

Present State of the Problem

According to the recent field report (DPHE, Shyamnagar upazila, Shatkhira District, Year 2010) various types of water supply mechanisms are installed in the affected zone which include deep and shallow tube-wells, shallow shrouded tube-wells (SST), very shallow shrouded tube-wells (VSST), pond sand filter (PSF) and rainwater harvesting equipments etc.

4. Data Collection

Collection of Primary Data
While performing site visits, water samples were collected from the rivers, and channels/canals of nearby the crop fields. Soil samples from the crop fields have also been following standard techniques. The land-use patterns, managements and socio-economic aspects of the coastal people have been collected from local administrative unit like Thana Agriculture Office and directly from the local people through questionnaire. In doing so data were collected from Ramjan nagor, Shyamnagar Sadar,Nurnagar, Kshimari. The local people in some selected areas of the coastal zones were also interviewed about their socio-economic aspects and livelihoods. In each location, some 10-20 farmers were randomly selected for the purposes.

Collection of Secondary Data
Relevant information have been accumulated by journals, periodicals, browsing internets, personal communications and visiting various Non Government Organization (NGO)s offices like Sushilon, OXFAM, Brati, Muslim Aid, Christian Aid, Action Aid, Pragati etc.

Summary of the questionnaire survey
Table 1: Results of the questionnaire survey

Total No of family	170
Total population	850
Type of family	
(a) Nuclear	110
(b) Extended	60
No of families using tube well as drinking source	52
No of families using PSF as drinking source	90
No of families using rain water harvesting & other units	28
Average drinking water required in each family (l/c/d)	25
Average water required for cooking in each family (l/c/d)	8
No of families using pit latrines or sanitary latrines	45
Open defecation or others	55

5. Results and discussions from the questionnaire survey

PSF is the main drinking water sources in the study area. Another largest drinking water source is tube-well. But most of the tube-wells are salinity affected. The salinity level is not acceptable level. This drinking water sources do not satisfy the drinking water standards. Therefore, increased unavailability of fresh water the people are forced to drink contaminated water. As a result people are affected by different water borne diseases diarrhea, cholera etc. On the other hand people in general have a very poor knowledge about sanitation. Sanitation coverage is not satisfactory one in these areas. Sanitation coverage is only 45%. People are not aware about their health. People in the area often defecated on the drains, in open fields, near the road sides, or on the riverbanks. There are no specific actions on strategies regarding safe water supply and sanitation facilities in the study areas. Thus, strong policy advocacy is required to ensure safe water supply and hygienic sanitation facilities in the study area.

Figure 2: Existing water supply facilities in Shamnagar Upazila

Table 2: Sanitation Facilities in Shamnagar Upazila

SI no	Name of union	Total Family no	No of family who use sanitary latrine	No of family who are not use sanitary latrine	Eligible but there is no latrine	No of Ineligible family	ineligible and there is no land	In (%)
01	Vhurulia	2674	721	1322	02	426	203	26.96
02	Khashimari	4857	2339	1528	160	744	86	48.15
03	Shyamnagar	5650	3193	1074	287	1096	-	56.51
04	Nurnagar	3895	1536	1217	167	852	123	39.44
05	Koikhali	3602	1277	1873	75	361	16	35.45
06	Romjannagar	4455	1783	2209	27	303	136	39.95
07	Munshigonja	5304	1545	2396	42	910	411	29.12
08	Eswaripur	3896	1414	1004	419	1004	55	36.29
09	Burigoalini	5167	2029	1340	562	956	280	39.26
10	Atulia	4560	1532	1792	112	1034	90	33.60
11	Padmapukur	3221	596	2160	129	297	39	18.50
12	Gabura	5017	534	2675	142	1510	156	10.64
	Total	52298	18496	20590	2124	9493	1595	34.48 (average)

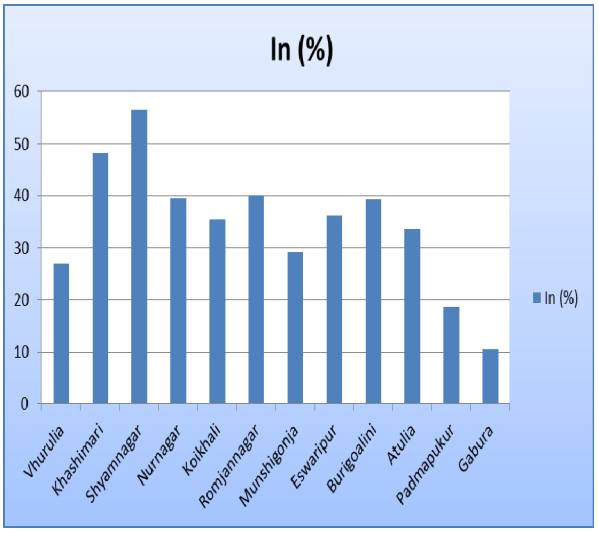

Figure 3: Sanitation Uses in Shamnagar Upazila

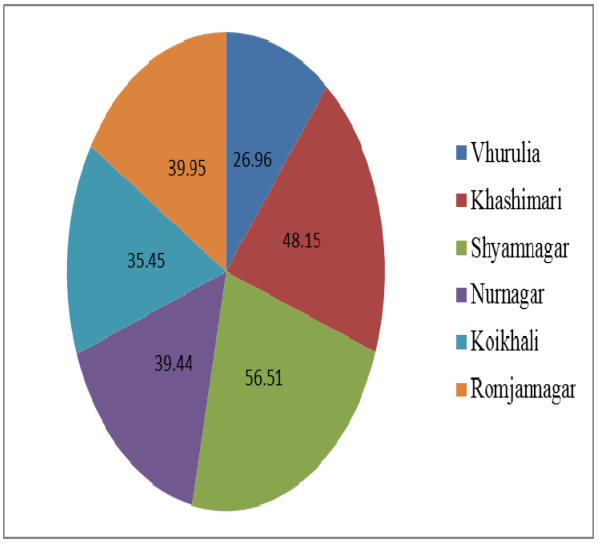

Figure (a)

