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Optimization of Procurement & Purchase Order Process in Foot Wear Industry by Using VBA in Ms Excel

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Abstract
In the case company there were typical various reports which were made manually in excel spreadsheets. The data was used to be downloaded from Microsoft Dynamics AX in excel spreadsheet and processed as per the requirements of the reports. In some of the reports, there was decision making on the values to be entered in different cells in the excel spreadsheet. Procurement report was one of those reports; it needed full concentration of an employee and if the employee is tired or mentally absent, there could be greater chance of putting wrong values in the wrong cell address in the spreadsheet. Since those values were associated with the cost; thus it was the greatest need to find fully automated way to make the report in which the computer will be used to make the decision as per the defined conditions. Therefore, Procurement report and purchase order against it were automated by using visual basic for applications (VBA) in excel.VBA code was compiled and run in the visual basic editor (VBE) in MS excel. Language procedures mainly based on the if conditions and for loops were used to circulate those condition into the required worksheets. Time study (which was conducted by the help of stopwatch) of report for both methods i.e. manual and automated was conducted. Procurement report was used to take 2076.751 sec to be completed as per old method when there were 120 items (to be procured) in the report. Moreover, it took 516.578 sec to be completed by automated method containing same number of items. Comparison of time study of both methods indicated that the new method was taking 75% less time in making the procurement report; whereas, new method to make the purchase order (PO) was taking 2-3 seconds instead of 15-20 minutes. After the required modifications and troubleshooting of the automated procurement report template, its results were verified. Automated method for making the report was up to the mark of departmental requirements and most importantly, the new method of making both reports was error free whereas, in old method the chance of error was greater. This research paper contributes in providing the solution to industries by which the conditional decision making can be automatically conducted by use of VBA. The small scale (with no or little cost) efficient system can be produced with interesting interface with set of macros capable enough to perform the tasks of hours in minutes.

Key words: Optimization, Visual Basic Application (VBA), Procurement, Purchase order, Automation

INTRODUCTION AND LITERATURE

The integration of the various functions as per defined plan by the help of which plant facilities are utilized and goods are regulated orderly during the entire cycle of manufacturing i.e. from procuring the material to the shipment of finished goods at the predetermined rate Ramachandran et al. (2016). There are various stages of planning and material planning is considered as the tactical level of planning. It is associated with the demand and supply of goods; which require initiation, control and monitoring of purchasing orders and manufacturing so the material flow and value addition can go on without any interruption Jonsson and Mattsson (2002). Economic performance includes the cost of procurement and waste reduction under operational performance; the most important thing in that is minimum levels of inventory stock and greater capacity utilization Dey and Cheffi (2013).A conceptual model by Paul et al. (2011) broadly suggest the integrated managerial paradigm in which the strategic partnership is made with few trusted suppliers who have through an extensive evaluation process.

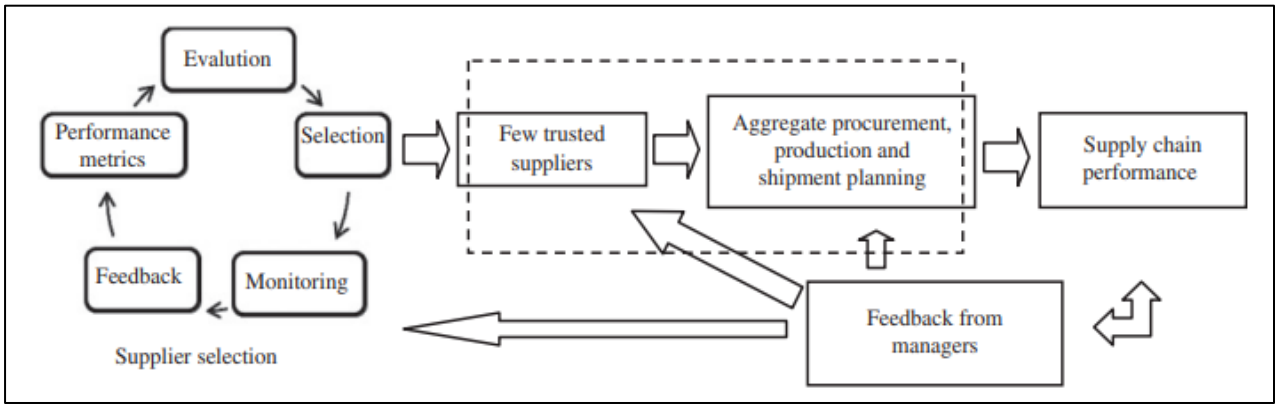

Fig.1.Conceptual model for aggregate procurement, production and shipment planning and feedback loop to monitor supply chain performance
(Pal et al. 2011)

This whole mechanism is followed by initiation and development of a joint procurement plan, production routine and delivery schedule totally grounded on the total cost minimization Pal et al. (2011). Procurement is used to specify and bring the material in facility by the help of vendors/suppliers; thus to establish the specifications is the function of Procurement Bhattacharya (2015). Purchasing can be divided into two section: i.e. procuring and scheduling of supplier and follow up Bhattacharya (2015). Throughout the supply chain, lead time is an essential element to be carefully considered for timely delivery of products to the customer. The calculation of lead times can be based on the experience, the results of enterprise resource planning (ERP) system or through monitoring of actual time. Lead times which are calculated on the basis of experience have drawback same as the experience based estimation of safety stocks and order quantities Jonsson and Mattsson (2006). If the completion time of some value added activities of supply chain is reduced i.e. preparation of procurement report and purchase order (PO); it will be counted as the reduction in the lead time of order although it is of some minutes. The use of machines i.e. computer has played its role in making some tasks of supply chain so quickly i.e. procurement report.

