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Network Analysis for Optimizing Customer Support Services

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Abstract
The problem of poor project execution, non-completion and behind schedule, and inability to meet customers' needs on time, are rampant in our society today but this will be a thing of the past if network analysis tools are employed and incorporated into the project plan or services at the onset of work activities.. This will identify the minimum time a project can take before completion. It will eliminate any sort of redundancy or dangling of activities so that the developer can meet the needs of other clients who need its services on other projects. In planning and scheduling the activities of large-sized projects, the two network techniques — PERT and CPM — are used conveniently to estimate and evaluate the project completion time and control the resources to see that the project is completed within the stipulated time and at the minimum possible cost. Many managers, who use the PERT and CPM techniques, have claimed that these techniques drastically reduce the project completion time. Although it may not be the only antidote when incorporated into the project plan, it will make a huge difference. This research will focus on how PERT and CPM are used to schedule projects. Descriptive methodology, information was gathered through interviewing various customer care services organizations, reading relevant literature, and direct observation. The analysis made use of both the Critical Path Method (CPM) and the Project Evaluation and Review Technique (PERT). "Crashing" is a technique used to speed up project completion that entails bringing in extra resources for tasks that are essential to finishing the project. My focus is on "NETWORK ANALYSIS FOR CUSTOMER SUPPORT SERVICE OPTIMIZATION. According to the results of this study, it is possible to draw the conclusion that using both CPM and PERT methods for managing and scheduling clients' complaints, needs and orders of products has a substantial impact on the project's completion time. Since the lines separating these two management tools are becoming increasingly unseen as time goes on and the methodologies gradually cover, it can be quite helpful to use both techniques on a project when appropriate.

Keywords: Network Analysis, Customer Support, Programme Evaluation and Review Technique, Critical Path Method (CPM)

Introduction

The need for customer support services evolution has become increasingly important in today's business environment,. When resolving a wide range of issues, customer support professionals encounter a variety of dynamics and challenges. First-come, first-served policies are common in traditional customer service systems, which may result in inefficiencies as agents spend time handling unimportant concerns before resolving urgent ones. Innovative methods like network analysis—more especially, PERT (Programme Evaluation and Review Technique) and CPM (Critical Path Method)—must be investigated in order to maximise customer support services. Through the application of these methodologies, customer support teams are able to find the most effective sequence for resolving customer concerns by estimating the time required for various tasks and identifying the critical path. The utilization of network analysis methodologies in customer support optimization is congruent with the demand for inventive methodologies to augment service provision. Hesamamiri and Bourouni (2016) introduce a modelling technique for optimizing customer assistance, highlighting the significance of creating methodical strategies to improve support offerings. Furthermore, Chochliouros et al. (2020) highlight the possibility for highly customizable service and tenant requirements as well as the ongoing nature of research in this area as they examine the benefits and problems in dynamic network slicing. The aforementioned sources offer significant perspectives on the dynamic field of customer service optimization and the possible advantages of utilizing sophisticated methodologies.

Additionally, the study by Rodríguez et al. (2017) highlights the potential of ongoing software-intensive product and service deployment, pointing to a plethora of prospects for software-intensive businesses and researchers.

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This demonstrates how cutting-edge software deployment techniques may be included in customer support optimization, meeting the demand for cutting-edge technical solutions.

The organizational design of customer support services is just as important as technology developments. The structure of customer support services is covered by Sharma (2020), who emphasizes the superiority of teams over hierarchies as a means of achieving considerable gains in operational efficiency and effectiveness. Jia (2017) delves into the connection between brand loyalty and customer services, suggesting that customer support services can strengthen brand loyalty initiatives and, in turn, the marketing strategy as a whole. The study by Alshaer & Haas (2022) on dynamic LiFi network slicing, which highlights the creation of a resource scheduler to optimize network slicing based on network resource and service utility, adds more evidence to the applicability of network analysis for customer support optimization. This shows how sophisticated network optimization methods can improve customer assistance services' overall effectiveness. In general, the incorporation of network analysis methodologies like PERT and CPM into customer support optimization offers a noteworthy prospect to augment the efficacy, efficiency, and general calibre of customer care offerings. Businesses may rethink the crucial role of customer support services, fortify client connections, and achieve a competitive edge in the contemporary business environment by utilizing sophisticated modelling techniques, technology breakthroughs, and organizational tactics.

Materials and Methods

In order to optimize customer support services, the study design is carefully constructed to explore the field of network analysis. Programme Evaluation and Review Technique (PERT) and Critical Path Method (CPM) are two important approaches that are carefully explored with this design, which takes an analytical approach. The main goal of the research design is to find the crucial path and rigorously assess time estimates in the complex world of customer support activities. The goal is to give a systematic framework for comprehending and enhancing the temporal dynamics in customer support operations by utilizing PERT and CPM. In order to do this, the design makes use of a systematic evaluation process, acknowledging the dynamics and complexity present in customer support scenarios. It entails a methodical analysis of job lengths and the subsequent dependencies between different types of support activities. In-depth research is ensured by the design, which captures the subtleties of time management in the context of customer support.