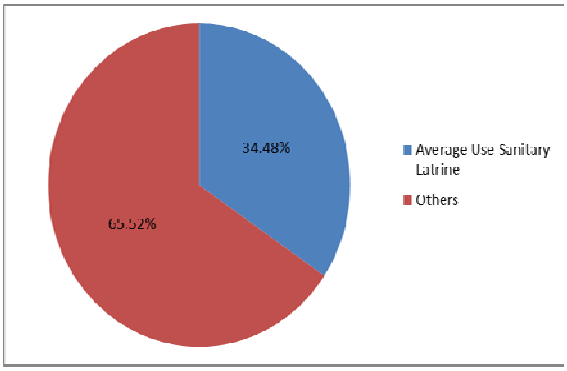

Figure 4: Present practice of sanitation based on questionnaire survey (Shamnagar Upazila)

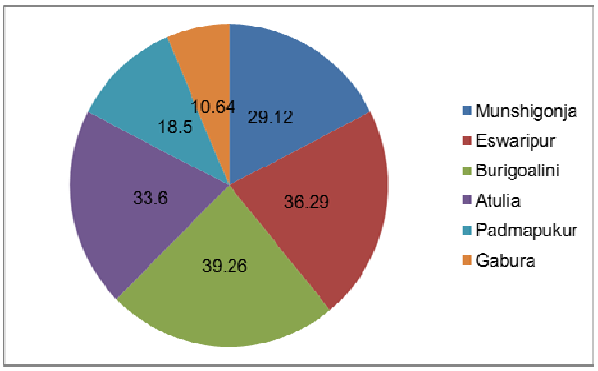

Figure (b)

Figure 5: Present Sanitation practices in Shamnagar Upazila

People in the Shamnagar Upazila, sanitation practice are not good. Sanitation coverage is the maximum at Shamnagar 56%. In other Upazilas sanitation coverage condition is more deplorable. This is due to the occurrences of divesting cyclone Sidr and Aila.Because sanitation sector are the vulnerable due to storm surges. Another cause is people in these areas are not conscious about their health. As a result, they suffer by the different sanitation related diseases.

Table 3: Drinking water sources in Shyamnagar upazila

		Tubewell			Shallow tubewell		
Serial no.	Name of union	Total	Functioning	Closed	Total	Functioning	Closed
01	Vhurulia	161	138	23	30	19	11
02	Khashimari	472	450	22	40	30	10
03	Shyamnagar	387	350	37	61	44	17
04	Nurnagar	191	166	25	46	33	13
05	Koikhali	94	81	13	12	08	04
06	Romjannagar	91	65	26	08	03	05
07	Munshigonja	153	110	43	05	02	03
08	Eswaripur	174	119	55	37	15	22
09	Burigoalini	129	67	62	24	17	07
10	Atulia	181	142	39	14	08	06
11	Padmapukur	268	250	18	11	09	02
12	Gabura	158	147	11	28	25	03

--	Total	2459	2085	374	316	213	103

Source: DPHE – 2010

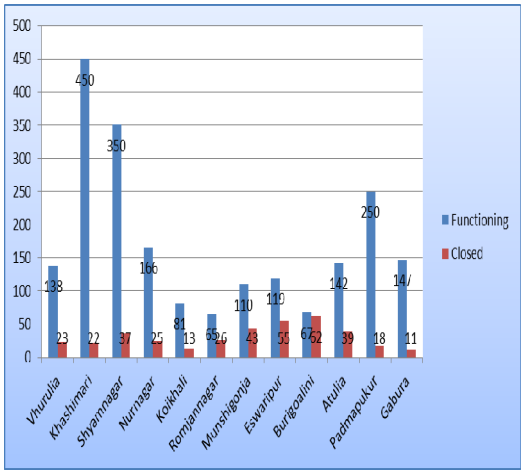

Figure6: Drinking water source in Shamnagar Upazila (Tubewell)

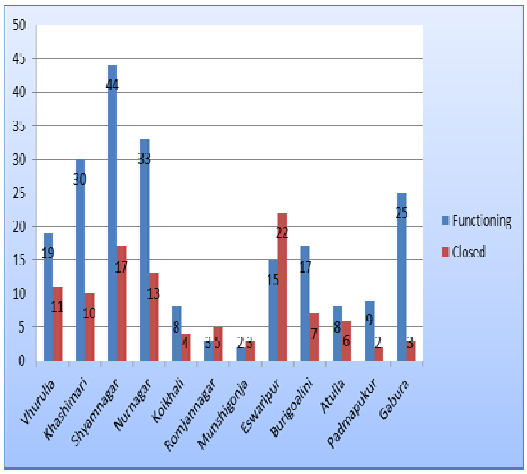

Figure **7**: Drinking water source in Shamnagar Upazila (Shallow Tube-well)

Table 4: Drinking water sources in Shyamnagar upazila

		SST			Rainwater harvesting unit		
Serial no.	Name of union	Total	Functioning	Closed	Total	Functioning	Closed
01	Vhurulia	21	19	02	05	05	00
02	Khashimari	45	42	03	00	00	00
03	Shyamnagar	132	127	05	08	08	00
04	Nurnagar	51	49	02	01	01	00
05	Koikhali	05	05	00	05	05	00
06	Romjannagar	02	02	00	03	03	00
07	Munshigonja	00	00	00	00	00	00
08	Eswaripur	26	24	02	05	05	00
09	Burigoalini	10	09	01	04	04	00
10	Atulia	01	01	00	02	02	00
11	Padmapukur	00	00	00	01	01	00
12	Gabura	00	00	00	03	03	00
--	Total	293	278	15	37	37	00

Source:DPHE2010

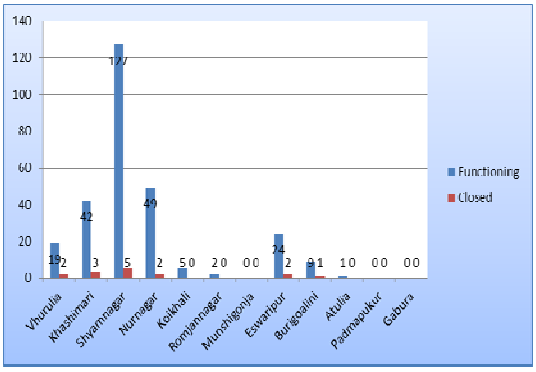

Figure **8**: Drinking water sources in Shyamnagar upazila (Shallow Shrouded Tube-well)

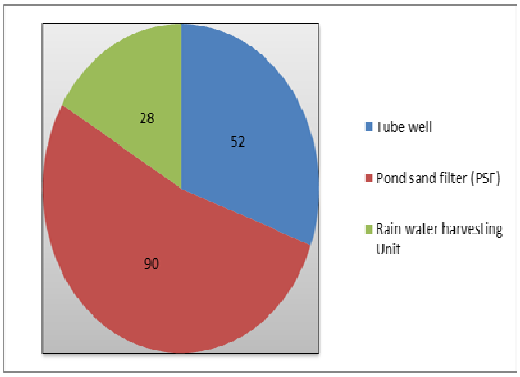

Figure **9**: Different sources of drinking water (Shamnagar Upazila)

At Shamnagar most of the people drink PSF water for drinking purposes. Although some of these PSF water does not satisfy the drinking water standard. But people in these areas are careless.

