AUTOMATED CYCLE TIME AND PROCESS BOTTLENECK ANALYSIS THROUGH INTEGRATION OF AI INTO EXCEL'S MACRO PROGRAMMING

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ABSTRACT

In today's fast-paced and highly competitive business industry, organizations are constantly looking for ways to optimize their processes to reduce cycle time. To do this, accurate and efficient analysis of data from several variables is needed. One way to achieve it is by leveraging an Artificial Intelligence (AI) tool to analyze process cycle time by integrating it into an Excel spreadsheet.

Microsoft Excel, a widely used spreadsheet software, has an extensive data analysis capability and is readily available to most businesses. By integrating AI algorithms into Excel, organizations can make a powerful program that could streamline the process of analysis and gain valuable insights from gathered data.

This paper shows an example of how an Excel spreadsheet turned into a program that can provide automatic analysis of cycle time data to identify the process bottleneck, and its successful implementation.

1.0 INTRODUCTION

In manufacturing company, cycle time and bottleneck analysis are essential tools for optimizing production processes. Understanding these concepts and applying them effectively can significantly improve efficiency, productivity, and overall business performance.

Engineers, Planners, Supervisors and Data Analysts had to meticulously track and record production data, such as start and end times of individual tasks, machine utilization, and equipment downtime. This manual process was prone to errors and inconsistencies, and it was challenging to identify bottlenecks and optimize production efficiency effectively. Moreover, the manual analysis of large volumes of data was a tedious undertaking, making it difficult to gain actionable insights into process performance. This time-consuming and error-prone approach hindered the timely identification of production inefficiencies and limited the ability to make informed decisions to improve production flow and overall manufacturing performance.

However, with the introduction of AI through Visual Basic for Applications (VBA) Macro, the process cycle time and bottleneck analysis could be done automatically. By using AI-powered tools, businesses can quickly and easily identify the steps in a process that are taking the longest and the bottlenecks that are preventing the process from running smoothly. AI has shown its potential is in the calculation and analysis of cycle time and bottleneck processes through VBA Macro

VBA is a programming language developed by Microsoft that enables the automation of repetitive tasks in Microsoft Excel. It allows users to create macros, which are a series of commands and functions that automate a specific task. With the power of AI, VBA Macro can now be used to calculate and analyze cycle time and bottleneck processes in a more efficient and accurate manner.

<u>1.1 Automated Process Cycle Time & Bottleneck Analysis</u> <u>Overview</u>



Figure 1: Sample Cycle Time Dashboard.

The proposed system leverages Microsoft Excel's VBA macro functionality to automate the calculation of process analysis metrics. The system consists of a user interface and a series of VBA program that perform the calculations.

The user interface allows the user to enter process data, such as total available time, process run time, no. of manpower for each process and process steps. The system calculates the following metrics:

1.1.1 Process Takt Time

It is the rate at which products must be produced to meet customer demand. It plays an important role in optimizing production processes, minimizing waste, and meeting customer demand. Process Takt Time is calculated by dividing the available production time by the customer demand rate

 $Takt Time = \frac{Available \ production \ time}{Customer \ demand \ (qty)}$

<u>1.1.2 Process Cycle Time</u>

Cycle time is the time it takes to complete one unit of work. It is an important metric in manufacturing and other industries because it can help to identify bottlenecks and improve efficiency.

$$Cycle Time = \frac{Total \ Process \ Run \ Time}{No. of \ Output}$$

1.1.3 Approximate Hourly Output

The number of products that can be produced in one hour.

1.1.4 Bottleneck Analysis

Identification of the process step with the longest cycle time, which determines the overall process capacity.

<u>1.2</u> Importance of automating the analysis and calculation of process takt time, cycle time and bottleneck process

With the introduction of this system, even non-technical people may obtain important insights into their operations by simplifying the complex calculations of takt time and cycle time. In order to assess a process's efficiency, two key indicators are takt time (the average amount of time needed to manufacture a unit of product in order to fulfill consumer demand) and cycle time (the amount of time needed to finish a single unit). Businesses may pinpoint bottlenecks and opportunities for improvement quickly by automating these computations, which enables them to allocate resources wisely. Managers and/or Supervisors are better able to manage time and personnel by using this concise analysis, which guarantees that they have the capability to satisfy client demands.

