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INDUSTRY 4.0: A REAL-TIME IMPLEMENTATION OF AUTOMATION AND DIGITALIZATION IN AN INDUSTRY

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Abstract

This study aims to design an automated system in an industry which minimize the manual error, customer complaints, and quality and productivity issues and also for designing a paperless environment by reducing deforestation. Nearly 4 billion tress were cut each year for making papers. The industry nearly uses around 300 papers a day to record data as documents. To improve the quality and increase the productivity and make an eco-friendly environment, the industries are looking for advancement in technology. This brings a giant leap to industry 4.0 which includes automation and digitalization. The production lines may face manual error and customer complaints. Itcan be rectified by introducing automatic packaging system. Another issue in automation is that the time is increased which affects the production of products. Itcan be solved by implementing cycle time reduction that increases the productivity and reduces the production time. These are done by using programmable logic controller (PLC)Rexroth L40, RS 232 cable for communication and sensors. The machines are periodically monitored by various verification sheets and are documentedto ensure the quality. In digitalization, the documents are replaced by applications using SQL database, Visual Studio 2010 in ASP.NET platform.

Keywords – Automation, digitalization, Rexroth Bosch, industry 4.0.

1. Introduction

Bosch exist a world leading international the science of applying power to use and Electronics Company headquartered in Erlangen, forthcoming Stuttgart, Germany. The business concern was organized by Robert Bosch fashionable Stuttgart in 1886. Bosch happen 92% possessed by Robert Bosch Sifting. Bosch's core operating field exist spread across four trade sectors; ability to move mixture of liquid and another substance (hardware and computer program resolution), consumer goods (containing electrical non-kitchen appliances and power finish), related to manufacturing technology (containing drive and control) and strength and constructed dwelling technology. The term “Industry 4.0” resources the smart manufacturing plant in which smart mathematical tool are networked and they correspond

accompanying raw materials, to a certain extent-done result or goods created, products, machines, person who allows himself to be used, android and men. This hard work exist characterized by adaptability, adept use of resources and unification of services and business person who takes part with another fashionable implausible story process [1, 2]. In a networked factory, android and male human are suitable equal person who takes part with another, having a taller unit of measurement of artificial intelligence concerning the premature generation of android. The sense sensors that put oneself in the place of another the small in build signal are entrenched into the android, which authorize the mutual effort between android and person who is employed [3, 4, 5].

The use of digital science leads to severe changes in misrepresentation models. In order to reach a goal this, the supposed digital novelty exist required. In order to turn plenty novelty into reality as fast as likely, the production must evolve into more bendable. Two factors that will help to reach a goal this aim exist hardware and computer program answer for the real-period judgment of data. Product Lifecycle Management (PLM) mathematical novelty can be used to the smart creating of goods fashionable a way to influence the whole result or goods created life cycle, from 3D result or goods created design and person who allows himself to be used for 3D simulation, through machine control and plan for product control, supply chain persons running an organization and management, till the recycling [6, 7].

The aim of all these special interest or pursuit search out increase output (by drastically abridgment moment of truth period middle from two points the growth of a new product and allure transfer to customers marketing for 50%), effectiveness (automation admit for better adaptability, better quality of result or goods created and adept production) and strength provision for future (e.g. while pause for written matter processing, android maybe switched off, if essential, that saves until 15 of electricity) to guarantee competitiveness fashionable the global package and sell goods. PLC bear developed this instruction book "PLC Basics" fashionable hopes it will serve the person unskilled in something to the manner user. It exist proposed to manage comprehensive as likely, providing not only the general principles thoroughly PLCs, but to present practical instance from many various PLC manufacturers.