Table 5: Turbidity, pH. Salinity of raw water and treated water and NO_3 ,Total solid, dissolved solid and suspended solid.(for PSF water)

SI No.	Location	Turbidity (NTU)		pH		Salinity (mg/L)					
		Raw Water	Treated Water	Raw Water	Treated Water	Raw Water	Treated Water	NO_3 (mg/L)	Total solid	Dissolved Solid	Suspended Solid
01	Shamnagar	17.6	3.92	7.32	7.31	230	200	Under range	180	100	80
02	Burigoalini	7.79	4.18	8.06	7.88	642	469	0.6	270	130	140
03	Munshigang	8.79	1.32	7.22	6.87	150	80	0.3	630	460	170

. **Findings from the Field Investigation**

On the basis of the data collection and chemical analysis of the collected sample, the following observations can be drawn-

- The values of alkalinity, salinity, turbidity were found very high. Because Aila was occurred two year ago at the southern region of Bangladesh.
- Salt water intrusion is a major problem in most of the tube-well. The upper aquifers are mostly saline.
- In most of the bank of the pond is not well protected. So the outside impure water could easily enter into the pond during Aila.
- In most areas deep tube-wells (though more expensive) provide fresh water. Other technologies include PSF, SST, VSST & RWH.
- Coverage of safe drinking water is low compared to the rest of the country. This part of the coastal belt is by far the most under-served area.
- People are bound to use this water. This water is not satisfying the drinking water standard.
- The impurities removal efficiency of the existing PSFs is not adequate which does not satisfy the drinking water standard.
- Water and sanitation infrastructures are vulnerable to cyclones and storm surges.

Most of the sanitary latrines were destroyed during Aila. The practicing of open defecation is increased after the divesting cyclone Aila & Sidr.

6. Conclusions

Bangladesh is one of the most victimized countries of the world due to the climate change. Water supply and sanitation is the most vulnerable sector due to climate change. The upper aquifers are mostly saline. people living in the affected areas suffer from deprivation of the water supply and sanitation facilities and become vulnerable to several health risks. At Shamnagar people in general have a very poor understanding of the relationship between the health and sanitation. It is important to understand that the improvement of health is not possible without sanitary disposal of human excreta. However, neither sanitation nor water supply alone is good enough for health improvement. It is now well established that health education or hygiene promotion must accompany sufficient quantities of safe water and sanitary disposal of excreta to ensure the control of water and sanitation related diseases. People in the area often defecate on the drains, in open fields, near the road sides, or on the riverbanks. There are no specific actions on strategies regarding safe water supply and sanitation facilities in the study areas. Water supplied by Government and NGO is insufficient. Extensive research and development for cost effective and socially acceptable solution is required. Improvement of existing water supply facilities is required. Raising awareness to avoid practicing open defecation and use sanitary latrines. Thus, strong policy advocacy is required to ensure safe water supply and hygienic sanitation facilities in the study area. The sanitary collection, transportation, treatment and disposal of human waste promotes health, improves the quality of the environment and thus, the quality of life in a community. In communities occupying coastal areas, human waste is directly disposed of into the surface water such as rivers,

canals and sea or in the mudflat to await the tide. These surface waters, however, are often the communities' sources of food, and water for drinking, domestic and personal cleaning. Present condition of sanitation shows that contaminated water and human wastes are major factors in the transmission of serious diseases in coastal regions of Bangladesh.

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Paper ID: RT-P24

Water Quality in Market drains of Khulna City Area: Sustainable Market Waste Management Perspective

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Abstract

Khulna is the statutory body to all types of conservancy services within the city area including management of the solid wastes. These cities are now struggling with the problems of high volumes of market wastes, the disposal technology and the impact of market wastes on the environment. This study revealed that most of the natural water bodies in the vicinity of market areas have been highly polluted sometimes became completely anaerobic state due to biodegradable market wastes. After testing water quality parameters of various market drains of KCC, it was found that the highest COD value was 3520 mg/L and lowest 1920 mg/L, the highest BOD was 240 mg/L and lowest 123.9 mg/L. The pH, turbidity, color and hardness varies between 7.39 to 8.08, 262 to 721 NTU, 680 to 4840 Pt.Co.Unit and 419.8 mg/L to 981.56 mg/L respectively. And the TC, FC & EC were more than 700 No/100mL. This information would help to prepare a master plan of market waste management and implementation technique for sustainable treatment process that would have been put forward here to address effectively the problems relating to the market wastes.

Keywords: *Water quality parameter, Market waste Management, Environmental pollution, Recycling, and Final Disposal Site.*

1. Introduction

Comprehensive solid waste management (SWM) programs are one of the greatest challenges to achieving institutional sustainability [4]. Effective SWM requires a complete understanding of the composition of a waste stream as well as the activities that determine its generation in the first place [5]. Examining waste by generation source is particularly important, as the characteristics and composition of solid waste vary according to its source [7]. Considering this, SWM programs that are based on the reality of the generating source, are far more successful than mimicked programs that have been implemented elsewhere [1]. A variety of approaches have been adopted for assembling detailed quantitative data on the amount, location, and characteristics of a waste stream [8] some of which include: reviewing waste management records, visual waste assessments, interviewing waste management staff and extrapolating data from other institutions [2]. Direct waste analyses or waste characterization studies, however, offer the most effective process for examining the various wastes generated and identifying opportunities for waste reduction, reuse, recycling, and composting [8].