<u>1.3 Benefits of Using AI for Process Cycle Time Analysis</u> in Excel

- 1. Faster and More Accurate Analysis: AI has the ability to process large datasets quickly, making it ideal for process cycle time analysis. It can handle complex calculations and identify patterns and trends that may not be easily recognizable by humans. This can save the user a considerable amount of time and effort in analyzing their process cycle times.
- Identification of Bottlenecks: AI algorithms can effectively pinpoint areas in a process that are causing delays or bottlenecks. By analyzing data and identifying patterns. This information can then be used to make datadriven decisions and implement process improvements.
- 3. Predictive Analysis: AI can also help the user to predict future cycle times based on historical data. This can provide valuable insights for businesses to plan their processes and resources more effectively.
- 4. Increased Productivity: With AI handling the process cycle time analysis, employees can focus on other valueadded tasks. This can lead to increased productivity and efficiency within the organization.

2. 0 REVIEW OF RELATED WORK

Not Applicable

3.0 METHODOLOGY

To create an effective AI data analysis for cycle time and bottleneck processes using VBA macros encompasses several steps such as 1) Conceptualization 2) Data Gathering 3) Data Cleaning & Preparation 4) Dashboard Generation 5) Macro development

3.1 Conceptualization

The automated cycle time and process bottleneck analysis system is a visual presentation of the essential metrics such as process flow, process run time, process cycle time and process takt time. This system provides a concise overview of a critical data, allowing the decision makers to realize which process needs an improvement or whether an organization can meet the demand of the customer base in the given timeframe. The steps below can help create or conceptualize an effective automated cycle time and process bottleneck analysis system.

3.1.1 Define your goal

Start by identifying the strategic objectives or goals you want to measure. This helps to visualize what metrics or data a system should contain.

3.1.2 System or Dashboard Design

There are many tools that can be used to create a dashboard such as Excel, Google Sheets, or specialized dashboard software, but since Excel is readily available in all organizations, it is the most recommended to use to create an effective dashboard.

3.1.3 Choosing of Graph

When choosing a graph, it is necessary to use a graph that can be easily understood or interpreted by the user or to easily provide an analysis or recommendation based on the result such as a bar chart. This is one of the charts most often used to represent the cycle time data.



Figure 2: Sample Graph of Cycle Time Data.

3.2 Data Gathering

In this step, it is important to get the essential data such as process flow, total run time, output, process takt time, and number of manpower to conduct an effective cycle time and bottleneck analysis and to provide accurate result and valuable insights for process optimization.

3.2.1 Process Flow

The process flow is a visual representation of the sequence of steps involved in a particular process. By mapping out the process flow, organizations can identify bottlenecks, redundancies, and inefficiencies, which can then be addressed to streamline operations.



Figure 3: Sample process flow of cable Assembly.

3.2.2 Total Run Time

Total run time refers to the time it takes to complete a process from start to finish. By measuring and analyzing the total run time, the analyst can identify areas where time can be saved, leading to increased productivity and reduced costs.

3.2.3 Number of Output

Output refers to the number of finished products produced by a process within a given time frame. By tracking the product output, the organization can monitor the production capacity and can identify if there is a needed improvement.

3.2.4 Manpower

Manpower refers to the number of employees required to complete a process. By analyzing the manpower required for each step of the process, organizations can identify areas where additional resources may be needed or where staff can be reallocated to more productive tasks. Table 1. Sample data for Cycle Time and Bottleneck Analysis

Process	Total Run Time	No of Output	No. of Manpower	Takt Time	Required Output	Process Cycle Time
Labelling	8	2	1	14.4	50	4.00
Crimping - 1	3	2	1	14.4	50	1.50
Final Assembly	16	2	1	14.4	50	8.00
Wire/Tube Cutting	19	2	1	14.4	50	9.50
Crimping - 2	9	2	1	14.4	50	4.50

3.3 Data Cleaning & Preparation

By ensuring data accuracy, consistency, and integrity, data cleaning enhances the reliability and effectiveness of the analysis. It will also help to reduce the computational load on the macro, allowing it to run faster and more efficiently. It may involve removing duplicate rows, formatting dates and numbers correctly, and creating calculated fields.