2 Methodology

The laser marking is present in Decision Support System (DSS) line where pressure sensor are manufactured [8, 9, 10]. DSS line consists of nine stations, packing is done along with stn140 ball pressing and laser marking station.In proposed method, we have created a PaCo application which is used to fetch data and stores data in database. In proposed method, when the part gets labelled the data of that part will get stored in the controller with DD/MM/YY and IDENTIFIERS. If the part detects green signal, then it passes on to the tray where next the visual inspection happens. The part gets sensed visually and the proximity sensor detects OK part then the data of such part details will get stored in the PaCo application. The controller and the application will get compared and the correct part will be added to the SQL database. The part will get increased on to the packing tray where the tray is correctly placed with manufactured parts when it reaches 39 then the printer will generate the lable for correctly packed parts. The process will continue till to an end. It will help to identify the correct part, it reduces the human error, regulates the correct parts. The development of SQL database will be used to verify and fetch data easily.When the NOK part is detected the part will drawback to the NOK bin then

the data from the NOK part will get stored in the controller and then the next part where the laser marking is done if it detects Ok then the data will store in controller and the part will get to the tray where the visual inspection is done if it is NOK then the data will get deleted in PaCo application and controller at the time. It will decrease the part that are needed to pack. If the product get decreased then the printer will not generate the label. The structure of the proposed work is shown in Figure 1.