Information technology (IT) has been playing a remarkable role in the processing, calculation and retrieval of data. The goal of data organization and management is to produce the meaningful information from the organized sets of data. Management information system is the main factor which facilitates any organization in the data processing and decision making Karim (2011). Most of small and medium organizations use spreadsheets for departmental reporting i.e. costing, planning etc. Spreadsheets are usually used for multi-purpose i.e. entering data, storing data, its analysis and visualization: many of the spreadsheet programs are utilized for all these mentioned functionsBroman and Woo (2018). It is difficult to build the reliable spreadsheet as known by the experience of practitioners Dunn (2009). Spreadsheets are most widely used programming systems in the world Fisher et al. (2002). Businesses and individuals use spreadsheets for the innumerous applications i.e. simple calculations for making decisionsAbraham et al. (2007).In order to perform these functions, big organizations require large management information systems; but if, the data is small and less diverse, then the systems can be built on small level in MS excel along with the use of VBA. Visual Basic for Applications (VBA) is a type of program in Excel that enables the user to save formulations and methods in the form of computer code which are called as "macros" Perry(2012). There is no or little cost associated with the systems made by the use of VBA in excel and on the same time, complex analysis with high performance can be conducted. Moreover, less skilled analysts can produce the accurate results with the greater efficiency Blayney and Sun(2019).Once the macros are programmed in excel they can be executed by just clicking the button. By the use of VBA, user can automated all the spreadsheet tasks and develop user-defined functions as well Abraham et al. (2007). VBA is quite different in the comparison of excel formulae and the provided programming environment (visual basic editor) is also different as compared to the spreadsheet Abraham et al. (2007).

Blayney and Sun contributed intelligent big data analytics Blayney and Sun (2019).Balson discussed a method to produce a limited form of User defined spreadsheet functions (UDSFs) in MS Excel without using VBA Balson (2012). Whereas, it was even better to program all required UDSFs in module with the dynamic input range and later the functions could be called in the spreadsheet by an ordinary user. Alexei Botchkarev checked the suitability of Monte Carlo (MC) simulation in the excel VBA and excel was indicated as the powerful tool for MC simulation Botchkarev (2015).A research conducted by Ajinkya et al. presented statistical research on application of Microsoft Excel in the estimation of quantity and cost of construction work i.e. excavation, PCC, brickwork, RCC work and plasteringAjinkya(2017). Raza and Gulwani used VBA in excel for highlighting anomalous measuring points and the information of missing points was inserted by the help of VBA Raza and Gulwani(2017). Except introductory stuff, very few research papers have been published on the spreadsheet automation related to the industrial reporting e.g. costing, budgeting, scheduling etc. This research paper contributes in providing the solution to industries by which the conditional decision making can be automatically conducted by use of VBA; furthermore, every single minute task can be done by the VBA. Visual basic for applications is the need for industries especially when reporting accuracy and efficiency are on question. In the gravity of this principle, procurement report at the one of the renowned footwear company of Lahore was automated by the use of VBA. Every single task was automated so that the user can have the accurate report in quite less amount of time. This research paper explains the old and new

method of making the procurement report being made at the planning and costing department of ABC Footwear Company of Lahore Pakistan.

THEORITICAL FRAMEWORK

In this modern world of technologies, routinely conducted computerized work is taken towards the automation so that the human error and the time consumption can be minimized. This research describes the way procurement report formation was automated at the ABC Company of Lahore. This research contributes in providing the solution for reporting (routine based reporting) in small and medium enterprises across the globe. Most of the employees, prepare the reports manually in the applications of Microsoft office i.e. excel. Manually prepared reports cause the wastage of tremendous amount of time but anything either simple or complex can be automated by the help of visual basic for applications (VBA)in excel MacDonald (2004). The lines of code which are written in the visual basic editor are called as procedure. Commonly, procedures are of two types i.e. sub and function. Functions can be made to perform amazingly powerful feats with a little programming effort Walkenbach (2013). Use of automation, increase the delivering speed of the solution which result in decrease of total time of completion of task Sajja (2017). The key concepts used for the automation of procurement report at the case company (which is presented in this research) are taken from the basics of visual basic for applications in excel i.e. decision making with conditional statements. Most of the time, user is supposed to decide among the values present in the one or more than one cells that where what to put? As in the case of procurement report, user needs to decide whether to put an order or reserve from the purchase order quantity (see fig.10) and how much quantity is needed to be reserved physically? For such situations, programming languages facilitates the programmers with the conditional statements. The 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 and Sun(2019). Sometimes, there are multiple condition in the IF statement and result is needed to be returned if both 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(2006). 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 timesWalkenbach (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).

DEFINITIONS OF IMPORTANT TERMS

Some of the terms which are used in the research paper are defined below.

Transaction: It is the set of items (with their prod. Numbers, configuration, size, color and the warehouse with which it belongs) and their quantities required in the specific order.

On hand Inventory: It is the description of items which are physically present in the stock or they are entered into the system against any purchase order (the description and quantity of items to be procured).

Total Available Quantity (T_{aq}): The value which represents the status of the stock of specific item.

Purchase Order Quantity (P_{oq}): The value against any item represents that it has been ordered for any item.

Physical Available Quantity (P_{aq}): The value by which the availability of item in the stock is represented.

Required Quantity (Q_r): The value by which the need of the specific item in any article is represented.

Order Quantity (Q_o): The value by which represents that in how much quantity an item is ordered.

Reserve from Order Quantity (R_{oq}): When the quantity of an item is booked/reserved against any article from the already ordered items.

Reserve from Physical Quantity (R_{pq}): When the quantity of an item is booked/reserved against any article from the physically available stock.

RESEARCH METHODOLOGY

The steps and methods for the preparation of the reports were collected from the concerned person at the planning and costing department of ABC Company of Lahore, Pakistan. Time of each activity performed during the formation of procurement report and its purchase order (both manual and automated) was recorded by using the stop watch. All the collected observations were put intoMS excel for calculation of average time of each activity. On the same time, the average time of each activity was plotted into MS excel. Visual basic for applications (VBA) was used as the programming language to automate manual activities in Microsoft Excel. Every single task (i.e. inserting/deleting row/column, merging values of two or more columns, data transferring from one sheet to another, applying vlookup formulae, counting number of non-empty rows in the worksheet, inserting pivot table, copy and paste data etc.) was programmed in macros. An interesting interface in the form ofuserform (consisted of multiple command buttons) was made so that all the programmed macros could be executed by clicking command buttons. Userformis appeared on the screen by pressing 'Ctrl + q'.Microsoft Visio was used in order to make the flowcharts of the code. Procurement report and its purchase order took 10 hours of the researcher to develop an automated worksheet; it took 2 hours for testing and troubleshooting of the worksheet.