Khulna is the third largest metropolitan as well as the second largest river port city of Bangladesh (Figure 1). It stands by the banks of the Rupsha and the Bhairab rivers. It is in the south-western part of the country with its location on the axis of Jessore-Mongla port, the second largest seaport of the country. Geographically, Khulna lies between 22°47´16´´ to 22°52´ north latitude and 89°31´36´´ to 89°34´35´´ east longitude. The city is 4 meter above the mean sea level (MSL). At present, it has a population of about 1 million [6]. The city is growing moderately in terms of its population and area. The existing public utility services and facilities cannot adequately cater to the needs of the burgeoning city population. The city generates a huge quantity of waste everyday from different sources. According to the Khulna City Corporation Ordinance, 1984 Khulna City Corporation (KCC) is responsible for collection, transportation, and treatment of solid waste in Khulna City [6]. Due to its resource and other

constraints and limitations, KCC has not been able to manage well entirely the whole task of solid waste as well as market waste disposal. In order to supplement the activities relating to the solid waste as like market waste disposal

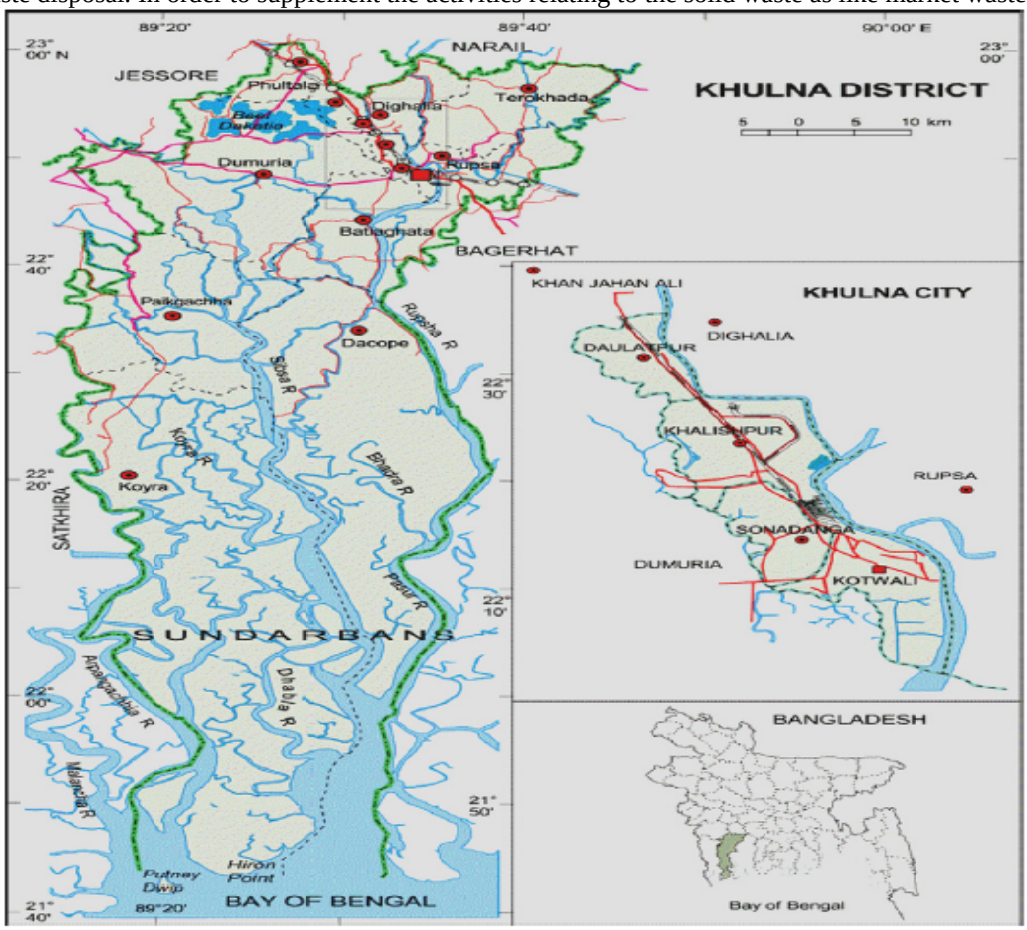


Figure 1: Khulna City Corporation Map

in KCC area, a number of non-governmental Organizations (NGOs), Community Based Organizations (CBOs) have come forward [6]. The first objective of this study was to test water quality parameter of various markets of KCC. Other objectives are to determine the scenario of ongoing market waste management in Khulna city area and hence formulating a general physical model of the waste materials flow path. The environmental degradation with regards to market wastes was also addressed in this study and safe strategies were proposed to reducing the environmental burdens.

2. Methodology

This study was conducted in the Khulna Metropolitan city (Figure 1) which is the largest river port city in Bangladesh. This research began in January, 2012 with an evaluation of internal policies and procedure related to the KCC sustainability and waste management, external documents including government regulations and guidelines and various municipal and waste composition studies. Waste haulage and disposal records were obtained through the various facilities department. The location of interior and exterior waste, recycling and compost receptacles were mapped and distinct flows of waste were documented. We identified three approaches to conducting a market waste characterization study: (1) the back end approach, which assesses the institution as a whole, (2) the activities approach, which tracks waste from distinct areas within the various market separately, and lastly, (3) an input/output approach, which tracks materials entering and leaving. There are total 12 big markets in KCC. So all the markets divided into 12 separate markets like Phulbarigate, Daulatpur, Chitrali, Boikali, Khulna borobazar, Khulna noyabazar, Khulna New market Bazar, Shandho Bazar, Khalispur, Nirala bazaar, Boyra bazaar, and Gollamari. The sizes of these markets are shown in table 1. This study documented the field survey data from “Tokai” (scavenger), cleaner, community service providers; waste resellers (Vangari shops) and many others shop keepers of Khulna city

area. After going to all markets of Khulna city area we contacted the shop keepers, tokai, cleaner, Community service providers and asked them for several data. After collecting these data primarily we collect data from waste collected people of Khulna city area. Then we compare these two data. We saw that there were very small differences among those data. In course of data collection and questionnaire we physically investigated the various environmental conditions in market places of Khulna city area.

Table 1: Major market areas (relative sizes) in Khulna City Corporation

SL.	Name of the market	Relative sizes of market areas
1	Phulbarigate	1.0
2	Daulatpur	3.5
3	Chitrali	1.0
4	Boikali	1.0
5	Khulna borobazar	11.0
6	Khulna noyabazar	2.0
7	Khulna New market Bazar	1.0
8	Shandho Bazar	0.8
9	Khalispur	1.0
10	Nirala bazar	1.8
11	Boyra bazar	0.8
12	Gollamari	1

Then we went again in all markets and collected drain water which is situated into the markets. We collected sample drain water from two different points of the drain, one was the sample into the market and other was the sample just falling before the river. After collecting the samples from different markets, we tested these samples to obtain water quality parameter.