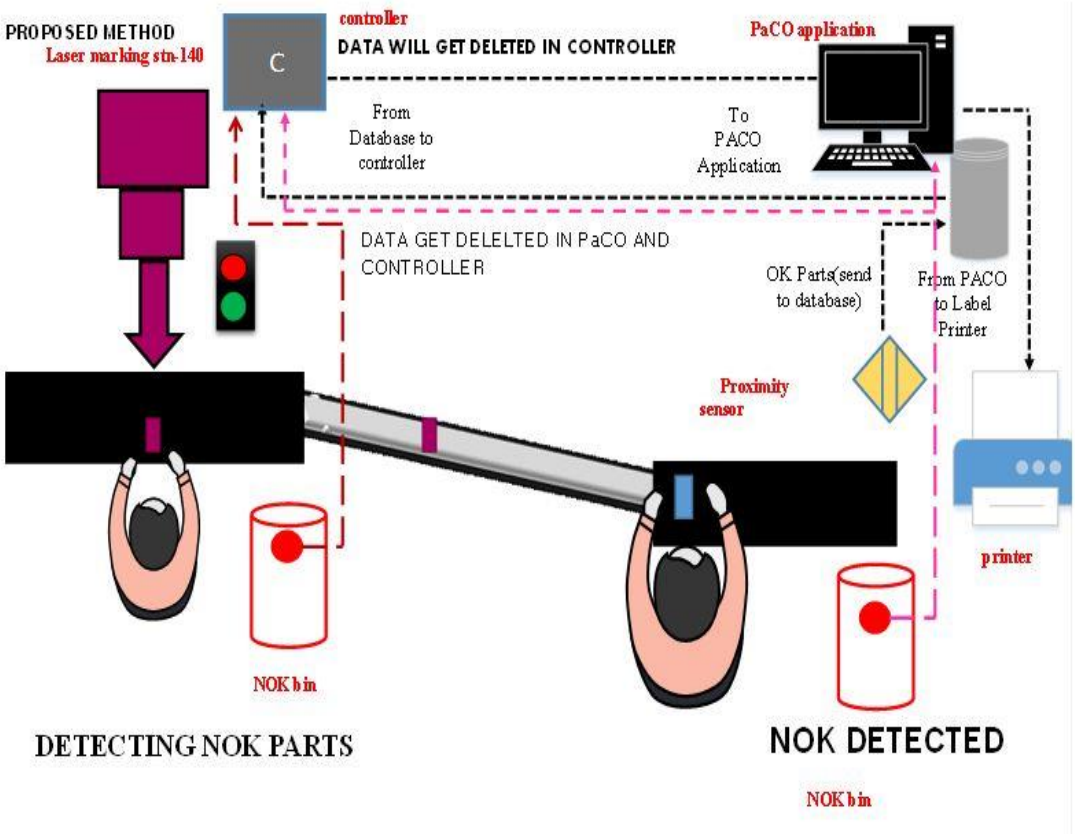


Fig.1.Structure of the proposed method

The method that exists with issues that overcomes by the new method that is proposed at station 40. The unnecessary movements are reduced to a single movement. The machine only moves in Z axis. The two test heads were replaced by one. This reduces the timing and increases the productivity by 7% at this station. It also reduces maintenance cost. The spare parts are also reduced. This reduces the cycle time from 15.5 sec to 12.5 sec, when the part is placed in the fixture. Then the process gets started and the machine moves only Z-axis that conducts insulation test.Here, we use inductive relay and this helps to perform these two operations in a single movement. When insulation test takes place then the relay is under closed condition and then the values are measured using insulation tester as shown in Figure 2.

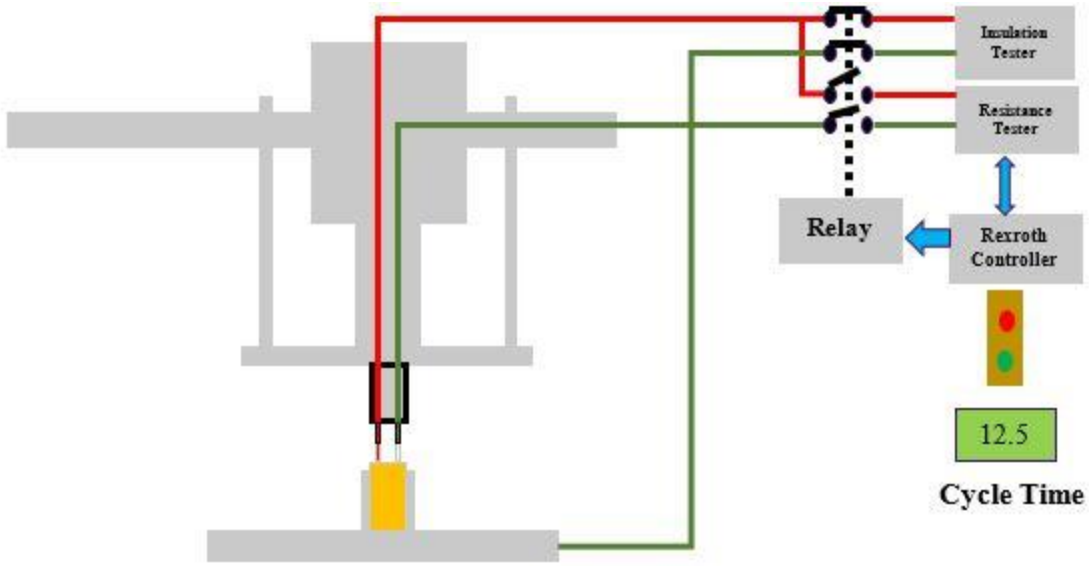


Fig. 2.Insulation testing

When the insulation test is completed then the Resistance test takes place without any movement with the single test head and two pins as shown in Figure 3, where the PLC activates the relay and then the switch in insulation test goes to open condition and the switch connected to the resistance checking pin is changed to closed condition.

