OPTIMIZATION OF MATERIAL DELIVERY TIME ANALYSIS BY USING VISUAL BASIC FOR APPLICATIONS IN EXCEL

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Abstract:

In small and medium enterprises, huge numbers of reports are prepared regarding the procurement, planning, production etc on daily, weekly, monthly, quarterly and yearly basis. If the interval between preparation of same report is longer then there is the greater probability that employee can forget the procedure of preparing the report; thus it is beneficial to automate these types of reports especially when there is no cost required for automation. In the same way, material delivery analysis is a kind of report which is prepared on monthly basis and as per the employees` feedback they usually forget some of the steps of report formation; therefore, there was the chance of mistake at the end of employee. Therefore, this report was automated for to minimize the chance of error and report preparation time. All the manual tasks were enlisted and were programmed for automation by the help of VBA macros. For the execution of macros, userform was designed in visual basic editor (in MS excel) consisted on four command buttons and macros were called on command buttons` click. On pressing 'ctrl + q' userform used to appear on the screen. Furthermore, the comparison of old and automated methods was conducted to reflect the best suitable method. The report used to take 1.55 minutes to be made manually. Comparison of time of both methods of report formation indicated that suggested method took 70.86% less time as compared to the old method of preparing material delivery time analysis report.

Keywords: footwear; lead time; optimization; material delivery.

1. Introduction

VBA is a programming language which is used in Microsoft Excel for the automation of manual operation. It need less time in order to perform calculations with 100% accuracy in excel (Abidin, Juahir, Azid, Mustafa, & Azaman, 2015). VBA can be broadly used for mathematical calculations i.e. creating variables, dealing with various equations and producing results (Bernard, Dwi Minarti, & Hutajulu, 2018; Norton & Tiwari, 2013). It is also known as macro programming. Macro is the group of instructions by the help of which complex user specified operations are automated in MS office environment (Ding, Qi, Zhao, & Xu, 2017). When the applications are programmed with VBA in MS office, no or quite less cost is involved but in those applications, complex analysis with greater accuracy can be conducted. Furthermore, less skilled employee can operate such applications and can obtain accurate results with increased efficiency (Blayney & Sun, 2019). Macros can be run with just one click of the button once after they are programmed in excel. User can initiate user-defined functions and automate all spreadsheet tasks by using VBA (Abraham, Burnett, & Erwig, 2009). Visual basic editor and VBA are different as compared to the spreadsheet environment and excel formulae respectively (Abraham, Burnett, & Erwig, 2009). The benefits of visual basic for application in excel are: i.e. they are economical, time saving, and MS office applications are easy to find and accessible/usable as well (Bernard et al., 2018). Microsoft has provided the facility of VBA into its various office applications i.e. word, excel, access and PowerPoint. MS excel has been categorized as the most accepted application as the standard for spreadsheets in the industrial world and at the same time, the application of VBA, can also be used in the firms (Cirujano & Zhu, 2013). Present research paper presents the automation of material delivery time analysis reports by using VBA in excel. Due to the heavy workload of manual work at the purchase department of ABC footwear company, management thought to automate some of office work in excel so that employees could be given some time for the relaxation and learning other operations. At the same time, mistakes were also focused to be minimized from the calculations of the report. In this regard, material delivery time analysis report was automated by using VBA in excel.

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2. Literature Review

As per the requirement of the purchase department of the ABC Company, formatting and formulae were kept to be the same but the manual operations from the report were totally eliminated. On the subject of VBA, literature was reviewed in the context of automation in excel. (Kalwar & Khan, 2020a) conducted a research in which procurement report and purchase order report were automated by the help of VBA in excel; after the automation, both reports took around 520 seconds instead of around 2096 seconds (Kalwar & Khan, 2020a).Air pollutant index (API) and water quality index (WQI) was summed up using VBA in excel by (Abidin et al., 2015). For calculating indices, the VBA program was used with converted formulae and the application was programmed; Moreover, coded detail of the index was calculated in order to highlight value of index by itself shown along with it (Abidin et al., 2015). It was executed as a dairy model in excel with VBA by (Ahmadi et al., 2018).The implementation of the CTR Dairy model was carried out as research with the use of VBA in excel by (Ahmadi et al., 2018). CTR dairy is a vigorous simulation model for grazing lactating dairy cows that is used to predict the overall milk production and profits on various parameters i.e. the absorption of nutrients under intermittent schedules of feeding and ruminal digestion. In the last few years, impulsive driving came on the surface before the government and general masses (Kalwar, Khan, Shaikh, et al., 2020; Kalwar, Khan, & Shaikh, 2020; Kalwar, Shaikh, & Khan, 2021; Khaskheli et al., 2018). Due to infrequent clients and discontinuation of SMART software; to transform input in to output, the CTR dairy model was translated into excel VBA. It was turned into availability to the broad range of farmers, researchers and advisors, dairy nutrition consultants through this research (Ahmadi et al., 2018). For the result of Leak Analysis Program 5 (RELAP5) and Reactor Excursion through post-processing developed - using excel VBA by (Belchior Junior et al., 2011). It was highlighted to be significant to pace up output data analysis (Belchior Junior et al., 2011). It was also programmed by (Hila, 2009) in VBA excel in order to identify outliers in the data and arrangement of data by itself. The number of steps were automated for verifying data and cleaning it before importing it into MS access (used as a database) (Hila, 2009).A new method was developed by the use of VBA excel in order to create manpower planning report automatically (Cirujano & Zhu, 2013). Moreover, Roles, assignments and schedules of the engineers for various projects were collected as per new method. Later on, collected information was compiled, analyzed and organized. The method ensured its significance by getting validated in consulting firm with more than hundred employees. It highlighted that manpower planning report could be deduced through it; hence, it would result in reducing time and cost (Cirujano & Zhu, 2013). An application to transfer an image data to a worksheet click of Web-icon from the data set was developed as an application by using VBA in excel (Sato & Yokoyama, 2001). Lessa et al. (2016) used visual basic for application (VBA) in excel to automated a practical mathematical model for calculation of logic program and packaging. The designs of graphics were created so that packages get filled automatically (Lessa et al., 2016). Furthermore, (Evensen, 2014) used VBA for the first time in 2014 to implement instrument communication in excel (Evensen, 2014).An automatic report generating system