4.1 Data Collection

The descriptions of small activities to make the procurement report were collected along with time taken by them was recorded which is discussed in the below given headings.

4.1.1 Time of activities to be performed manually in excel

In order to have the average time to perform one activity, 10 observations for each activity were taken as shown in the table 1. The time was recorded in the seconds because of very small magnitudes of time.

4.1.1.1 Legends

a = Call Transaction form Microsoft Dynamics as per the given Prd# numbers
b = Filter the data (criteria 1: Leather Store, criteria 2: Shoe mat)
c= Copy the columns (A:F) and Paste in columns (H:M)
d= Delete Columns (A:G)
e = Insert one column in order to merge the specific columns
f = Merge Columns With the help of '=Concatenate' formulae (item number + configuration + size + color)
g = Copy the merged values and paste in the same column in order to avoid the error in formula
h = Delete the unnecessary columns
i= Apply the 'pivot table' in order to calculate the sum of quantity of each of the item used in the article
j = Copy the data from the 'pivot table' and paste in the same sheet next to pivot table
k = Put the headers on columns (3 columns)
l = Delete the pivot table
m = Remove '-' sign from column named as 'quantity'
n = Arrange items in three categories i.e. Leather, Local material, imported material
o = Delete the last row containing 'Grand Total'
p = Take out the data of 'on hand inventory' from Microsoft Dynamics
q = Put the headers on columns (4 columns)
r = Put zero in the blank cells
s = Copy the transaction data and paste into the 'Order Calculation' Worksheet
t = Apply vlookup to collect the quantities in three different columns
u = Time of each activity for putting one order/reserve quantity against one item to be procured

Table 1. Recorded time of the individual activities required for making the procurement report

Activity	Obs. 1	Obs. 2	Obs. 3	Obs. 4	Obs. 5	Obs. 6	Obs. 7	Obs. 8	Obs. 9	Obs. 10	Mean Time
a (sec)	202.8	211.1	214.9	177.3	205.35	202.34	169.07	207.2	206	213	200.954
b (sec)	7.29	6.95	8.92	7.38	3.89	8.56	8.14	8.11	7.24	9.52	7.600
c (sec)	8.01	9.10	8.04	8.67	9.98	9.57	8.33	9.20	11.35	9.12	9.137

d (sec)	6.56	4.49	6.40	5.90	5.29	4.65	4.91	5.12	7.77	6.82	5.790
e (sec)	3.52	3.39	1.24	2.76	2.9	1.8	2.61	3.18	1.46	4.09	2.695
f (sec)	10.09	9.19	6.46	10.8	10.22	10.58	11.76	10.98	7.65	11.3	9.901
g (sec)	2.35	3.01	2.97	2.74	4.86	2.56	3.97	3.87	4.89	2.94	3.416
h (sec)	7.17	9.44	4.91	5.28	6.41	8.27	5.39	7.73	4.25	4.44	6.329
i (sec)	28.19	23.15	14.93	26.43	14.31	14.32	18.3	20.97	23.1	23.2	20.681
j (sec)	12.95	12.96	13.89	11.3	9.9	10.93	13.97	10.78	10.4	14.2	12.133
k (sec)	22.5	21.92	19.83	23.28	20.8	19.27	22.66	24.45	21.8	20.1	21.661
l (sec)	9.68	7.19	10.51	7.22	6.6	9.14	11.03	10.12	8.38	7.94	8.781
m (sec)	32.02	30.76	30.19	27.52	31.29	27.97	29.87	31.77	29.8	29.5	30.063
n (sec)	454.9	506.2	484.6	484.6	473.29	503.07	490.51	519.5	503	481	490.077
o (sec)	7.27	8.99	6.78	8.13	6.75	4.97	6.56	8.94	7.24	7.81	7.343
p (sec)	232.1	273.2	281.4	335.4	285.87	325.33	303.72	274.3	209	299	281.988
q (sec)	26.25	25.57	25.77	20.35	25.26	24.77	24.91	26.12	21.6	25.4	24.600
r (sec)	38.37	33.22	33.67	24.89	25.15	28.79	19.75	25.6	23.9	24.8	27.809
s (sec)	17.22	16.07	14.43	10.93	16.43	14.23	17.23	17.84	18.8	15.5	15.867
t (sec)	66.62	68.39	67.04	59.68	64.22	67.42	71.55	69.22	66.7	65.7	66.654
u (sec)	5.9	5.54	7.9	5.5	8.95	6.43	5.73	6.48	6.9	6.44	6.577

The average time of the activities to be performed in the excel spreadsheet can be seen in the fig.1.1 which is given below.

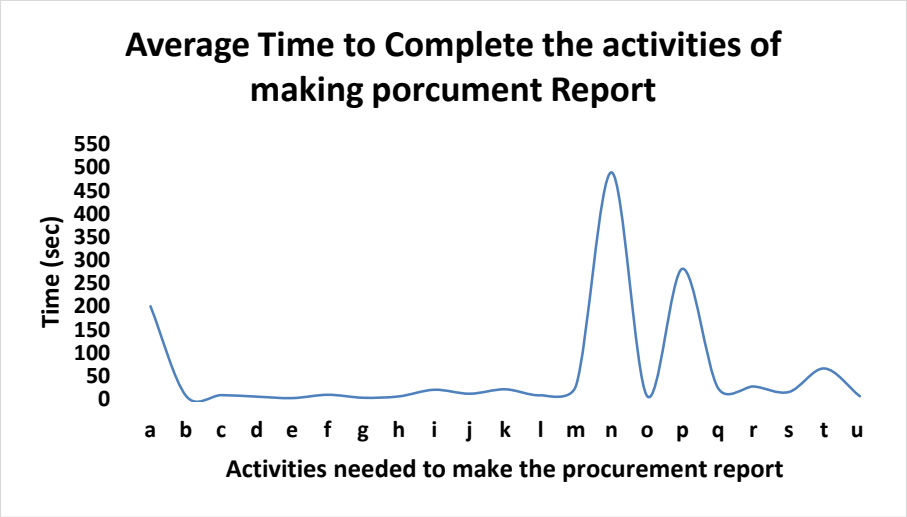

Fig.1.1. The average time to complete the small manual activities for the procurement report at ABC footwear Company

It can be seen in the fig.1.1 that the user spent maximum time on arranging the item in three different categories i.e. Leather, local material and imported material.