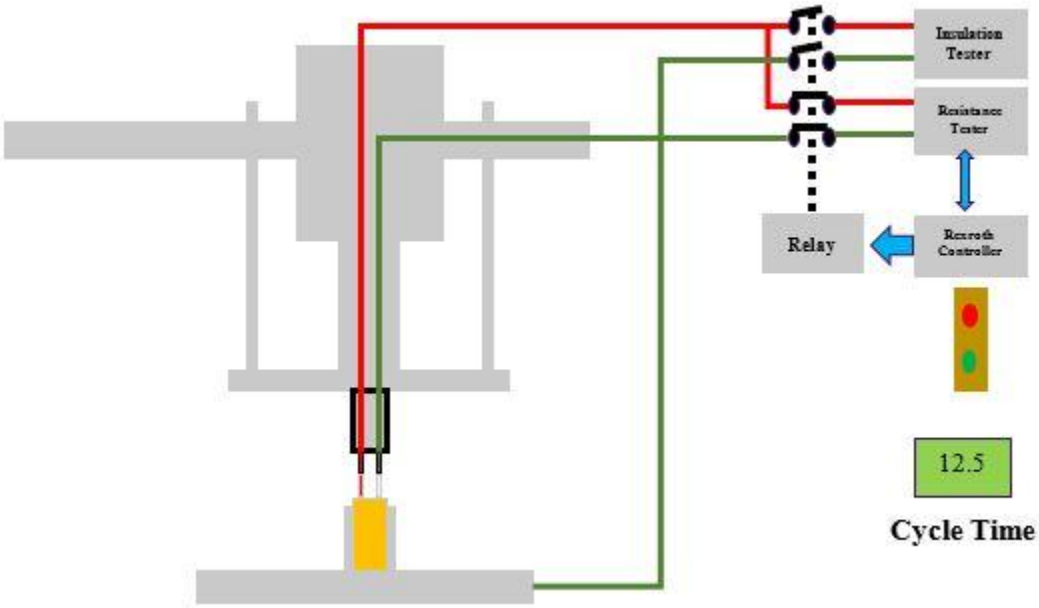


Fig. 3.Resistance testing

3 Programming

The programming for automation and digitalization of the proposed work is given in this section.

****MAINTANENCE AND SUPPORT SYSTEMACKNOWLEDGE****

```
Private Sub FLMAcknoweldge_FormClosing(ByVal sender As Object, ByVal e As System.Windows.Forms.FormClosingEventArgs) Handles Me.FormClosing

    'e.Cancel = True

frmMain.Show()

GlobalVariable.DisableClientTimer = False

  End Sub

  Private Sub FLMAcknoweldge_Load(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles MyBase.Load

frmMain.Hide()

GlobalVariable.DisableClientTimer = True

btnReleaseLine.Enabled = False

GlobalVariable.Filter = 3

    Call DatabaseLoading()

  End Sub
```

****CHANGE RELEASE SHEET AND SETUP VERIFICATION ADMIN PAGE*****

```
Try

        If Session("Role").ToString = "Admin" Or Session("Role").ToString = "Developer" Then

          Dim LoginStatusAs String

          Try

LoginStatus = Session("LoginStatus").ToString

          Catch ex As Exception

LoginStatus = "Login"

          End Try
```

```
                If LoginStatus = "Login" Then
        Response.Redirect("~/Account/Login.aspx")
                End If
              Else
        Response.Redirect("~/Default.aspx")
              End If
            Catch ex As Exception
        Response.Redirect("~/Account/Login.aspx")
            End Try
              End Sub
```