was invented using VBA in MS project by (Blattner & Valrico, 2007). The invented system pave the way for users to select, format filter and sort the report with the help of dialogue box highlighted on the screen (Hila, 2009).Moreover, mapping rules were implemented in the form of VBA macros in excel by (Wettlaufer, 2010). One macro was programmed for each report. In the separate spreadsheet expected values were written i.e. expected value spreadsheet. Later on, it moved the patients follow-up to the merline.net server for processing the data and processed patient follow-up session was generated which included reports package in the winrar file (Hila, 2009). Furthermore, VBA was used to develop code for making engineering students comprehend the analysis of novel freezing technology by (Norton & Tiwari, 2013). A new method was proposed for the analysis of production process, its automation and visualization was contained on the synchronization of production planning module of SAP enterprise resource planning (ERP) with VBA and excel worksheet proposed by (Bartoszewicz & Wdowicz, 2019). The novel process for data analysis and migration was re-engineered and executed- which was more resilient and swift and with the assistance of which thorough process of convoluted analytical report was paced up (reduction in time to 5 minutes from 2 hours) (Lessa et al., 2016). A research conducted with the aim and objective to advance the application with the usage of VBA excel that could make the mediocre level rainwater conveyance system- using rational method as highlighted in MSMA 2 by (Harahap & Azmi, 2017; Evensen, 2014). In addition to that, an application with the use of VBA excel for an automatic calculation and generation of bill of material (BOM) of transmission line was prepared by (Yan & Wan, 2017). Accuracy and efficiency are widely upgraded. with the application and design of the template and errors in the process of designing of total steel BOM were reduced (Yan & Wan, 2017). Kalwar & Khan (2020a) conducted a research in which the procurement and purchase order reports were automated at planning and costing department of ABC Company of Lahore. The reduced the report formation time to 516.578 seconds from 2076.751 seconds (Kalwar & Khan, 2020b). (Mustafa & Hatemi-J, 2020) designed and developed a dynamic model in order to learn the concept of lag order and the developed model was to be used for financial data computation and statistics` classes. The complex process of finding optimal lag value was automated; it was a multivariate and multi-step process and it was done by the use of VBA in MS excel. Multivariate dynamic model was estimated by using that VBA program and at the same time, the optimal lag value was found through the mentioned program (Mustafa & Hatemi-J, 2020).

3. Research gap

From the reviewed literature, it was indicated that, some of the research was conducted on automation of models for purpose of teaching, one of the researcher, designed the automated generation of BOM in MS excel. One of them automated the report of resource planning report in MS project by the use of VBA but none of them have ever focused on the vendor analysis i.e. material delivery analysis report. In the present research, the report i.e. material delivery analysis report from purchase department was automated. The contribution of

present paper cannot be ignored because of presented analytical comprehension on the subject along with its implementation by the use of VBA.

4. Aims and objectives

Aims of the present research included the error minimization in the material delivery analysis report and at the same time, employee workload was tried to be reduced.

- To reduce the report formation time of material delivery analysis report
- To increase accuracy of the report to 100%

5. Research methodology

5.1. Data Collection

All the manual activities needed to be performed in order to make the material delivery analysis report were enlisted and their time study was conducted by the help of stopwatch. Time study of the execution time of all the macros was conducted after the automation.10 observations of each activity were taken. Mean time of each activity was calculated in MS excel. The snaps were taken by using snipping tool in Windows 10.

5.2. Data Analysis

All the collected data of time study before and after automation was put into MS excel and was organized into the Tables. Average time of each activity was calculated from collected 10 observations which was collected earlier. At the end, comparison of old and automated methods was conducted.