Fig.2: Drain and Dustbin of Khulna city area market

3. Results and Discussion

Problems in ongoing market waste management

By almost any form of evaluation, market waste management is a growing environmental and financial problem in developing countries like Bangladesh. Despite significant efforts in the last decades, the majority of municipalities in the developing countries cannot manage the growing volume of waste produced in their cities. This inability to manage urban solid waste consists of failures in the following areas: Inadequate services, Inadequate financing, inadequate environmental controls, Poor institutional structure, Inadequate understanding of complex systems,

inadequate sanitation etc. This part considers the key constraints in terms of the development of integrated, sustainable, partnership-based market waste management systems in developing countries, and the issues that underlie these constraints. The irregular collection of solid wastes, unscientific disposal of wastes, lack of enthusiasm of the city dwellers, nonpayment of service charges by the beneficiaries, lack of research, lack of initiatives for recycling of resources, lack of co-operation, etc. were the main identified problems of the current market waste management in Khulna city area. We have developed a model for waste management and waste marketing that is attached in the next page of this article. This model is an aggregate and integrated model for waste management and marketing. In this model we have shown the sources of wastes, the collection process, the participatory groups, waste recognition and assortment system for marketing them and moreover the total marketing process is shown too. We have also shown the integrated waste marketing process that includes not only assortment but also grading, bagging and selling mechanism of different categories of wastes. A simple marketing mix analysis of the wastes and recommendations for waste marketing can explain the uncovered prospect for sustainable solution by using waste. This covered categorizing the waste as product, pricing them as per their commercial value; make the proper distribution channel, and lastly promotional activities include creating the awareness of the commercial value of the wastes among the community.

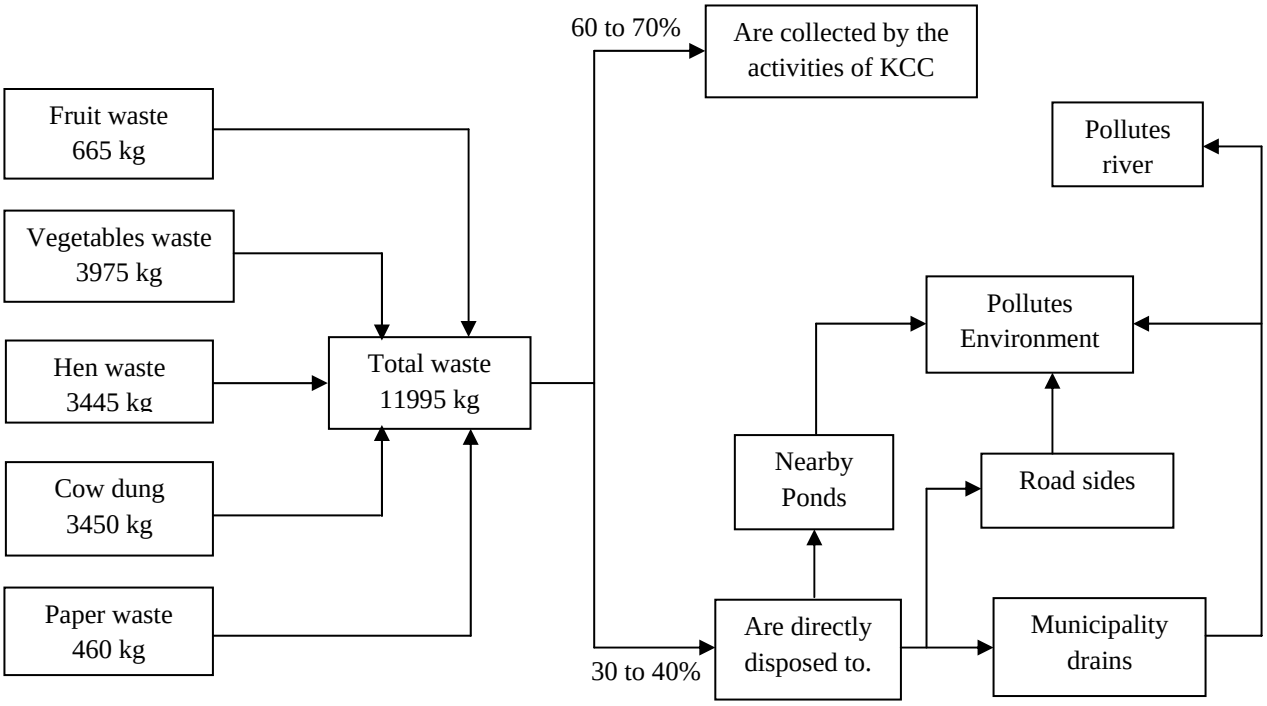


Fig. 3: Flow chart of analysis of market waste for KCC per day.

Strategies for Sustainable Market Waste Management

Strengthening inter-sectoral partnerships support a long-term vision of the goals of waste management in developing countries. This goal is to achieve sustainable solid waste management systems which are stable over time, and which are beneficial to the society, the economy and the environment. The point here is that it is possible, given the state of the art in both developed and developing countries, to bypass intermediate motivations, and to seek to create and implement sustainable waste management systems from the outset. This action plan is set up to pursue this goal. This paragraph defines the different elements of sustainability listed below:

- Sustainability will only be attainable if the current concept of refuse disposal, which imposes great burdens on the environment and resources, is transformed into a closed-cycle system, restoring various natural cycles, thus preventing the loss of raw materials, energy and nutrients.

Organic wastes are typically the heaviest component of a waste stream, thereby costing the most money to dispose of, and have the highest potential to emit green house gases, once buried in a landfill. The high financial and environmental costs of improperly disposed organic wastes make this component especially important when considering opportunities for increased waste reduction and diversion.