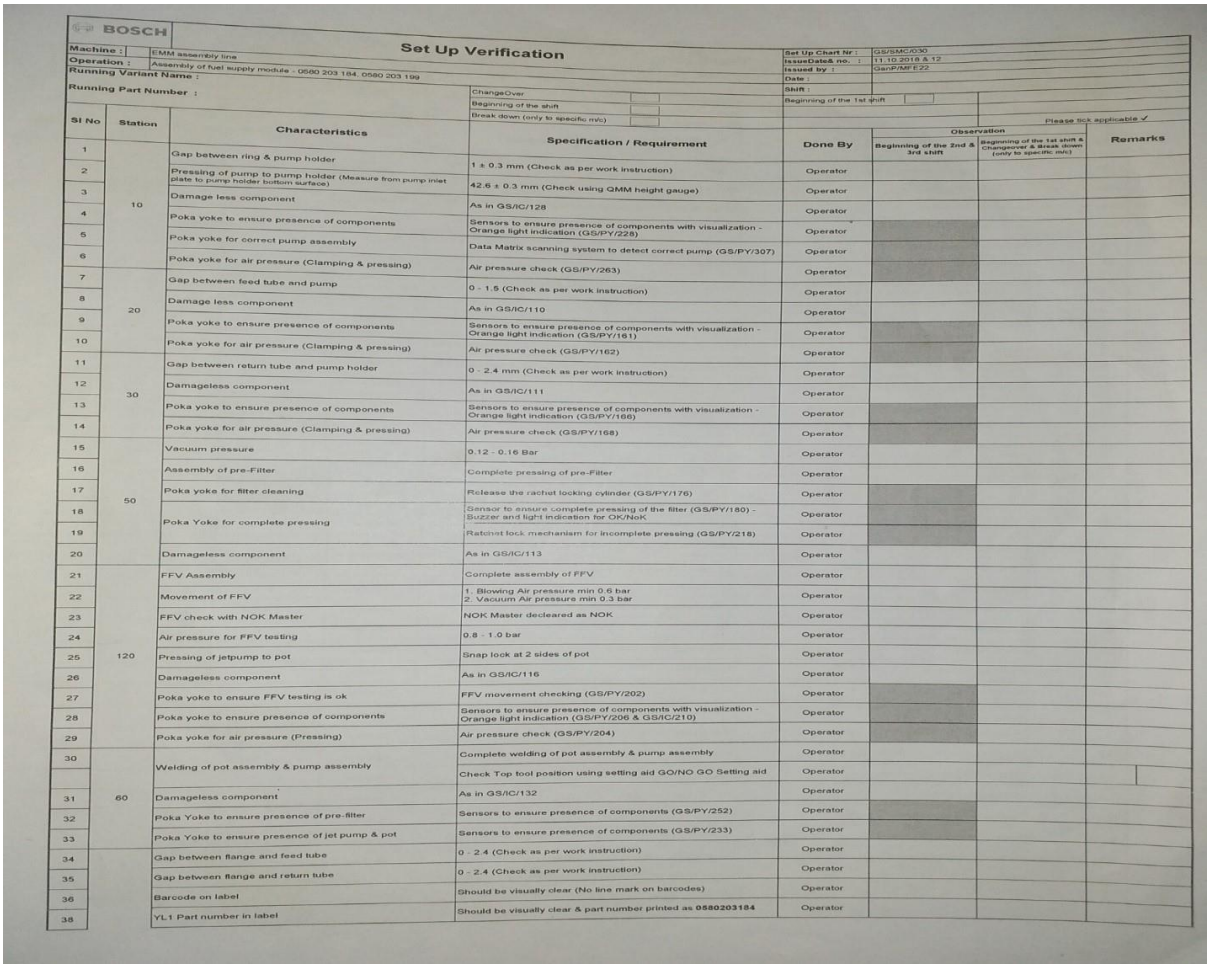
*****ADD BUTTON****

```
        Protected Sub btnAddMachine_Click(ByVal sender As Object, ByVal e As System.EventArgs)
Handles btnAddMachine.Click
            Try
              Dim Conn As New SqlConnection
              Dim Cmd1 As New SqlCommand
              Dim LineNameAs String = ddlLineList.Text
              If LineName = "0" Or LineName = "" Then
        MsgBox("Please Select the Line where you want to the Machine name")
              Else
Conn.ConnectionString=(ConfigurationManager.ConnectionStrings("MyConnectionString").ConnectionSt
ring)
                Cmd1.Connection = Conn
        Conn.Open()
                Cmd1.CommandText="INSERTINTO blLineInfo([_LineName],[_MachineName]) VALUES
('" &LineName& "','" &txtNewMachineName.Text& "')"
        Cmd1.ExecuteReader()
```

```
Conn.Close()

txtNewMachineName.Text = ""

        End If

    Catch ex As Exception

MsgBox("While Inserting a new Variant we have this Error : " &ex.Message)

    End Try

  End Sub
```

4 Hardware setup

The set up verification sheet is used to record the parameters of each and every machine in all lines. This verification is done before each shift and after every breakdown. Totally, the company uses around 8000-10,000 papers only for setup verification per year. This is done by one of the operator before the start of that machine**.** This is the default page when the operator gets logged in. In this page, operator will be able to select the line. The type of variant, and the machine which will display in the drop down list. Then the tick box is available to choose when the setup is done whether at the time of setup or after breakdown or changeover.When the required details are given, the stations are automatically displayed according to the line and machine according to type of variant used. Figure 4 shows the connection string for the SQL Database and Visual studio 2010.