OLD METHOD TO PREPARE THE PROCUREMENT REPORT

Procurement report is contained of three sections as shown in the table 2. 1) Transaction, 2) on hand inventory and 3) order calculations. Each section is described below.

5.1 Transaction

Transaction data is obtained from Microsoft dynamics AX against the particular range of production numbers/order (prod#) and is used to be exported to excel (see fig. 1) so that the procurement report can be prepared. The data which is needed from the transaction is item and its quantity which can straight away be taken but the same items can be there against different production numbers as can be seen in the rows 7-10 in the fig. 1. Therefore, it is necessary to sum all the quantity against each item.

In the start of transaction column G (warehouse) is filtered with criteria 1: 'Leather Store' and criteria 1: 'Shoe Mat' and the filtered rows are copied (A:F) and then pasted into the range of blank columns (H:M). Since the names of items can be same with different configuration/color/size; thus to make an item unique, the four values are merged to one value (i.e. Item number + configuration + size + color) by using '=contactenate' formula and then columns (B:E) are deleted.

	A	B	C	D	E	F	G	H	I	J
1	Prod#	Configuration	Item number	Size	Color	Quantity	Warehouse	Location	Site	CW quanti
2	Prod_00185091	Export sho	3444 CFS	40	D.Brown	40.00	Exp WH	Export	Factory	
3	Prod_00185091	Cow	Polisher	1.4-1.6 mm	Tan	-42.56	Lthr Store		Factory	
4	Prod_00185091	FomMolto	Molto Foam	3 mm	L/Brown	-2.92	Shoe Mat	Shoe Mater	Factory	
5	Prod_00185091	PUMicro	PU Micro Fiber Imp	Default	Brown	-2.76	Shoe Mat	Shoe Mater	Factory	
6	Prod_00185091	RbrFomSock	Rubber Foam Socks	6 mm	Beige	-2.28	Shoe Mat	Shoe Mater	Factory	
7	Prod_00185091	Thread Loc	Polyester Thread Local	20/3	M/Brown262	-320.00	Shoe Mat	Shoe Mater	Factory	
8	Prod_00185091	Thread Loc	Polyester Thread Local	30/3	M/Brown262	-280.00	Shoe Mat	Shoe Mater	Factory	
9	Prod_00185091	Thread Loc	Polyester Thread Local	40/3	M/Brown262	-100.00	Shoe Mat	Shoe Mater	Factory	
10	Prod_00185091	Thread Loc	Polyester Thread Local	40/3	M/Brown262	-120.00	Shoe Mat	Shoe Mater	Factory	
11	Prod_00185091	Chemical	Pasting Solution Ltr	Default	Yellow	-0.60	Shoe Mat	Shoe Mater	Factory	
12	Prod_00185091	Chemical	Latex	Default	White	-0.60	Shoe Mat	Shoe Mater	Factory	
13	Prod_00185091	Perlon Tap	Perlon Tape	4 mm	Black	-22.00	Shoe Mat	Shoe Mater	Factory	

Fig. 2. Transaction as exported from Microsoft Dynamics AX

After all this, three columns are left i.e. Prod#, Item, Quantity; the data in the remaining columns is converted into pivot table and the columns (A:C) are deleted. In pivot table sum of quantity and the items are copied and pasted in the next blank columns (C:F) and pivot row is deleted; when the data is obtained based on two columns, the user put the headers and remove the negative sign from the values of quantity.

	A	B
1	Item	Quantity
2	Alarm ChipAlarm Chip C4Identity-B3100170	2010
3	Alarm ChipAlarm Chip C4Identity-S3100687	4020
4	Alarm ChipMicro PakDefaultGreen	2010
5	Chemical WWax Cream P/29DefaultBlack	2.82
6	Chemical WWax Cream P/29DefaultNatural	3.4
7	ChemicalHot Melt Cmnt For ScksDefaultWhite	1.98
8	ChemicalLatexDefaultWhite	52.64
9	ChemicalPasting Solution LtrDefaultYellow	33.6
10	CowPolisher1.4-1.6 mmBlack	964
11	CowPolisher1.4-1.6 mmTan	1174.66
12	FomMoltoMolto Foam3 mmBlack	66.14
13	FomMoltoMolto Foam3 mmL/Brown	80.6

Fig. 3. Transaction data required for the procurement report

After performing the set of activities the transaction looks like as shown in the fig. 3. In the end, it is the formality to arrange the items in different categories i.e. Local material and imported material. At the end last row containing 'Grand Total is deleted'.

Table 2. Description of activities and time needed to complete the organization of transaction data

Activity	**Time (sec)**
a = Call Transaction form Microsoft Dynamics as per the given Prd# numbers	200.954
b = Filter the data (criteria 1: Leather Store, criteria 2: Shoe mat)	7.600
c= Copy the columns (A:F) and Paste in columns (H:M)	9.137

d= Delete Columns (A:G)	5.790
e = Insert one column in order to merge the specific columns	2.695
f = Merge Columns With the help of '=Concatenate' formulae (item number + configuration + size + color)	9.901
g = Copy the merged values and paste in the same column in order to avoid the error in formula	3.416
h = Delete the unnecessary columns	6.329
i = Apply the 'pivot table' in order to calculate the sum of quantity of each of the item used in the article	20.681
j = Copy the data from the 'pivot table' and paste in the same sheet next to pivot table	12.133
k = Put the headers on columns (3 columns)	21.661
l = Delete the pivot table	8.781
m = Remove '-' sign from column named as 'quantity'	30.063
n = Arrange items in three categories i.e. Leather, Local material, imported material	490.077
o = Delete the last row containing 'Grand Total'	7.343
Total time incurred on the organization of transaction' data	**836.561 = 13.94 min**

All the activities are given in the table 2. Total time incurred in preparation of transaction is calculated to be 836.561 sec (13.94 min).

5.2 On Hand Inventory

Data regarding the on hand inventory is obtained from Microsoft Dynamics AX and then exported similarly to the excel same as transaction. The needed data from this sheet is Item (Item number + configuration + size + color), physical inventory (I), order in total (J) and total available (M).