5.2.1. Indices

i = index refers to the item

j = index refers to the purchase order

k = index refers to the vendor

5.2.2. Parameters

R = received quantity of an item i from purchase order j from the vendor k

SQR = sum of received quantity of an item i from purchase order j and from the vendor k on given delivery date

SDQ_0 = sum received quantity of an item i from purchase order j and from the vendor k in 1-5 days after the given delivery date

SDQ_{1-5} = sum received quantity of an item i from purchase order j and from the vendor k in 1-5 days after the given delivery date

SDQ_{6-10} = sum received quantity of an item i from purchase order j and from the vendor k in 1-10 days after the given delivery date

SDQ_{11-15} = sum received quantity of an item i from purchase order j and from the vendor k in 11-15 days after the given delivery date

SDQ_{15+} = sum received quantity of an item i from purchase order j and from the vendor k in more than days after the given delivery date

5.2.3. Binary Variables

T_{ijk} = equals to 1 if the vendor k delivered item i from the purchase order j on given lead time and 0 otherwise

$D_{(1-5)ijk}$ = equals to 1 if the vendor k delivered item i from the purchase order j in 1-5 days five days after given delivery data and 0 otherwise

$D_{(6-10)ijk}$ = equals to 1 if the vendor k delivered item i from the purchase order j in 6-10 days after given delivery data and 0 otherwise

$D_{(11-15)ijk}$ = equals to 1 if the vendor k delivered item i from the purchase order j in 11-15 days after given delivery data and 0 otherwise

$D_{(15+)ijk}$ = equals to 1 if the vendor k delivered item i from the purchase order j in more than 15 days after given delivery data and 0 otherwise

5.2.4. Formulae and Equations Needed For Making Report

The method and steps used for making the report were collected from the corresponding employee and were translated into mathematical formulae. Equations and formulae which were used or to be used during the formation of report are presented below. Since, there were many suppliers/vendors for different types of item at the case company. Total quantity of different items was used to be calculated by the help of Eq. (1) in order to evaluate the performance of vendors in terms of delivery of ordered quantity of items. The quantity of items delivered on the time by supplier was calculated by (2). Those items which were delivered within 5 days after the delivery date of the order; total quantity of delayed (1-5 days) items was calculated by (3). Those items which were delivered within 6-10 days after the delivery date of the order; total quantity of delayed (6-10 days) items was calculated by (4). Those items which were delivered within 11-15 days after the delivery date of the order; total quantity of delayed (11-15 days) items was calculated by (5). Those items which were delivered in more than 15 days after the delivery date of the order; total quantity of delayed (1-5 days) items was calculated by (6).

$$SQR = \sum_{k=1}^{K}\sum_{j=1}^{J}\sum_{i=1}^{I} R_{ijk} \ \forall \begin{cases} i = 1,2,3,\dots,I \\ j = 1,2,3,\dots,J \\ k = 1,2,3,\dots,K \\ R \geq 0. \end{cases} \quad (1)$$

$$SDQ_0 = \sum_{k=1}^{K}\sum_{j=1}^{J}\sum_{i=1}^{I} R_{ijk}T_{ijk} \ \forall \ T_{ijk} \in [0,1] \quad (2)$$

$$SDQ_{1-5} = \sum_{k=1}^{K}\sum_{j=1}^{J}\sum_{i=1}^{I} R_{ijk}D_{(1-5)ijk} \ \forall \ D_{(1-5)ijk} \in [0,1] \quad (3)$$

$$SDQ_{6-10} = \sum_{k=1}^{K}\sum_{j=1}^{J}\sum_{i=1}^{I} R_{ijk}D_{(6-10)ijk} \ \forall \ D_{(6-10)ijk} \in [0,1] \quad (4)$$

$$SDQ_{11-15} = \sum_{k=1}^{K}\sum_{j=1}^{J}\sum_{i=1}^{I} R_{ijk}D_{(11-15)ijk} \ \forall \ D_{(11-15)ijk} \in [0,1] \ (5)$$

$$SDQ_{15+} = \sum_{k=1}^{K}\sum_{j=1}^{J}\sum_{i=1}^{I} R_{ijk}D_{(15+)ijk} \ \forall \ D_{(15+)ijk} \in [0,1] \quad (6)$$

5.2.5. Methodology for Automation

All the manual activities were programmed in the form of macros of visual basic for applications (VBA) in visual basic editor of MS excel; so that they could be performed automatically. The basic concepts of programming were used in the code of targeted report i.e. for loops, conditional statements and VBA commands for cells` formatting in excel. Userform was designed in the visual basic editor consisted of four command buttons and all the macros were called on the click of them.

IF function allows the system to check if the value satisfies the defined criteria, it returns the desired result and another result is put in case of value doesn`t meet the defined criteria (Blayney & Sun, 2019). Sometimes, there are multiple conditions in if statement and result is needed to be returned when conditions come true or one of the two. In that situation, logical operators e.g. conjunction (And), disjunction (or) and negation (Not) are used (Hart-Davis, 2005).When, there are numerous items in the worksheet and set of applied conditions is applied on each of the row containing item descriptions and provided values; therefore, in order to decide among the values of each item in each row down, the condition is needed to be checked repeatedly in the same way row by row so that the order to be procured can be calculated. The term looping refers to the repetition of block of VBA statements for the number of times (Walkenbach, 2015). For-Next Loop is the simplest type of loop. Counter variable controls the looping, which start from 1 and stops at another value (Walkenbach, 2015). If the user wants the conditions to be repeated as much as the number of items present in the worksheet, then the loop would start at one and will stop at the counted number of non-empty rows in the worksheet. Same logic has been used in the procurement calculation mechanism. In the same way, transfer of data from one worksheet to another was also conducted by the help for loop in this report. Loop was repeated as much times as the number of non-empty rows in the worksheet (of the data to be transferred). Sometimes, when VBA code fails to run and in that situation, Microsoft Excel gives error which is often un-understandable by the common (unfamiliar with such systems) user. By the use of 'On Error statement' in VBA code (*on error resume next*) lets the user bypass Excel's built-in error handling and it handles the situation by the executing the next task programmed in the code (Walkenbach, 2013).