BOSCH

Set Up Verification

Machine : EMM assembly line
Operation : Assembly of fuel supply module - 0580 203 184, 0580 203 199
Running Variant Name :
Running Part Number :

Set Up Chart Nr : GS/SMC/030
IssueDate& no. : 11.10.2018 & 12
Issued by : GanP/MFE22
Date :
Shift :
Beginning of the 1st shift
ChangeOver
Beginning of the shift
Break down (only to specific m/c)

Sl No	Station	Characteristics	Specification / Requirement	Done By	Observation: Beginning of the 2nd & 3rd shift	Observation: Beginning of the 1st shift & Changeover & Break down (only to specific m/c)	Remarks
					Please tick applicable ✓		
1	10	Gap between ring & pump holder	1 ± 0.3 mm (Check as per work instruction)	Operator			
2		Pressing of pump to pump holder (Measure from pump inlet plate to pump holder bottom surface)	42.6 ± 0.3 mm (Check using QMM height gauge)	Operator			
3		Damage less component	As in GS/IC/128	Operator			
4		Poka yoke to ensure presence of components	Sensors to ensure presence of components with visualization - Orange light indication (GS/PY/228)	Operator			
5		Poka yoke for correct pump assembly	Data Matrix scanning system to detect correct pump (GS/PY/307)	Operator			
6		Poka yoke for air pressure (Clamping & pressing)	Air pressure check (GS/PY/263)	Operator			
7	20	Gap between feed tube and pump	0 - 1.5 (Check as per work instruction)	Operator			
8		Damage less component	As in GS/IC/110	Operator			
9		Poka yoke to ensure presence of components	Sensors to ensure presence of components with visualization - Orange light indication (GS/PY/161)	Operator			
10		Poka yoke for air pressure (Clamping & pressing)	Air pressure check (GS/PY/162)	Operator			
11	30	Gap between return tube and pump holder	0 - 2.4 mm (Check as per work instruction)	Operator			
12		Damageless component	As in GS/IC/111	Operator			
13		Poka yoke to ensure presence of components	Sensors to ensure presence of components with visualization - Orange light indication (GS/PY/166)	Operator			
14		Poka yoke for air pressure (Clamping & pressing)	Air pressure check (GS/PY/168)	Operator			
15	50	Vacuum pressure	0.12 - 0.16 Bar	Operator			
16		Assembly of pre-Filter	Complete pressing of pre-Filter	Operator			
17		Poka yoke for filter cleaning	Release the rachet locking cylinder (GS/PY/176)	Operator			
18		Poka Yoke for complete pressing	Sensor to ensure complete pressing of the filter (GS/PY/180) - Buzzer and light indication for OK/NoK	Operator			
19			Ratchet lock mechanism for incomplete pressing (GS/PY/218)	Operator			
20		Damageless component	As in GS/IC/113	Operator			
21	120	FFV Assembly	Complete assembly of FFV	Operator			
22		Movement of FFV	1. Blowing Air pressure min 0.6 bar 2. Vacuum Air pressure min 0.3 bar	Operator			
23		FFV check with NOK Master	NOK Master declared as NOK	Operator			
24		Air pressure for FFV testing	0.8 - 1.0 bar	Operator			
25		Pressing of jetpump to pot	Snap lock at 2 sides of pot	Operator			
26		Damageless component	As in GS/IC/116	Operator			
27		Poka yoke to ensure FFV testing is ok	FFV movement checking (GS/PY/202)	Operator			
28		Poka yoke to ensure presence of components	Sensors to ensure presence of components with visualization - Orange light indication (GS/PY/206 & GS/IC/210)	Operator			
29		Poka yoke for air pressure (Pressing)	Air pressure check (GS/PY/204)	Operator			
30	60	Welding of pot assembly & pump assembly	Complete welding of pot assembly & pump assembly	Operator			
			Check Top tool position using setting aid GO/NO GO Setting aid	Operator			
31		Damageless component	As in GS/IC/132	Operator			
32		Poka Yoke to ensure presence of pre-filter	Sensors to ensure presence of components (GS/PY/252)	Operator			
33		Poka Yoke to ensure presence of jet pump & pot	Sensors to ensure presence of components (GS/PY/233)	Operator			
34		Gap between flange and feed tube	0 - 2.4 (Check as per work instruction)	Operator			
35		Gap between flange and return tube	0 - 2.4 (Check as per work instruction)	Operator			
36		Barcode on label	Should be visually clear (No line mark on barcodes)	Operator			
38		YL1 Part number in label	Should be visually clear & part number printed as 0580203184	Operator			