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Configuration	Item number	Size	Color	Warehouse	Location	Physical inventory	Physical reserve	Available physical	Ordered in total	Ordered reserve	On order	Total available
2	Sticker	Additional Box Stckr LCM	Default	White	Shoe Mat	Shoe Mater							
3	Label	Address Label	3x3 cm	Default	Shoe Mat	Shoe Mater				99.00	99.00	########	-9,801
4	Tape Fiber	Adhsv Tape Cotton 680	25 mm	Black-011	Shoe Mat	Shoe Mater	5,869.85		5,869.85			950.56	4,919
5	AirMaish	Air Maish Kesar Loc	Default	Beige	Shoe Mat	Shoe Mater	180.00		180.00			81.41	98
6	AirMaish	Air Maish Kesar Loc	Default	D/Grey	Shoe Mat	Shoe Mater	27.33		27.33				27
7	AirMaish	Air Maish Kesar Loc	Default	Grey	Shoe Mat	Shoe Mater	58.94		58.94			22.14	36
8	AirMaish16	Air Maish M-1656 Imp	3 mm	Stone	Shoe Mat	Shoe Mater	68.25		68.25				68
9	AirMaish16	Air Maish M-1656 Loc	3 mm	Black	Shoe Mat	Shoe Mater	0.00		0.00	0.41			0
10	AirMaish16	Air Maish M-1656 Loc	3 mm	Grey	Shoe Mat	Shoe Mater	0.00		0.00			4.19	-4
11	Fabric	Air Maish M-30 With Backer	Default	Black	Shoe Mat	Shoe Mater						43.83	-43
12	Fabric	Air Maish M-30 With Backer	Default	Brown	Shoe Mat	Shoe Mater	11.93		11.93				11
13	AirMaish	Air Maish Sand Imp	Default	Beige	Shoe Mat	Shoe Mater	78.64	53.86	24.78				24

Fig. 4. On hand Inventory as exported from Microsoft Dynamics AX

Similarly to transaction, the columns are merged by using '=contactenate' formula; four columns are kept and the rest are deleted. After converting the data into pivot table, the values are copied and pasted into the range of blank rows. At the end blank cells are replaced with '0'.

	A	B	C	D
1	Item	Physical Inventory	Order in Total	Available Total
2	StickerAdditional Box Stckr LCMDefaultWhite	0	0	0
3	LabelAddress Label3x3 cmDefault	0	99	-9801
4	Tape FiberAdhsv Tape Cotton 68025 mmBlack-011	5869.85	0	4919.29
5	AirMaishAir Maish Kesar LocDefaultBeige	180	0	98.59
6	AirMaishAir Maish Kesar LocDefaultD/Grey	27.33	0	27.33
7	AirMaishAir Maish Kesar LocDefaultGrey	58.94	0	36.8
8	AirMaish16Air Maish M-1656 Imp3 mmStone	68.25	0	68.25
9	AirMaish16Air Maish M-1656 Loc3 mmBlack	0	0.41	0.41
10	AirMaish16Air Maish M-1656 Loc3 mmGrey	0	0	-4.19
11	FabricAir Maish M-30 With BackerDefaultBlack	0	0	-43.83
12	FabricAir Maish M-30 With BackerDefaultBrown	11.93	0	11.93
13	AirMaishAir Maish Sand ImpDefaultBeige	78.64	0	24.78

Fig. 5. On hand inventory data required for the procurement report

When all the activities are performed, the data reflects the view as presented in the fig.5.

Table 3: Activities and their time required for the organization of inventory data

Activity	**Time (sec)**
p = Take out the data of 'on hand inventory' from Microsoft Dynamics	281.988
e = Insert one column in order to merge the specific columns	2.695
f = Merge Columns With the help of '=Concatenate' formulae (item number + configuration + size + color)	9.901
g = Copy the merged values and paste in the same column in order to avoid the error in formula	3.416
h = Delete the unnecessary columns	6.329
i = Apply the 'pivot table' in order to calculate the sum of quantity of each of the item used in the article	20.681
j = Copy the data from the 'pivot table' and paste in the same sheet next to pivot table	12.133
q = Put the headers on columns (4 columns)	24.6
l = Delete the pivot table	8.781
r = Put zero in the blank cells	27.809
Total time incurred on the organization of inventory data	**398.30 = 6.639 min**

The total time incurred on the organization of inventory data is calculated to be 398.30 sec (6.639 min) as shown in the table 3.

5.3 Order Calculations

The data obtained from transaction was used to copied and pasted in the order calculation worksheet (first two columns) and against each item last three columns are called from the inventory sheet by using the '=vlookup' formula.

In the order calculation worksheet, first two columns (i.e. Item and reserve from physical quantity) and last three columns are given and remaining three are calculated. If the total available quantity is < 0 as in row 148 in fig 6; in this scenario, user put the required quantity

in the order quantity because -2010 > -25710; if total available quantity was greater than required quantity as in row 153; -2010 < -18 thus the user put -18 in order quantity, reserve 78 pieces form the purchase order quantity and reserve 1914 from physical available quantity (see row 153 of fig. 6)

7	Item	Required Quantity	Reserve from Physical Quantity	Reserve from Purchase Order Quantity	Order Quanti ty	Physical Available Quantity	Purcha se Order Quantit	Total Available Quantity
148	PackngGen.Nylon String5"White	2010.00			2010.00	1108	100000	-25710
149	PackngGen.Nylon String9"White	2010.00		2010		0	50000	42404
150	PackngTapePacking Tape C41/2"Default	40.20	35		5.66	36	0	-6
151	PackngTapePacking Tape C47 cmDefault	18.12		18		304	95	96
152	Perlon TapPerlon Tape4 mmBlack	1105.50	1106			19834	0	3596
153	PictogramLthr+Txtle+Othr2x3 cmWhite	2010.00	1914	78	18.00	1932	78	-18
154	PUMicroPU Micro Fiber ImpDefaultBlack	62.54	0		62.51	0	0	-63
155	PUMicroPU Micro Fiber ImpDefaultBrown	76.18			76.18	0	0	-76
156	RbrFomSockRubber Foam Socks6 mmBeige	114.56	9	106		939	106	169
157	Shoe BoxTEX C-4 SS19330x180x12White	2010.00	476	1534		476	1534	0
158	SizeStickrSize Sticker C440White	504.00			504.00	1827	81	-942

Fig. 6. Order calculation worksheet of the procurement report

In the second condition if the total available quantity is ≥ 0 then, the user is supposed to look at purchase order quantity firstly and then to the physical available quantity as in row 157; 2010 pieces is the requirement and the total available quantity is 0; in this scenario, the user reserves 1534 from purchase order quantity and 476 from the physical available quantity.