Table 2: Water quality parameter of Market drain water (Sample into the market)

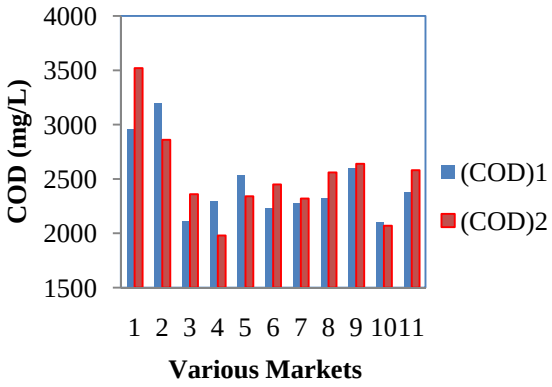
Various Markets	TC (Nos per mL)	EC (Nos per mL)	FC (Nos per mL)
Phulbarigate	54	13	44
Daulatpur	61	23	31
Chitrali	23	9	23
Boikali	34	13	33
Borobazar	42	19	15
New market	19	7	7
Shandho Bazar	33	13	12
Khalispur	24	11	10
Nirala bazar	51	21	27
Boyra bazar	49	31	37
Gollamari	30	17	11

Table 3: Water quality parameter of Market drain water (Sample just falling before the river)

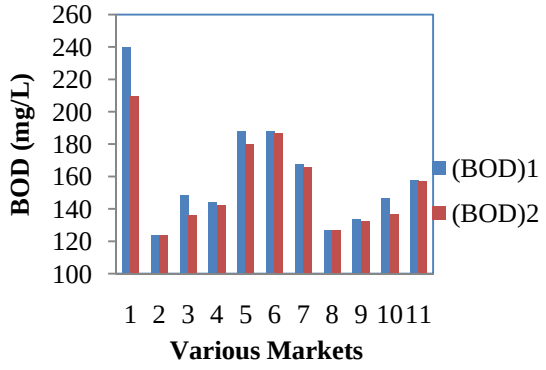
Various Markets	TC (Nos per mL)	EC (Nos per mL)	FC (Nos per mL)
Phulbarigate	34	19	32
Daulatpur	43	21	17
Chitrali	23	9	21
Boikali	51	24	12
Borobazar	41	19	21
New market	34	19	23
Shandho Bazar	29	13	19
Khalispur	48	23	11
Nirala bazar	28	12	17
Boyra bazar	45	17	13
Gollamari	47	29	21

Table 4: Name of the various Markets for water quality parameter graphs

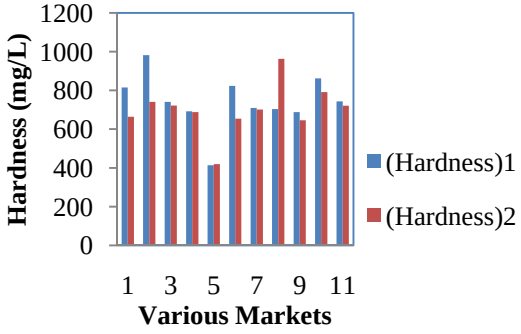
Various Markets		Various Markets		Various Markets		Various Markets	
1	Phulbarigate	4	Boikali	7	Shandho Bazar	10	Boyra bazar
2	Daulatpur	5	Borobazar	8	Khalispur	11	Gollamari
3	Chitrali	6	New market	9	Nirala bazar		



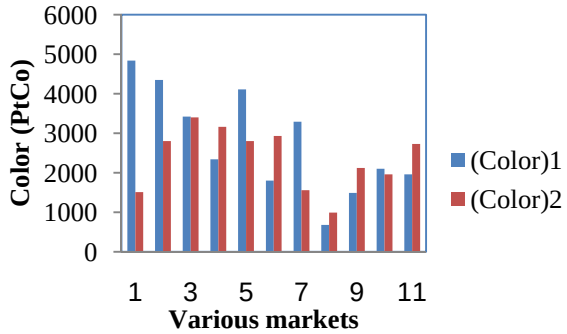
(COD)1= Sample into the market
(COD)2= Sample just falling before the river
Fig.4: Variation of COD of various markets drain in KCC



(BOD)1= Sample into the market
(BOD)2= Sample just falling before the river
Fig.5: Variation of BOD of various markets drain in KCC



(Hardness)1= Sample into the market
(Hardness)2= Sample just falling before the river
Fig.6: Variation of Hardness of various markets drain in KCC



(Color)1= Sample into the market
(Color)2= Sample just falling before the river
Fig.7: Variation of Color of various markets drain in KCC

4. Conclusions

There is a whole culture of waste management that needs to be put in place-from the micro level of household, market to the macro levels of city, state and nation. The general assumption is that Solid waste management should be done at the city level first and as a result; solutions tried out have been essentially end-of pipe. But we should keep this mind that rather than making a long-term holistic approach, we can start it within our community and can create an example for the whole country.

If we can start our waste management process at the micro level, like as community based system then it can be easily manageable as well as it can create examples for others. Most of the developed countries now a day are trying to rethinking about their waste disposal system and developing a wide range of system and approach to minimize the environmental hazard as well as reaching a profitable solution using these wastes.

In our country, we can also dream for a better future, where our environment will be protected as well as we can reach a sustainable solution by using market waste, and develop our entrepreneurial activities. Further this study tried only to develop a theoretical model for better waste management in Khulna city. It needs a complete empirical study to examine the feasibility of this model. This model will also provide the platform for further study and exploration of the waste management and practices in Khulna city.

5. Acknowledgement

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ROOM HEATING BY ENERGY TRANSFER AND ITS PERFORMANCE

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Abstract

In this research, a room heater by solar panel is designed, fabricated and its performance is assessed in the perspective of an emerging/developing country with a huge energy demand like Bangladesh. The winter season (mid-November–mid-February) of the country characterizes by low temperatures, cool air blowing from the west or northwest, clear sky and meager rainfall. Minimum temperature in the extreme northwest in late December and early January sometimes reaches 3^0 C and day length is about 10 h. The shortness of winter days can be compensated by reducing the heat loss during long nights. The heater by solar panel will be constructed to prevent as much heat loss as possible. In other words, the heating of air will be accomplished by maximizing light gain and minimizing heat loss. It is expected that the fabricated room heater by solar panel will work efficiently. The maximum room temperature is 45^0C. The experimental outlet temperatures have been compared with that of theoretical values. Due to the uses of low-cost and simple technology, it would affordable in all aspects, visualization of cost, operation and maintenance by the typical people of Bangladesh.

Keywords: *solar power, photovoltaic cells, solar energy.*

1. Introduction

People have become increasingly concerned about the rapid depletion and uncertainty in the cost of fossil fuels. There is some fear about the possible environmental and safety risks associated with fossil fuels, such as global warming, greenhouse effect, sea level rise, climatic change and acid rain precipitation. These concerns have focused worldwide attention on the potential of harnessing the Sun's power in new and varied forms to meet society's growing energy needs and for saving conventional energy. Although the Sun has been a major energy source throughout the ages, technological advances in several fields of science and engineering now make it possible to accelerate the use of solar energy to meet the world's expanding energy requirement [1]. Despite the efforts of various government institutions, universities, NGOs and international development organizations, renewable energy technologies are yet to make a substantial contribution for betterment of the quality of life in the developing countries. To find a wider acceptance, it is very important to make sure that renewable energy solutions are accessible, affordable and appropriate [2].