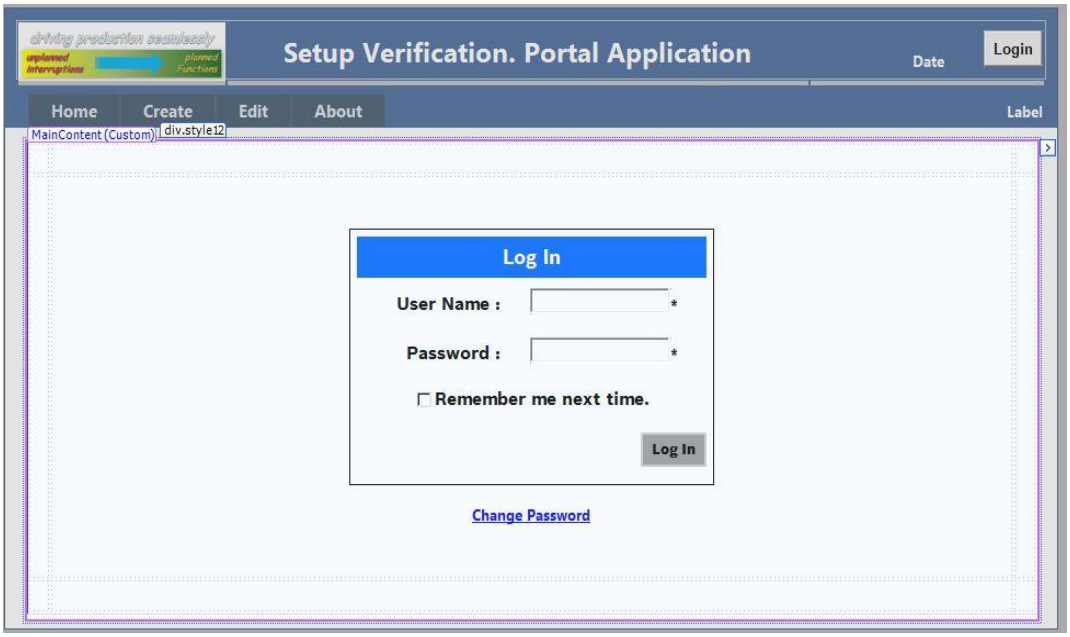
Fig. 4. Connection string for the SQL Database and Visual studio 2010

The developed system may have the following drawbacks:

- Manual errors
- Difficult storage
- Sometimes the verification is done after the products are being produced.