3.4 Dashboard Generation

Dashboard generation is an essential component for this project. It provides real-time visibility, data consolidation, trend analysis, customization, and collaboration capabilities that allow the users to identify, resolve, and prevent bottlenecks effectively. By embracing the importance of dashboard creation, businesses unit can unlock significant improved efficiency. benefits, including enhanced competitiveness, data-driven decision-making, and continuous improvement. In the generated dashboard, it can show important details such as:

- 1) Required takt time to meet customer demand
- 2) Average cycle time of a unit
- 3) Approximate hourly output and
- 4) List of bottleneck process

3.4.1 Generation of Excel Dashboard

3.4.1.1 Data Gathering

The first step in creating a digital dashboard is gathering of data from the processes where the unit will pass through, its process run time and the quantity of manpower is assigned to each process. Once the data is available, automatic calculation of the process takt time & cycle time could be done by setting excel

3.4.1.2 Creating a Pivot Table

Once the data was cleaned and prepared, a PivotTable can be created to summarize and visualize the data. A PivotTable is a powerful tool that allow to quickly and easily create interactive tables and charts. To create a Pivot table, below processes have to be followed.

3.4.1.2.1 Select the Data Range

First, highlight the cells containing the data you want to analyze with the PivotTable.

3.4.1.2.2 Insert a PivotTable

Go to the Insert tab in the Excel ribbon then click on PivotTable. In the dialog box that appears, verify the cell range for your data.

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Figure 4: Figure shows how to insert a Pivot Table.

3.4.1.2.3 Choose Fields

In the PivotTable Fields pane, drag and drop the relevant fields from your data into the Rows, Columns, and Values areas. The Rows and Columns represent the categories of data, while the Values area shows calculations (e.g., sum, count, average) based on your chosen fields.

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Figure 5: Figure shows how to choose in a Pivot Table Fields.

3.4.1.2.4 Customize Your PivotTable

Right-click on the PivotTable cells to access options for formatting, sorting, and filtering. The title of row labels can change, apply custom formatting, and more.

3.4.1.2.5 Add Charts and Visualizations

Once a PivotTable is created, charts and visualizations could be added to help visualize the data. Excel offers a different variety of chart types to choose from, including bar charts, line charts, and pie charts.

To add a chart on PivotTable, simply click on the chart to add, and then drag and drop it onto the PivotTable. The chart will be automatically updated once changes is applied to the PivotTable.



Figure 6: Figure shows how to insert a Pivot Chart.

3.4.1.2.6 Format Your Dashboard

Once all of the charts and visualizations were added, formatting the dashboard is necessary to make it clear and easy to read. This may involve changing the font, color, and size of the text, adding borders and shading, and creating custom number formats.



Figure 7: Sample Dashboard for Cycle Time & Bottleneck Process Analysis.

3.5 Macro Development

VBA macros can be used to automate the process of cycle time & bottleneck analysis by importing data from various sources, performing calculations, and generating reports. The macro was programmed to:

- a) Import process takt time, cycle time, and manpower data from spreadsheets or databases.
- b) Calculate the difference between process takt time and cycle time to identify bottlenecks.
- c) Identify steps with insufficient manpower based on manpower data and process takt time.
- d) Generate reports summarizing the bottleneck analysis, including a list of bottlenecks and recommendations for improvement



Figure 8: Sample Macro Programming for Automated Cycle time and Bottleneck Analysis.

3.6 Integration of Chat GPT in Excel

ChatGPT is a large language model known for its conversational and text generation capabilities, into Microsoft Excel presents a fascinating prospect with the potential to revolutionize the way we interact with and analyze data. ChatGPT's ability is to understand and interpret natural language can be leveraged to analyze data in Excel more intuitively. Users can ask questions about the data in plain English, example is 'What are the bottleneck process(es) based on the given cycle time and takt time data? And this system will provide a summary and reports based on excel data. ChatGPT also has many capabilities such as data analysis, data cleaning, formula generation, language translation and etc.