6. Old method for making the report

Old method used for preparation of material delivery analysis report was consisted of series manually performed tasks as presented in the Table 1. All those tasks were manually performed in excel. Time study of all those tasks is presented in the Table 1.

6.1. Basic Data

The basic data which is required for the report was used to be downloaded from Microsoft Dynamics AX to excel; basic data can be seen in the Figure 1.

Notations

a= to insert F and G columns

b= to put the formulae in both columns

c= to insert the pivot table from that data

d= to copy the data from pivot table and paste next to it

e= to apply formulae for calculation of required percentages and tolerance

f= to put the interior colors of headers and put border

T=Total time of Preparation of Report

T = a + b + c + d + e + f T = 319.479 sec

T = 5.324 min

Total taken by the report to be prepared by manual way (old method), it used to take 319.479 sec (5.324 min) as calculated by the above equation.

7. Suggested method for making the report

Around the world, footwear industry is growing fast (Kalwar & Khan, 2020b, 2020a; Kalwar, Khan, & Malik, 2020; Kalwar, Marri, & Khan, 2021; Kalwar, Shaikh, & Khan, 2020) but it is backward from the side of computerized automation. Improved efficiency, performance and cost effectiveness are the benefits of using latest technology (Kalwar & Khan, 2020a). Because of manual reporting in

Table 1: Time study of various tasks performed manually as per old method of preparation of material delivery analysis report.

Activity	Obs. 1 (sec)	Obs. 2 (sec)	Obs. 3 (sec)	Obs. 4 (sec)	Obs. 5 (sec)	Obs. 6 (sec)	Obs. 7 (sec)	Obs. 8 (sec)	Obs. 9 (sec)	Obs. 10 (sec)	Mean Time (sec)
a	69.5	69.18	87.22	70.42	59.93	70.58	65.89	66.6	74.21	74.97	70.85
b	34.53	42.71	34.19	15.89	45.41	28.03	46.34	48.34	35.53	35.74	36.671
c	24.64	55.77	41.08	41.55	23.51	90.54	53.46	46.12	52.81	48	47.748
d	12.83	13.48	11.2	7.69	8.34	13.33	10.5	12.7	10.5	11.5	11.207
e	129.83	111.95	122.99	119.23	113.81	122.21	122.38	130.2	113.93	137.82	122.435
f	30.95	23.47	30.79	31.21	15.48	50.67	34.8	20.14	39.36	28.81	30.568

Figure 1: Basic data for the preparation of material delivery analysis report.

excel, a lot of time was used to be spent on the formation of reports and the purchase department used to decide for the vendors` performance. Since, cost is associated with the time (Kalwar, Khaskheli, Khan, Siddiqui, & Gopang, 2018; Kalwar, Mari, Memon, Tanwari, & Siddiqui, 2020; Khaskheli et al., 2020) and decisions were based on the report and at the same time, chance of errors in the report was greater; thus it was decided to automate the material delivery time analysis report. New method/suggested method is consisted of interface (userform) designed to execute the various macros for performing the tasks automatically in MS excel.

7.1. Designed Interface for Execution of Macros

The interface of the report is a userform, consisted of four command buttons as can be seen in the Figure 2. This form appears on pressing 'Ctrl + q'.
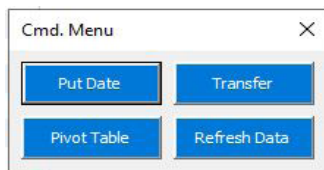

Figure 2: Userform designed for execution of macros.

Macros at the back hand of the command buttons can be seen in the visual basic editor of MS excel (see Figure 3). There are only five macros called behind four command buttons.

7.2. Needed Worksheets

Four worksheets are needed to make the report material delivery analysis report automatically. In 'Raw Data' worksheet, downloaded data (from the Microsoft Dynamics AX) is pasted on the same time whole data from PO Status report is copied and pasted into 'PO Status' worksheet in the material delivery analysis report.

After inserting the columns (with formulae) into the basic data, it is then copied to the 'Pivot Table' worksheet.