2. Solar Energy:

About half the incoming solar energy reaches the Earth's surface.
The Earth receives 174 pet watts (PW) of incoming solar radiation (insulation) at the upper atmosphere. Approximately 30% is reflected back to space while the rest is absorbed by clouds, oceans and land masses. The spectrum of solar light at the Earth's surface is mostly spread across the visible and near-infrared ranges with a small part in the near-ultraviolet [3]. Solar energy has much greater present and future potential because it produces large quantities of energy at low cost with minimal impact on the environment i.e. it satisfies three "E's" (energy, economy and ecology) [4]. Solar lights that charge during the day and light up at dusk are a common sight along walkways.
Although daylight saving time is promoted as a way to use sunlight to save energy, recent research has been limited and reports contradictory results: several studies report savings, but just as many suggest no effect or even a net loss, particularly when gasoline consumption is taken into account. Electricity use is greatly affected by geography, climate and economics, making it hard to generalize from single studies [5].

3. Project Setup:

A solar panel which is used to absorb the direct solar energy, connected with an energy storage device (a battery 12volt & 17 amps). The solar panel produces electricity, stored in the battery. A charge controller is then connected to the battery to control the flow of electricity. A heating device is connected with the charge controller by which we can heat our desired space. This is the whole process of my project that I have to be done.

Fig: Project setup

4. Procedure for Data Collection:

Inside and outside temperatures were measured by placing a thermometer at inside and outside of the room respectively. The other necessary data were collected with the help of different references such as book, internet, and thesis paper and so on.

4.1. Calculation:

Efficiency of solar panel:
We have:

Solar power P =20 watt
Solar area A =630×290 mm^2
= (0.63×0.29) mm^2
=0.1827 m^2

Let,

Irradiation, G =4. 2 kWh/m^2/day
Input power =4. 2×0.1827 kW/day
=0. 76734 kW/day
=767. 34 kWh/day

Let,

Sunshine be 7 hr/day
7 hrs give =767.34 wh
1 hr give $=\frac{767.34}{7}$ watt
=109.62 watt

So efficiency,

$\eta = \frac{20}{109.62} \times 100$
=18.24%

. **Time needs to charge the battery:**

(1) Calculate the Ampere per hour of the charger: 20 watts/18 volts=1.11 amp
(2) Calculate the division: 12 Ah/1.11 amp=10. 8 hr
(3) Add 10%: 0.1

So time needs to charge the battery= 11 hr

Battery backup time:

We have: Ah= (7.5+4.5) Ah
=12 Ah
V_t =18 volt
25 watt bulb

So,

Wh $= Ah \times V_t$
$= 12 \times 18$
$= 216$ Wh

Or, h $= \frac{216}{25}$ hr
$= 8.64$ hr $= 8$ hr 38 min

4.2. DATA COLLECTION & DISCUSSION:

Day 1:

Time	Room temp(^{0}C)	Ambient temp(^{0}C)	Temp difference(^{0}C)
5.00 pm	30	29	1
5.15 pm	31	29	2
5.30 pm	32	29	3
5.45 pm	33	29	4
6.00 pm	33.5	29	4.5
6.15 pm	34	28.5	5.5
6.30 pm	34.5	28	6.5
6.45 pm	35	28	7
7.00 pm	36	28.5	7.5
7.15 pm	37	29	8
7.30 pm	38	29	9
7.45 pm	38.75	28	10.75
8.00 pm	39	28	11
8.15 pm	39	27	12
8.30 pm	39	27	12
8.45 pm	39.5	27	12.5
9.00 pm	40	27.5	12.5
9.15 pm	40	27.5	12.5
9.30 pm	40	28	12
9.45 pm	41	27	14
10.00 pm	41	28.5	12.5
10.15 pm	41	27	14
10.30 pm	41.5	27	14.5
10.45 pm	41.5	27	14.5
11.00 pm	42	27	15
11.15 pm	42	27	15
11.30 pm	42	27	15
11.45 pm	42	27	15
12.00 pm	42	27	15