3.6.1 Integration of ChatGPT in Excel

Step 1: Open Excel Workbook

Step 2: On the home tab click the Add-ins

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Figure 9: Process on how to add ChatGPT in Excel.

Step 3: Choose the ChatGPT for Excel and A
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Figure 10: Figure on how to Install ChatGPT in Excel.

Step 4: Once the ChatGPT is installed, the formula below can be used to provide accurate results based on the needed data.

Excel Formula:

=GPT("is there a bottleneck process(es) based on the cycle time result", *click the data or cell you want to analyze*). Refer to Figure 12 to see the sample ChatGPT analysis.



Figure 11: Sample Dashboard Analysis Report.



Figure 12: ChatGPT Sample Analysis.

3.7 System Test Run

The System Test Run process ensures the effectiveness of the application. By performing tests to the data visualization solution, you can catch bugs and mistakes before using and implementation.

3.7.1 Data Accuracy Checking

In conducting data accuracy checking, it is necessary to ensure that all data is correctly retrieved at every level and properly displayed, all conditional formatting rules for data sets where applied, verify the accuracy of all calculations and code and simulate the addition of large data sets to be sure that your dashboard and visualizations can handle high amounts of values.

3.7.2 Graph or Chart Testing

A dashboard cannot be useful without graphs. You may give more context and information about previous patterns to your audience by using these graphics.

Since graphs are so crucial to dashboards, it is necessary to thoroughly test them to guarantee that information is displayed accurately. Decisions made with incorrect information might result from data interpretation errors and a lack of a design-focused testing procedure.

Data accuracy checking requires confirming that all data is appropriately retrieved at every level and displayed, that all conditional formatting rules for data sets are applied, that all calculations and code are accurate, and that you can simulate adding large data sets to make sure your dashboard and visualizations can handle large values.

4.0 RESULTS AND DISCUSSION

Implementing an AI-based cycle time and bottleneck analysis solution using a VBA macro has multiple advantages. VBA macros are highly customizable, enabling tailored solutions to meet specific analysis requirements. It seamlessly integrates with existing Excel spreadsheets, where data is commonly stored and analyzed.

The implemented solution successfully achieves its objectives:

1. Process Bottleneck Identification: The analysis accurately pinpoints specific bottlenecks within the production or supply chain, helping to identify areas that are most impactful on overall efficiency. This enables targeted bottleneck relief strategies.

- 2. Optimized Production Planning: The analysis results empower a deeper understanding of cycle times and bottlenecks, allowing planners to make informed decisions. It enables the optimization of production schedules, manpower, and capacity planning.
- 3. Data-Driven Decision Making: The solution leverages collected data to present actionable insights. Decision-makers can rely on the analysis results to justify changes and implement targeted improvement initiatives.

5.0 CONCLUSION

The implementation of an AI cycle time and bottleneck analysis using VBA macro proves to be highly effective in optimizing processes and enhancing operational efficiency. The macro leverages AI's analytical capabilities, automate tasks, and provide valuable insights, empowering users to make informed decisions and unlock significant process improvements. As AI continues to evolve, its integration with process analysis tools holds immense promise for ongoing innovation and productivity enhancements.

6.0 RECOMMENDATIONS

This automated system is highly recommended to be used by production managers, supervisors, planners, engineers and analysts to speed up and be accurate in the analysis of process cycle time data.

The use of VBA macros could also be used for other data driven activities such as KPI and Cost analysis.

7.0 ACKNOWLEDGMENT

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8.0 REFERENCES

1. <u>https://www.bing.com/videos/riverview/relatedvideo?&q=das</u> <u>hboard&&mid=603613E198958671F45D603613E198958671F45</u> <u>D&&FORM=VRDGAR</u>

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9.1 About the Author



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10.0 APPENDIX

Not applicable.