In the 'Pivot Table' worksheet, pivot table is inserted form the available data in the active sheet. Moreover, at the second last step of the report completion, the data is transferred to the 'Data' worksheet; and finally it is then again transferred to the 'Report' worksheet and with this transfer, the report is fully prepared.
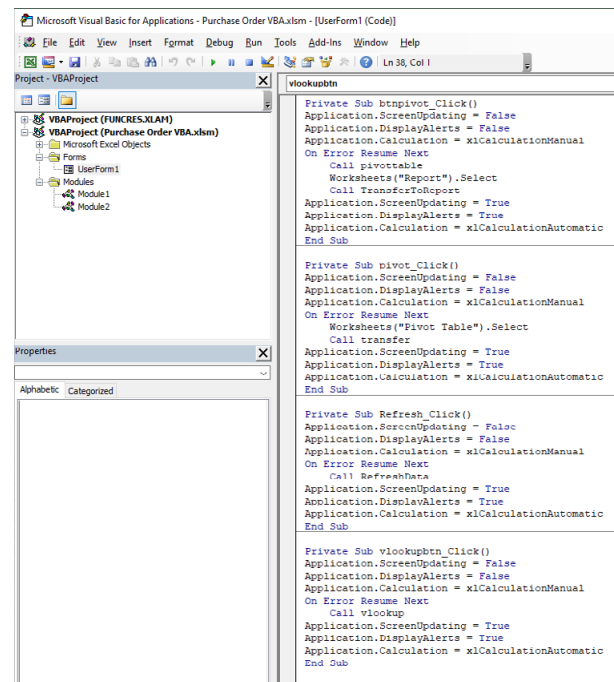

Figure 3: Macros behind each of the command button of the userform presented in Figure 2.

Figure 4: Needed worksheets for the automated material delivery analysis report.

7.3. Macros behind Command Buttons

Five macros were written to automate material delivery analysis report in excel and all those macros are explained individually in below given headings.

7.3.1. Apply Vlookup

Macro which is executed at the very first for the preparation of the report is given below. By the help of this macro, two columns i.e. F and G are inserted (as highlighted in Figure 5) and their headers are put i.e. 'Delivery Date' and 'Difference of Days' respectively. In 6th column i.e. F, the delivery dates are picked from the 'PO Status' worksheet against each item by the help of vlookup formula.

```
Sub vlookup()
On Error Resume Next
Application.ScreenUpdating = False
rowscount = Worksheets("Raw Data").
Cells(Rows.Count, 1).End(xlUp).Row
With Worksheets("Raw Data")
    .Columns("F").Insert
    .Columns("F").Insert
    .Range("F1").Value = "Delivery Date"
    .Range("G1").Value = "Difference of Days"
End With
Row = 2
Dim vlookuprange As Range
Dim vlookupvalue As Double
Set vlookuprange = Worksheets("PO Status").
Range("E5:Q1048576")
  For i = 1
Torowscountvlookupvalue=Worksheets("Raw
Data").Cells(Row, 2).Value
    With Worksheets("Raw Data")
      .Cells(Row, 6).Value = Application.
      WorksheetFunction.vlookup(Work-
      sheets("Raw Data").Cells(Row, 2).Value,
      vlookuprange, 13, False)
    End With
```

```
    Row = Row + 1
  Next
Application.ScreenUpdating = True
End Sub
```

Furthermore, in 7th column i.e. 'G', '=days360'formula is applied manually and difference of days is calculated which can be seen in the Figure 5.

7.3.2. Transfer the Data

After inserting F and G column along with their values, whole data is then copied to the 'Pivot Table' worksheet by the use of nested for loop (one for transferring row and another for column).

```
Sub transfer()
Application.ScreenUpdating = False
On Error Resume Next
rowscount = Worksheets("Raw Data").
Cells(Rows.Count, 1).End(xlUp).Row
colcount = Worksheets("Raw Data").Cells(1,
Columns.Count).End(xlToLeft).Column
Worksheets("Pivot Table").
Range("A2:J1048576").Value = ""
Row = 2
  For i = 1 Torowscount
    For j = 1 Tocolcount
      With Worksheets("Pivot Table")
        .Cells(Row, j).Value =
        Worksheets("Raw Data").Cells(Row, j)
      End With
    Next j
    Row = Row + 1
  Next
Application.ScreenUpdating = True
End Sub
```

Transferred data can be seen in the Figure 6.

Figure 5: Result of above given code.

Figure 6: Result of above given code.