Table 4: Activities and their time required for the preparation of the order calculation worksheet

Activity	Time (sec)
s = Copy the transaction data and paste into the 'Order Calculation' Worksheet	15.867
t = Apply vlookup to collect the quantities in three different columns	66.654
u = Time of each activity for putting one order/reserve quantity against one item to be procured	6.577

The average recorded time to put one order/reservation is 6.577 as given in the table 4. Thus time required to complete the order calculation worksheet (T_o) can be calculated by below given eq. i.

v = number of items to be procured

$T_o = 82.521 + (6.577 \times v)$ (eq. i)

5.4 Total Time Required to Complete the Report

Total time is the summation of the time spent on the transaction, inventory and order calculations which can be calculated by the eq. ii.

T_{t1} = Total time incurred on the organization of transaction data manually

I_t = Total time incurred on the organization of 'inventory' data
T_o = Total time incurred on the calculation of order
T = total time incurred on the formation of report

$$T = T_{t1} + I_t + T_o$$

$$T = 836.561 + 398.30 + 82.51 + 6.577xv$$

$$T = 1317.371 + 6.577xv \quad \text{(ii)}$$

SUGGESTED METHOD TO PREPARE THE PROCUREMENT REPORT

Since procurement report is as usual as the customer put an invoice in the company and it was found to be the time consuming report if the order is big. Therefore, due to the greater chance of human error and greater time to make it; it was required to automate the report in excel by the use of visual basic for applications (VBA).

Fig. 7: Userform designed for the preparation of the procurement report by the help of VBA excel

In order to run the report, a userform (see fig. 7) was designed to run the macros: since, there are three worksheets; thus three command buttons on the form for the execution of commands for each worksheet.

6.1 Preparation of Transaction`s Data

After the automation of procurement report, the process of organization of transaction is the same as before which can be seen in the flowchart given in the fig.8.

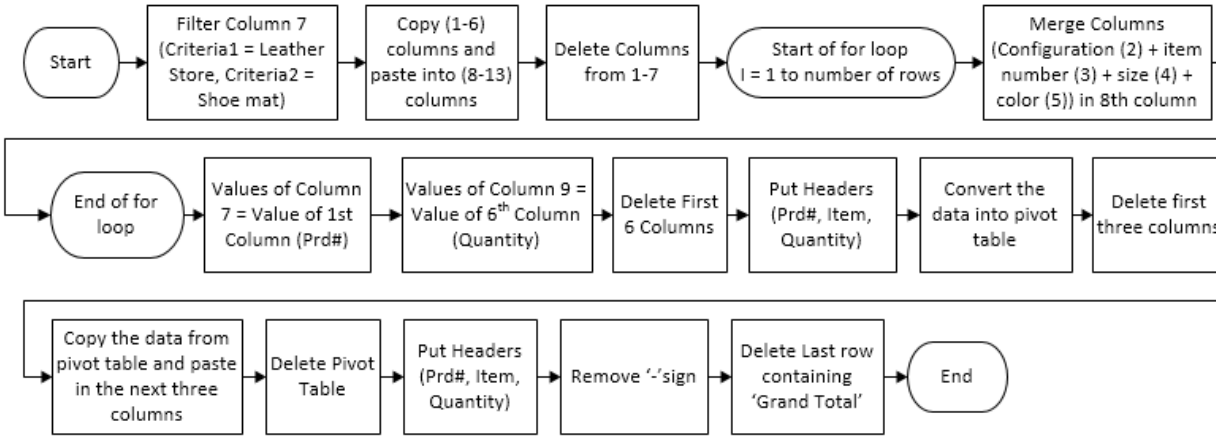

Fig.8. Flowchart for the mechanism of processing transaction datathrough Visual Basic For Applications

In manual work it used to take around 13 minutes but after the automated it takes quite less time.

6.2 Preparation of Inventory`s data

The automation of organization of inventory is contained of same activities which were used to be performed manually in the preparation of procurement report which can be seen in the below given flowchart presented in the fig.9.

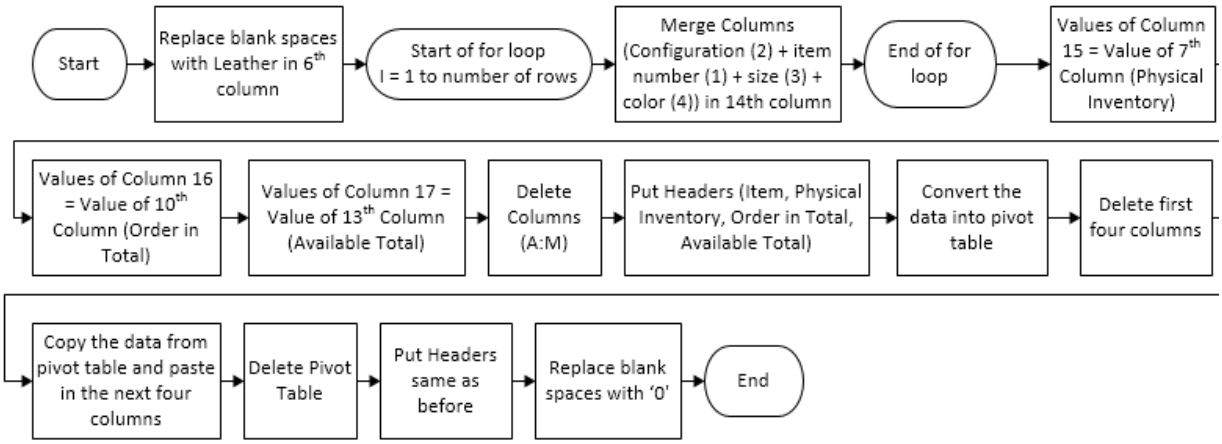

Fig. 9. Flowchart for the mechanism of processing inventory data through Visual Basic For Applications

6.3 Order Calculations for Procurement Report

The data which is obtained from the transaction is automatically pasted into the order calculation worksheet and values of inventory are called from the inventory worksheet by automatically applying '=vlookup' formula in the last three columns through macro. When the transfer button (see fig. 7), is clicked the whole macro is executed in few seconds.