Table 4.1: Data Of Day 1

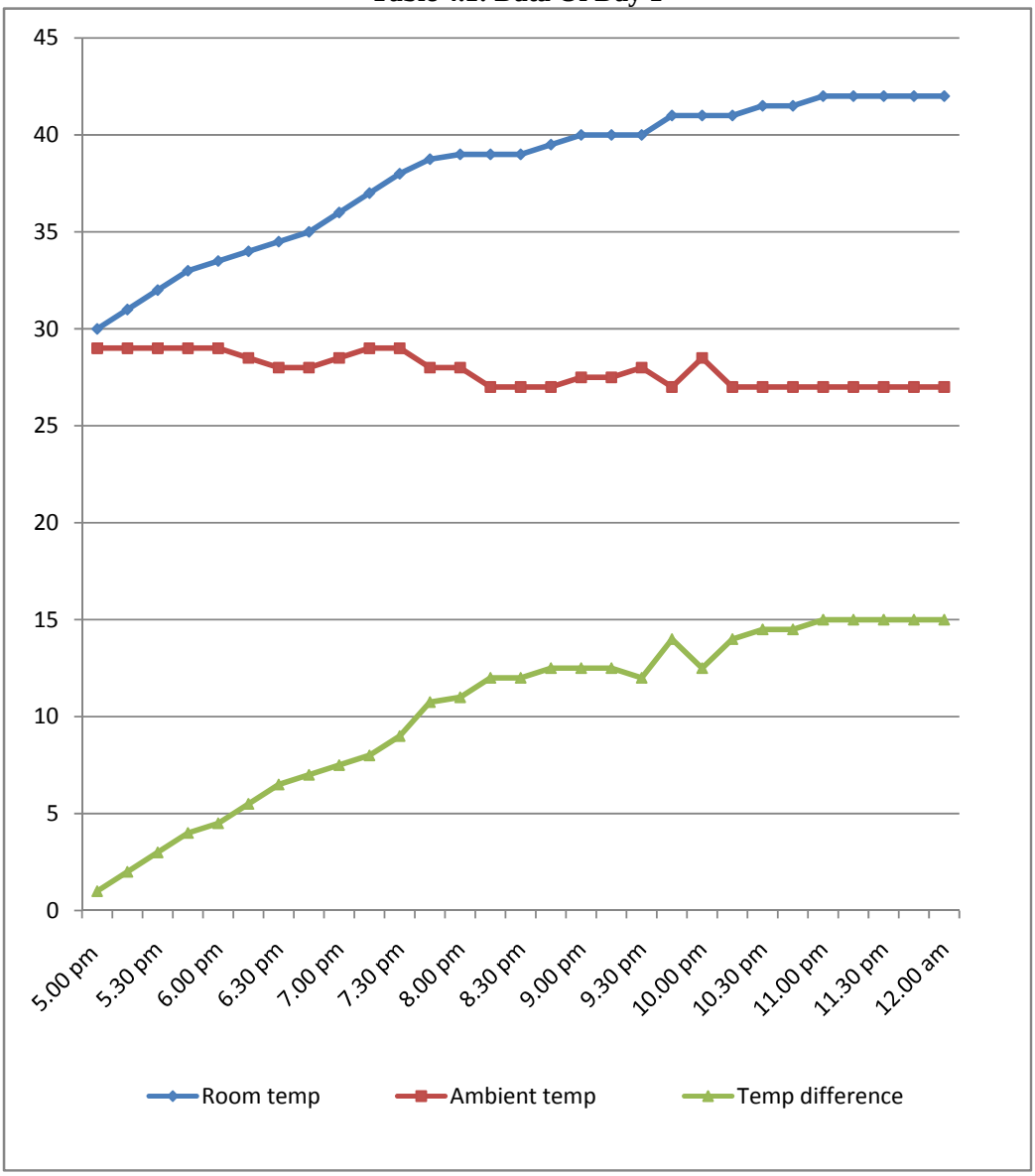

Fig4.1: Graph of day 1

From the graph we can see that, room temperature increases as time passes. Time is chosen from 5pm-12pm.to collects the data. From 5pm to 12pm temperature decreases slowly. Though the ambient temperature decreases slowly room temperature increases. Because in this experiment we have used the power of the battery not the direct solar power. If we used the direct solar power than the room temperature decreased with decreasing ambient temperature. Moreover the battery gives us a constant rate of power. So the room temperature increases in spite decreasing of ambient temperature

Again we know that,

$Q_{in}=Q_{absorbed}$

Or, $VIt=mcp\Delta T=\rho vCp\Delta T$

Or, $\Delta T=VIt/\rho vCp$

Or, $\Delta T=\frac{18\times12}{1.2\times10.16\times1.006}$

Or, $\Delta T=17.89^0C$

Here ΔT $=T_{Room}-T_{ambient}$. So $T_{room}=17.80C+T_{Ambient}$.
This is the theoretical value & the actual value of the room is determined by a thermometer.
And heat loss,

$$Q=AU\Delta T$$

Or, $Q=0.3681\times .48\times 12$

Or, $Q=2.2969$ watt

So percentage of heat loss $=\frac{2.2969}{18\times12}\times 100$

$=1.2\%$

The overall efficiency of this process $=\frac{43.35}{52.51}\times 100$

$=0.8247\times 100$

$=82.47\%$

5.1. Theoretical vs. Actual Graph:

Day 1:

Time	Actual temp(^{0}C)	Theoretical temp(^{0}C)
5.00 pm	30	46.89
6.00 pm	33.5	46.89
7.00 pm	36	46.39
8.00 pm	39	45.89
9.00 pm	40	45.39
10.00 pm	41	46.39
11.00 pm	42	44.89
12.00 am	42	44.89

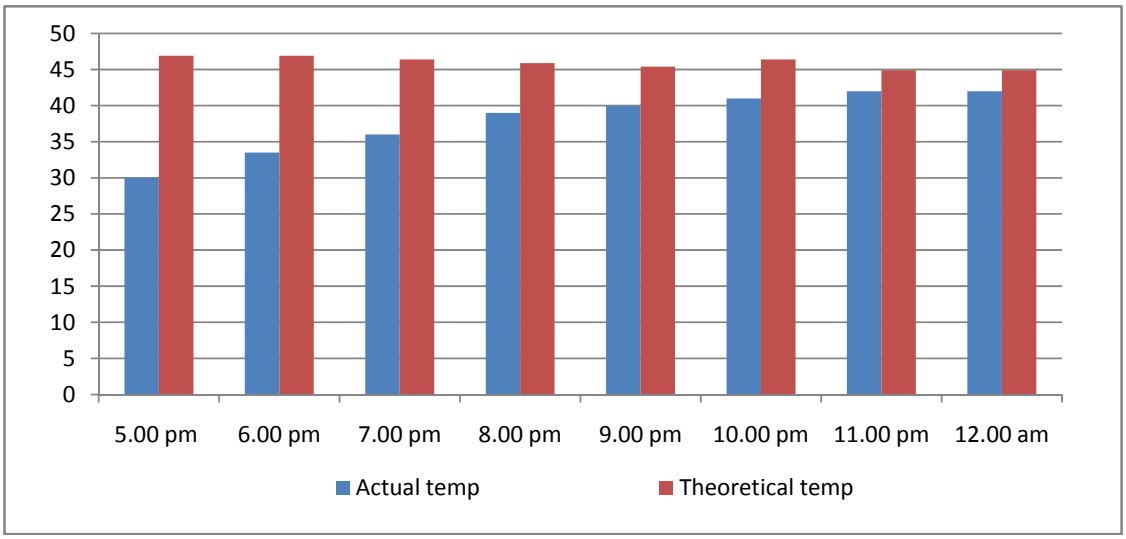

Fig 5.1: Theoretical vs. actual graph 1

From the graph we can see that the difference between the theoretical vs. actual graph of the day. Time is taken from 5-12 pm. At the beginning of the day, difference between the theoretical & actual more than the end of the day. At the end of the day the actual value reaches near to the theoretical value. Here the theoretical value gradually decreases & the actual value gradually increases with respect to time.

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Nomenclature

$\mathbf{Q_{in}}$=Heat inlet
$\mathbf{Q_{absorbed}}$=Heat absorbed
V=Voltage
I=Current
t=Time
m=Mass of the air
$\mathbf{C_p}$=specific heat of air
$\Delta \boldsymbol{T}$=Temperature difference
$\boldsymbol{\rho}$=Density of air
A=Area of room
V=volume of room
U=Overall coefficient of heat transmission
η=Efficiency

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