7.3.3. Insert Pivot Table

Pivot table is inserted by the execution of macro given below. Pivot table will be consisted of one row field i.e. 'Name' and 7 column fields i.e. 'Sum of received quantity', 'Sum of On Time','Sum of Late','Sum of Late (1-5)','Sum of Late (6-10)','Sum of Late (11-15)' and 'Sum of Late above 15' (see Figure 7).

```
Sub pivottable()

On Error Resume Next

Application.ScreenUpdating = False

rowscount = Worksheets("Pivot Table").
Cells(Rows.Count, 1).End(xlUp).Row

ActiveWorkbook.PivotCaches.Create(SourceType:
=xlDatabase, SourceData:=Worksheets("Pivot
Table").Range(Cells(1, 1), Cells(rowscount,
16)), Version:=xlPivotTableVersion15).
CreatePivotTableTableDestination
:=Worksheets("Pivot Table").
Range("Q1"), TableName:="PivotTable4",
DefaultVersion:=xlPivotTableVersion15

    With Worksheets("Pivot Table").
    PivotTables("PivotTable4").
    PivotFields("Name")

      .Orientation = xlRowField

      .Position = 1

    End With
With Worksheets("Pivot Table")
  .PivotTables("PivotTable4").
  AddDataFieldActiveSheet.
  PivotTables("PivotTable4").
  PivotFields("Received"), "Sum of Received",
  xlSum

  .PivotTables("PivotTable4").
  AddDataFieldActiveSheet.
  PivotTables("PivotTable4").PivotFields("On
  Time"), "Sum of On Time", xlSum

  .PivotTables("PivotTable4").
  AddDataFieldActiveSheet.
  PivotTables("PivotTable4").
  PivotFields("Late"), "Sum of Late", xlSum

  .PivotTables("PivotTable4").
  AddDataFieldActiveSheet.
  PivotTables("PivotTable4").
  PivotFields("Late (1-5)"), "Sum of Late (1-
  5)", xlSum

  .PivotTables("PivotTable4").
  AddDataFieldActiveSheet.
```

```
PivotTables("PivotTable4").
PivotFields("Late (6-10)"), "Sum of Late
(6-10)", xlSum

.PivotTables("PivotTable4").
AddDataFieldActiveSheet.
PivotTables("PivotTable4").
PivotFields("Late (11-15)"), "Sum of Late
(11-15)", xlSum
.PivotTables("PivotTable4").
AddDataFieldActiveSheet.
PivotTables("PivotTable4").PivotFields("Late
above 15"), "Sum of Late above 15", xlSum
End With

rowscount = Worksheets("Pivot Table").
Cells(Rows.Count, 17).End(xlUp).Row

colcount = Worksheets("Pivot Table").Cells(1,
Columns.Count).End(xlToLeft).Column

  With Worksheets("Data")

    .Range("A1:H1048576").Value = ""

  End With

  With Worksheets("Pivot Table")

    .Range(Cells(1, 17), Cells(rowscount - 1,
    colcount)).Copy

Worksheets("Data").Select

Worksheets("Data").Range("A1").Select

Worksheets("Data").Paste

    .Columns("Q:X").EntireColumn.Delete

  End With

Application.Calculation = xlCalculationAutomatic
```

After inserting the pivot table, the data (already present in the 'Data' worksheet) is deleted and whole data from 'Pivot Table' is copied and pasted into the 'Data' worksheet (see Figure 7).

7.3.4. Transfer Data for Finalizing Report

Initially, macro given below erases the whole data from 'Report' worksheet (see 10-14th lines of the code given below). The data obtained from the inserted pivot table is transferred to the 'Report' worksheet by the help of below given code. All values (cell by cell) are transferred by the use of for loop.

```
Sub TransferToReport()

Application.ScreenUpdating = False

On Error Resume Next
```

Figure 7: Result of above given code

```
rowscount = Worksheets("Data").Cells(Rows.
Count, 1).End(xlUp).Row
colcount = Worksheets("Data").Cells(1,
Columns.Count).End(xlToLeft).Column
'MsgBox (rowscount)
'MsgBox (colcount)
  With Worksheets("Report")
    .Range("A2:C1048576").Value = ""
    .Range("E2:E1048576").Value = ""
    .Range("G2:J1048576").Value = ""
  End With
Row = 2
  For i = 1 Torowscount
    With Worksheets("Report")
      .Cells(Row, 1).Value =
      Worksheets("Data").Cells(Row, 1)
      .Cells(Row, 2).Value =
      Worksheets("Data").Cells(Row, 2)
      .Cells(Row, 3).Value =
      Worksheets("Data").Cells(Row, 3)
      .Cells(Row, 5).Value =
      Worksheets("Data").Cells(Row, 4)
      .Cells(Row, 7).Value =
      Worksheets("Data").Cells(Row, 5)
      .Cells(Row, 8).Value =
      Worksheets("Data").Cells(Row, 6)
      .Cells(Row, 9).Value =
      Worksheets("Data").Cells(Row, 7)
      .Cells(Row, 10).Value =
      Worksheets("Data").Cells(Row, 8)
    End With
    Row = Row + 1
  Next
Application.ScreenUpdating = True
End Sub
```

The result of the above presented code can be seen in the Figure 8. Whole data from 'Data' worksheet (see Figure 7) is transferred into the 'Report' worksheet.

7.3.5. Refresh Data

When the user intends to make a new material delivery analysis report, he needed to erase previously prepared report in the template; therefore, in order provide facility for deleting the data from all the worksheets (i.e. Raw Data, pivot table, data and report worksheets).

```
Sub RefreshData()
Application.ScreenUpdating = False
On Error Resume Next
Worksheets("Raw Data").Select
  With Worksheets("Raw Data")
    .Columns("A:J").EntireColumn.Delete
  End With
Worksheets("Pivot Table").Select
  With Worksheets("Pivot Table")
    .Range("A2:J1048576").Value = ""
  End With
Worksheets("Data").Select
  With Worksheets("Data")
    .Range("A1:H1048576").Value = ""
  End With
Worksheets("Report").Select
  With Worksheets("Report")
    .Range("A2:C1048576").Value = ""
    .Range("E2:E1048576").Value = ""
    .Range("G2:J1048576").Value = ""
  End With
Application.ScreenUpdating = True
End Sub
```

7.4. Time Consumed by New Method

As similar the old method, time study of automated material delivery analysis report was also conducted. All the activities were enlisted (see Table 2) along with the 10 observations and their mean time.