The method of calculation of order and mechanism of putting values in order calculation worksheet is explained by the help of flowchart given in fig. 10 in the below given headings.

D_q = Difference of quantities

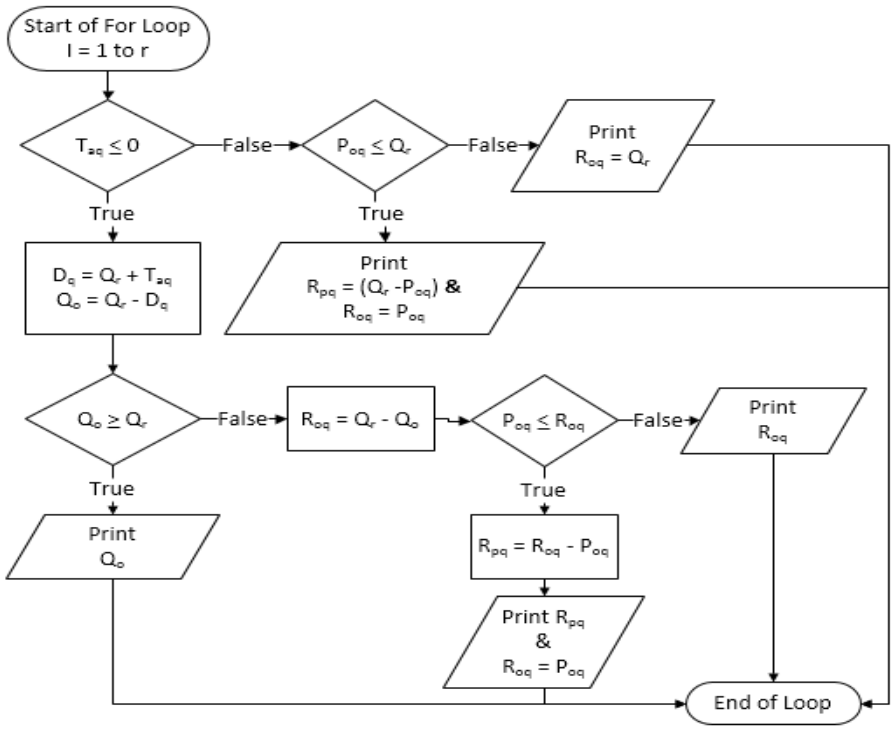

Fig. 10. Flowchart for the order calculation mechanism for the procurement report

The results obtained from the suggested method of making procurement reportwerematched with the results of procurementreport prepared at the ABC footwear Company manually.Few values were taken from the realistic data of procurement report (matching with all the conditions given in the flowchart of fig. 9) in order to confirm the authenticity of automated mechanism.

Table5.Data taken from the original procurement report prepared at the ABC Company

Items	**Q_r**	**R_{pq}**	**R_{oq}**	**Q_o**	**P_{aq}**	**P_{oq}**	**T_{aq}**
Item a	1750			**1750**	1108	10000	-25710
Item b	2010		**1992**	**18**	0	2000	-18
Item c	3000	**490**	**2500**	**10**	1000	2500	-10
Item d	115	**9**	**106**		939	106	169
Item e	6342		**6342**		242013	135690	134191

Note: Highlighted columns contain the values which are needed in order to prepare the procurement report

The mechanism given in the fig .9is based mainly on one condition: ($T_{aq} \leq 0$ is true and $T_{aq} \leq 0$ is false); thus values from the table 5 (values against each item i.e. a, b, c, d, e) were taken to test the condition given in the flowchart

6.3.1 Verification for Condition 1: if $T_{aq} \leq 0$ is true

The values of first three items i.e. a, b, c are satisfying the first condition because T_{aq} against all three items is < 0.

Table 6. Obtained results on testing the first condition if $T_{aq} \leq 0$ is true

Item a	Item b	Item c
$D_q = Q_r + T_{aq}$ D_q= 1750 + (-25710) D_q= -23960 $Q_o = Q_r - D_q$ Q_o= 1750 – (-23960) Q_o=25710 If $Q_o \geq Q_r$is true then $Q_o = Q_r$ **Q_o= 1750**	$D_q = Q_r + T_{aq}$ D_q= 1992 $Q_o = Q_r - D_q$ **Q_o=18** If $Q_o \geq Q_r$is false then, $R_{oq} = Q_r - Q_o$ R_{oq} = 2010 – 18 R_{oq} = 1992 If $P_{oq} \leq R_{oq}$ is false then, **R_{oq} = 1992**	$D_q = Q_r + T_{aq}$ D_q= 2990 $Q_o = Q_r - D_q$ **Q_o=10** If $Q_o \geq Q_r$is false then, $R_{oq} = Q_r - Q_o$ R_{oq} = 2990 If $P_{oq} \leq R_{oq}$ is true then, $R_{pq} = R_{oq} - P_{oq}$ R_{pq} = 2990 – 2500 **R_{pq} = 490** **$R_{oq} = P_{oq}$ = 2500**

When the result of above calculations were matched with the values in the table6; it was clear that the automated mechanism produce the accurate result as per the condition 1.

6.3.2 Verification for Condition 1: if $T_{aq} \leq 0$ is false

For the second condition the values of remaining items i.e. item d and item e are taken for testing: since the values of T_{aq}against both items is not < 0;

Table 7. Obtained results on testing the first condition if $T_{aq} \leq 0$ is false

Item d	Item e
If $P_{oq} \leq Q_r$is true then $R_{pq} = Q_r - P_{oq}$ R_{pq} = 115 – 106 **R_{pq} = 9** **$R_{oq} = P_{oq}$ = 106**	If $P_{oq} \leq Q_r$is false then **$R_{oq} = Q_r$ = 6342**

On matching the results of this condition with the real procurement report as given in table 5; it was quite clear that the automated report produced accurate and desired results.