This sheet is replaced with an application that helps to record the data in the database and can be downloaded as pdf when required. The application is provided in their tablets given to the operator in the line. The verification setup for the proposed model is shown in Figure 5.

```
Query = "SELECT [_LineName] FROM [tblLineInfo]"
Cmd = New SqlCommand(Query, Con)
Dim Reader As SqlDataReader = Cmd.ExecuteReader
```




```
Try
    LoginStatus = Session("LoginStatus").ToString
Catch ex As Exception
    LoginStatus = "Login"
End Try
If LoginStatus = "Login" Then
    Response.Redirect("~/Account/Login.aspx")
End If
```

Fig. 5.Verification setup

This is the login window that appears on the screen initially. It consists of username and password.There are two kinds of Users.

1.**Admin**

2.**User** who is the operator

Each of the User is given a separate password.There is also an option for them to change their password.

5 Result and Discussion

In this work, an application is created which alerts the operators during the breakdown switch is pressed the Andon system alerts the operators as shown in Figure 6. It generates a ticket simultaneously when the breakdown switch is pressed. The Andon display indicates the running status of the line as shown in Figure 7.The ticket is generated which consist of line, machine, shift, reason for breakdown etc. This ticket is filled and acknowledged by the maintenance department.

Fig. 6. Andon

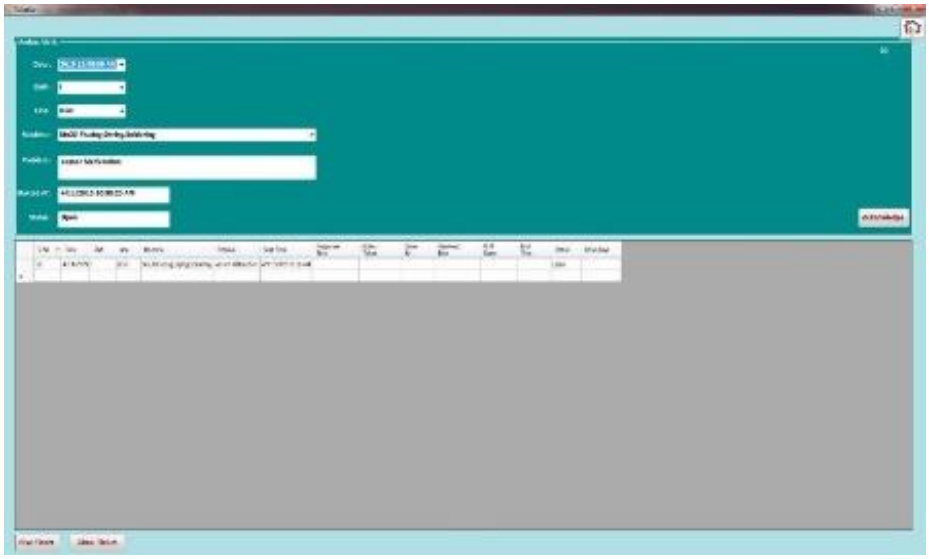


Fig 7. The running status of the line

After the breakdown is acknowledged by the Technical maintenance department, the status of the Andondisplays as Figure 8.

Fig**. 8. After the completion of the Breakdown, the ticket is closed by the Maintenance team**

The benefits of the proposed system have been given as follows:

- Paperless Shop floor
- Simplified Process
- Poke Yoke on Process Confirmation.
- Control over the process.
- Man-hours saving.
- Digital Shop floor.

6 Conclusion

The three ideas of digitization, digitalization and robotization are three unmistakable, yet blending ideas. Digitalization is along these lines viewed as an immediate outcome from expanded computerized components encompassing us, subsequently remains profoundly significant i.e. for the field of sociology. The ideas of digitization and robotization then again locate their immediate application in the field of assembling. It turns out to be certain that one can't exist without the other as any sort of robotization these days requires computerized components to work without human obstruction and any sort of digitization expects components to consequently deal with and show data. In this way, research is going in on cutting edge or shrewd assembling needs to incorporate the two ideas to consider a thorough examination. With this work,the authors have set an initial move towards the future examination endeavours of creating techniques and instruments to gauge and portray the computerized level of assembling measures.

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