Notations

g=Press Ctrl + Q and Form Appears

h=Execution time of Command Button Refresh Data'

i=Execution time of Command Button 'Put Date'

j=Put the formulae '=days360' manually in order to calculate the difference of days

k=Execution time of command button 'Transfer'

l=Execution time of command button 'Pivot Tale'

m=Close Form

T = a + g + h + i + j + k + l +m T = 93.093sec

T= 1.55 min

	A	B	C	D	E	F	G	H	I	J	K
1	Row Labels	Sum of Received	Sum of On Time	Percentage of On time	Sum of Late	Percentage of Late	Sum of Late (1-5)	Sum of Late (6-10)	Sum of Late (11-15)	Sum of Late above 15	After conisdering 1-5 days tolerance in RCT then ratio is
2	(SPL) Shafi China Office	3720	0	0%	3720	100%	0	0	0	3720	0%
3	99 Industries Pvt Ltd.	13138	12285	94%	853	6%	420	180	0	253	97%
4	A.T.S SYNTHETIC (PVT) LTD.	2831.75	1461.75	52%	1370	48%	685	0	0	0	76%
5	Ahmad Lace Works (Pvt) Limited	7510	1210	16%	6300	84%	0	0	0	0	16%
6	Ahn Synthetic pvt Ltd	17151	5232	31%	11919	69%	1735	1742	0	8442	41%
7	Ali & Faizan Engineering Works	18	18	100%	0	0%	0	0	0	0	100%
8	Alnoor enterprises	30977	5	0%	30972	100%	0	10184	0	20788	0%
9	altodigital	8	8	100%	0	0%	0	0	0	0	100%
10	AMEEJEE VALLEEJEE & SONS (PVT.) LTD.	43	43	100%	0	0%	0	0	0	0	100%
11	antoniana Minuterie SRL	25000	0	0%	25000	100%	0	0	0	25000	0%
12	Anwar-e-Madinah	321	321	100%	0	0%	0	0	0	0	100%
13	Ashar Packages	300	0	0%	300	100%	300	0	0	0	100%
14	ASIAN TRADERS	3089	3089	100%	0	0%	0	0	0	0	100%
15	Atif Lace Industry	54107	3923	7%	50184	93%	17002	1160	0	23766	39%
16	AXE Packages	5655	468	8%	5187	92%	238	915	0	2984	12%
17	B & T Laminates	5655.93	1860.36	33%	3795.57	67%	373.59	1067.84	10	2307.69	39%
18	Bilal Sewing Machine	3419	3419	100%	0	0%	0	0	0	0	100%
19	Boluo Shenglong industrial Co.Ltd	55847.5	55847.5	100%	0	0%	0	0	0	0	100%
20	Bond and Built Private Limited	39637.35	8028.85	20%	31608.5	80%	16007.5	11850	2885	866	61%
21	Celanese	120	0	0%	120	100%	0	0	0	120	0%
22	Chawla Industries (Pvt.) Ltd.	51	0	0%	51	100%	0	0	0	51	0%
23	Check Point Systems	25570	0	0%	25570	100%	0	0	0	25570	0%
24	Chenfull international co.ltd	32	24	75%	8	25%	0	0	0	8	75%
25	DADA ENTERPRISES PRIVATE LIMITED	2691	2251	84%	440	16%	0	0	0	0	84%
26	Deen Enterprises	292596	190026	65%	102570	35%	2570	0	0	100000	66%
27	Dongguan City Yuan Feng Shop Material Store	89.89	0	0%	89.89	100%	89.89	0	0	0	100%
28	DongGuan Sheng Fa Shoe Material Co. Ltd	250	0	0%	250	100%	0	0	0	0	0%
29	Electro Heat Service Centre	70	70	100%	0	0%	0	0	0	0	100%
30	Fainplast S.R.L	264	0	0%	264	100%	0	200	0	64	0%
31	Faisal Packages	599	0	0%	599	100%	0	0	0	599	0%
32	FINE INDUSTRIES (Pvt) Ltd.	5108.5	3167	62%	1941.5	38%	609	988.5	0	0	74%
33	Fujian Quanzhou Justsun Supply Chain Co Ltd	309	280	91%	29	9%	0	0	0	29	91%
34	Ghauri Chemical	500	0	0%	500	100%	500	0	0	0	100%
35	Ghulam Abbas Thread	4074616	3279189	80%	795427	20%	75018	21753	283621	115035	82%
36	Global Enterprises	4025	3375	84%	650	16%	0	0	650	0	84%

| ‹ | › | Raw Data | Pivot Table | Data | **Report** | PO Status | ⊕ |

Figure 8: Result of above given code.

After putting the values in above given equation, total time required for making the material delivery analysis report as per suggested method was calculated to be 93.093 sec (1.55 min).