6.4Time required to prepare the procurement report in the suggested way

Time was recorded (ten different times) on the preparation of each of the worksheet as presented in the table 8.

Table 8. Recorded time of preparation of various worksheets in the suggested way

Activity	Obs. 1	Obs. 2	Obs. 3	Obs. 4	Obs. 5	Obs. 6	Obs. 7	Obs. 8	Obs. 9	Obs. 10	Mean Time
T_{t2} (sec)	9.28 + n	8.95 + n	10.91 + k	9.38 + k	5.89 + k	10.56 + k	10.14 + k	10.1 + k	9.23 + k	11.52 + k	(95.96 + 10k)/10
I_t (sec)	11	12.09	11.04	11.66	12.98	12.57	11.32	12.19	14.35	12.12	12.132

T_o (sec)	2.74	6.2	1.31	7.43	4.01	5.68	6.17	3.98	4.67	5.54	4.773

T_{t2}= Total time incurred on the organization of transaction data as per suggested way

From table 3 row 2 mean time of T_{t2};

$$Tt2 = \frac{95.96 + 10k}{10}$$

T_{t2}=(10(9.596 + k))/10
T_{t2}=9.596 + k

From eq. ii

$T = T_{t2} + I_t + T_o$
T = 9.596 + k + 12.132 + 4.773
Since, k = 490.077 (from table 1)
T = 516.578 sec

Total time to make the procurement report in the suggested or automated way is 516.578 sec (8.61 min).

COMPARISON OF BOTH METHODS

In order to compare the time of manual and automated report, same report containing 120 items in the order calculation worksheet was made in both ways and the time. From the values of table 7, it can be seen that automated report takes 75% less time as compared to the old method of preparing procurement report.

Table 9. Comparison of time incurred in the procurement report formation as according to both methods

Worksheet	Time Taken By Manual Method (sec)	Time taken by Suggested Method (sec)	Difference (sec)	%
T_{t1} or T_{t2} (sec)	806.69	9.596+k = 499.673	307.017	38%
I_t (sec)	398.30	12.132	386.168	97%
T_o (sec)	15.867 + 66.654 + (6.577x120) = 871.761	4.773	866.988	99%
T (sec)	2076.751	516.578	1560.173	75%

Most importantly, three mistakes were found in the report prepared in the old way and the report which was prepared in the automated way was error free.

OPTIMIZATION OF THE PROCESS TO MAKE PURCHASE ORDER

When planning executive send the procurement report in the purchase department then purchase department is supposed to make the purchase order against the procurement report and get it signed by authority and forward to the vender. The time between receiving the procurement report and the making the purchase can be few days because the employee has to do a lot of work other than making the purchase orders. After the automation of

procurement report, purchase order was also automated. In the automation the purchase order same techniques were used i.e. inserting columns, put headers on the columns, pasting values and calculation of sum of on order total amount.

Item Number	Total Req. quantity	Reserve Physically	Reserved Order	Reserve Physically Reserved	Physical Available Unit Rate	Physical Total Amount	On Order	On Order Unit Rate	On Order T Amount
CowPolisher1.4-1.6 mmBlack	964		522	522	50	26080	442	60	26544
CowPolisher1.4-1.6 mmTan	1,175		1175	1175	50	58733		60	0
Chemical WWax Cream P/29DefaultBlack	3						3	60	169
Chemical WWax Cream P/29DefaultNatural	3						3	60	204
ChemicalHot Melt Cmnt For ScksDefaultWhite	2	2		2	50	99		60	0

Fig. 11. Sample of purchase order being made at the case company

Manually it used to take around 15-20 minutes and after its automation, it took only 2 to 3 seconds. This optimization somehow decreased the lead time and the time of employees incurred on the manual work.

DISCUSSION

In the routine work, if one is doing his work by performing same sequence of commands in excel, then he/she can save his time and effort by automating that work by the use of VBAKimmel et al. (2005)and Kofler (2000). Routine operations in excel can be the number of calculation made in excel, inserting/deleting row or column, formatting the working area, copying values from one worksheet to another and etc. These all operations were automated in the reports have been discussed in this paper. Any computer program without decision capability would be considered as dull Blayney and Sun(2019). In the field of programming, decision making is one of most important section because the course of action is specified on the occurrence of various events. In the present research, order calculations were programmed with nested if statements (see fig. 10) so that the decision of putting the right value at the right place could be made automatically. When non-empty rows increase in the worksheet, it gets slower; that's why looping is used for maintaining the operation. Loops are used to repeatedly execute a lock of code until the specific value or any condition is met: otherwise, the same code would be written repeatedly as much as needed Walkenbach (2015). There are different types of loops for loop, do loop, do while loop, do while loop Walkenbach (2015). When the code is executed after its completion, screen of excel does fair amount of flickering: that flickering is due to excel redraw the screen when it executes each section of the code, this takes the memory resources: therefore, in order to save that memory for speeding up the execution of operation, property of application.screenupdatingis disabled Alexander(2015). On the same time, this property is enabled when the macro is fully executed so that excel can redraw the screen same as before the execution of the codeAlexander(2015).The disadvantage of VBA procedures and user-defined functions is that model may be less transparent to unfamiliar users of VBA Rees (2018). In case VBA error in the spreadsheet, unfamiliar user will unable to fix that error.

CONCLUSION AND SUGGESTIONS

The comparison of time study of old and automated methods (procurement report) indicated that automated method took 75% less time in completion of the reports than the manual one. Purchase order was also automated by which 15 to 20 minutes of an employee were saved. This paper contributes in providing a framework for automation of daily excel based

reporting in industrial sector especially in those areas where humans are supposed to make decision and make the reports. One of the major limitations of this automation is that in case of any error, the common (unfamiliar to VBA) user will be unable to fix that unless he/she is trained enough. An Excel file can get corrupted easily and the user will be at the same as before (doing manual work). Researchers suggest the case company to develop the mechanism of producing the procurement report and purchase order into Microsoft Dynamics AX. Since the data for procurement report and purchase order is obtained from Microsoft Dynamics AX, it will be very convenient for the user to take out the report instantly. The VBA code which has been used for the automation of procurement report can be taken as the reference for the development such mechanism in Microsoft Dynamics AX.

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