8. Discussion

Every small and medium enterprise (SME) hires employees for making reports on daily, monthly, quarterly bi-annually and yearly basis. Most of the report in mentioned sector is conducted in MS excel. MS excel takes tremendous amount of time manually in the case of complex reporting and at the same time, there is the greater chance of error

as well. Especially for this problem. Microsoft has thus already kept the flexibility of customized automation in its application i.e. Word, Excel, PowerPoint and Project by Visual basic for applications (VBA). The work on VBA is conducted in visual basic editor (VBE). Therefore, Microsoft has already developed the technologies i.e. VBA, VSTO, ActiveX and etc. (Ding et al., 2017; Porter & Stretcher, 2012). In Microsoft windows, VBA technology is provided on the platform of many software (Kuka & Karamani, 2011; Norton & Tiwari, 2013; Harahap & Azmi, 2017). These days, companies` employees are promoted for gaining the skills and knowledge of using excel and VBA (Chatvichiencha, 2015). When it is about VBA, then it is about the customization and development in integrated

Table 2: Time study of all the activities used in the suggested method for preparation of material delivery analysis report.

Activity	Obs. 1 (sec)	Obs. 2 (sec)	Obs. 3 (sec)	Obs. 4 (sec)	Obs. 5 (sec)	Obs. 6 (sec)	Obs. 7 (sec)	Obs. 8 (sec)	Obs. 9 (sec)	Obs. 10 (sec)	Mean Time (sec)
a	69.5	69.18	87.22	70.42	59.93	70.58	65.89	66.6	74.21	74.97	70.85
g	1.48	1.4	1.5	1.41	1.34	1.28	1.26	1.41	1.25	1.26	1.359
h	1.91	1.89	1.99	1.97	1.82	1.98	1.86	2.15	2.09	1.8	1.946
i	1.22	1.43	1.51	1.63	1.21	1.42	1.13	1.66	1.72	1.6	1.453
j	9.31	14.93	7.89	11.56	9.98	8.68	9.84	8.95	6.94	9.72	9.78
k	2.83	2.9	2.86	3.1	3.13	3.01	3.11	3.04	2.54	2.7	2.922
l	3.92	3.02	3.77	3.53	3.4	3.46	3.66	3.44	3.43	3.93	3.556
m	1.21	1.09	1.14	1.19	1.25	1.21	1.15	1.69	1.19	1.15	1.227

development environment (IDE) in the applications of MS office for the automation and simplification of manual, complex and repeated work (Ding et al., 2017; Evensen, 2014; Minto, 2009; Harahap & Azmi, 2017; Kuka & Karamani, 2011). Simply, it is known for automating the routine work in existing office productivity applications (Ding et al., 2017; Chatvichiencha, 2015). Objective of the present research was to automate the material delivery time report analysis. This report was used to be prepared at the case company once in a month and in the mean time employees often used to forget the steps of making the report and due to this chance of error was greater. Number of macros were programmed to execute those commands which were once done manually in excel. All those macros were set behind the command buttons on a userform so that they could be run on the single click. Userforms are used when the input from user is to be taken (Evensen, 2014). They may also have code at their back hand so that operations can be performed automatically (Evensen, 2014; Harahap & Azmi, 2017; Kalwar & Khan, 2020b). If literature is traced back and the prevalence of same research is found. As (Bartoszewicz & Wdowicz, 2019) used VBA in order to redesign and implement the process for migration of data and its analysis; it was faster, flexible and the way to speed the complex analytical report formation; comparison of old and new method revealed that by the help of VBA, time of report was reduced from 2 hours to 5 minutes (Bartoszewicz & Wdowicz, 2019). Another researcher, (Cirujano & Zhu, 2013) used VBA and worked on the manpower resource planning report; an experienced employee had to work for 30 working hours to make the report but after the automation by VBA, it takes 10 minutes (Cirujano & Zhu, 2013). In the same, way (Kalwar & Khan, 2020) automated the procurement report at the planning and costing department of the company by using VBA; by which 75% of the employee`s time was saved (Kalwar & Khan, 2020b). Old method of preparing the material delivery analysis report used to take 5.324 minutes, whereas, new method takes 1.55 minutes to complete the report. Comparison of the time study of both methods indicates that the new method takes 70.86% less time as compared to the old method. It seems obvious that new method is beneficial moreover, because of automated operation, there would be no chance or error in the report if the basic data is 100% accurate. (Yan & Wan, 2017) developed a mechanism of generating bill of material of transmission line by using VBA; efficiency and accuracy of calculation are tremendously improved;

at the same time, errors in the calculation process of steel BOMs were reduced (Yan & Wan, 2017; Abidin et al., 2015) also used VBA and calculated API and WQI in the automated way; they reported that calculation time and errors were reduced by automating the calculations (Abidin et al., 2015; Chaudhry, Kalwar, Khan, & Shaikh, 2021) used VBA in MS excel for increasing the efficiency of small level management information system at civil aviation authority, logistic center south: they succeeded in reducing the data retrieval time by 50%).

9. Conclusion

There are many ways of improving employee's productivity and reducing errors in the reporting process. Since, the value added reports are fundamental documents on the base of which decisions are made; thus it should be accurate and free of errors. In this regard, the material delivery time analysis report was automated by the use of Visual basic for applications (VBA). By this automation three benefits are achieved: 1) reduced time to make the report, 2) increased report accuracy, 3) increased employee productivity.

10. Implications

There was no visual basic for applications VBA programmer in the Company and in case of any error in the report, it was not possible to trace and solve that error. Therefore, it was necessary for the company to train its employee in the context of the VBA.

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Conflict of interest

No conflict of interest among the authors of the present report was found.

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