The goal of the research design is to gain a thorough understanding of how methods for network analysis help to optimize customer support services. The analysis takes into account the relationship between time estimates and essential path identification, acknowledging their crucial functions in restructuring the sequence and effectiveness of resolving customer issues. PERT and CPM are strategically included in the design. While CPM highlights the critical path and allows jobs to be rearranged for maximum efficiency, PERT offers a strong foundation for evaluating the time needs for various customer service tasks. A comprehensive investigation of temporal factors in customer support optimization is ensured by this dual-methodology approach. Findings that can result in noticeable enhancements to customer support services are the ultimate goal of the research design. The study aims to provide useful solutions for improving the overall quality and temporal efficiency of customer assistance by utilizing a rigorous analytical approach with PERT and CPM. The data-gathering procedure is to obtain the necessary data for comprehending and improving customer support services. In this stage, relevant information about customer support tasks—such as their descriptions, predecessors, and durations—is systematically gathered. Gathering thorough information about different customer support actions is the goal of the data-gathering process. Information on the types and details of jobs performed by customer service representatives, the connections between tasks (predecessors), and the amount of time needed for each activity are all part of this process. In order to guarantee an accurate and perceptive examination, the research also makes use of historical data obtained from a Customer Support Ticket Dataset from Dawnily Technology Company Limited, a Nigerian Technology firm that specializes in software development and other technology-related activities. Consideration is given to a variety of customer support scenarios to ensure that there is improvement in the data's representativeness and dependability. This method makes sure that the network activities diagram that is created captures the diversity that exists in customer support tasks and allows for varying levels of complexity and time constraints.

Ethical issues are critical at every stage of the data collection process. Sensitive information is protected by anonymizing data and carefully maintaining the privacy and confidentiality of customer support conversations. To guarantee the accuracy and reliability of the data gathered, the study adheres to ethical guidelines.

- **Network Analysis Application**

We will use PERT to estimate how long certain customer care jobs will take, giving us insights into how long they will take. The order in which customer support issues are resolved will be optimized using the critical path,

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which will determine the key path. Setting up an effective sequence for resolving customer problems will depend on how these strategies are implemented.

PERT is used to estimate how long an activity would take. It is used for proper coordination and scheduling of tasks throughout a project. A flowchart diagram is used to show the Project Evaluation and Review Technique. Four definitions of time are used to estimate project time requirements.

- Optimistic time (**OT**) is the least amount of time it can take to complete a task.
- Pessimistic time(**PT**) is the maximum amount of time it should take to complete a task.
- Most likely time (**MT**) –This is the best or most reasonable estimate of how long it should take to complete a task assuming there are no problems in the project.
- Expected time (**ET**) – The best estimate of how much time will be required to complete a task and it is given by the PERT assuming there are no problems in the project.

$$\text{PERT Estimate} = \frac{\text{Optimistic} + 4 \times \text{Most Likely} + \text{Pessimistic}}{6}$$

During this research, a trained neural network will handle this prediction for our dataset.

CPM on the other hand has the following parameters attached to it:

- Earliest Start Time (ES): This is calculated by
  ES= max (EF of preceding tasks) + 1
- Latest Start Time (LS): This is calculated by
  LS = LF − Task Duration+1
- Earliest Finish Time (EF): This is calculated by
  EF = ES + Task Duration − 1
- Latest Finish Time (LF): This is calculated by
  LF = min (LS of succeeding tasks) − 1
- Float: This is calculated by
  Float (TF) = LS − ES or Float (TF) = LF − EF

An example is given below to illustrate their usage:
Below is a network diagram for likely activities, we will draw the network diagram and identify the critical path

ACTIVITY	OT	PT	MT	ET
1-2	6	12	9	9
1-3	3	11	4	5
2-4	2	14	5	6
3-4	4	8	6	6
3-5	1	5	1.5	2
2-6	5	7	6	6
4-6	7	15	8	9
5-6	1	3	2	2

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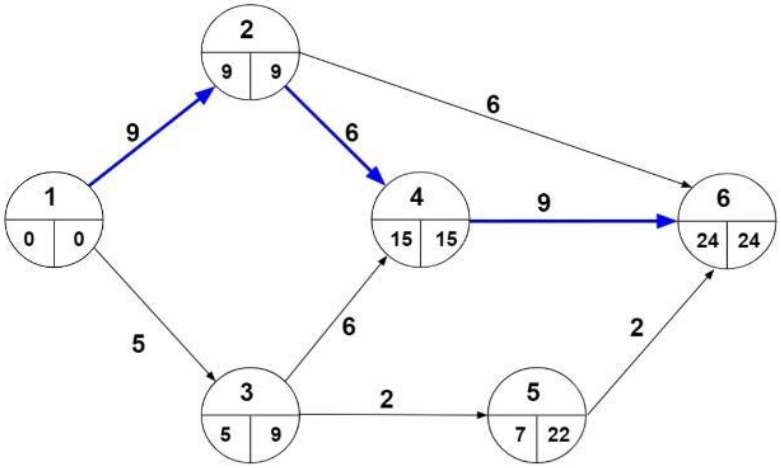
The network diagram and critical path are shown below:

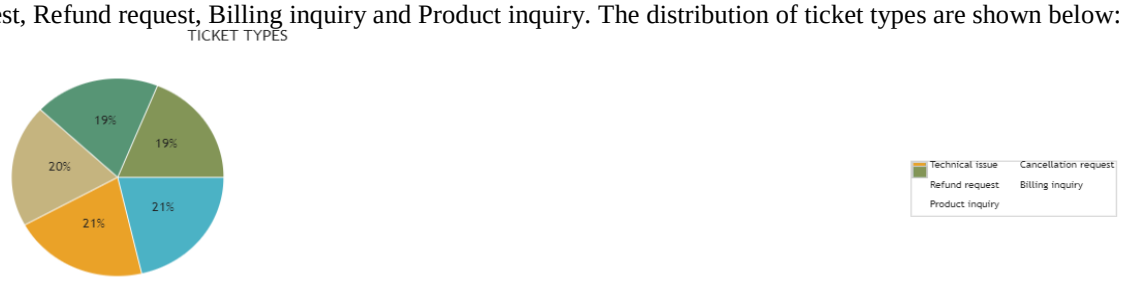


- **Sampling Technique**

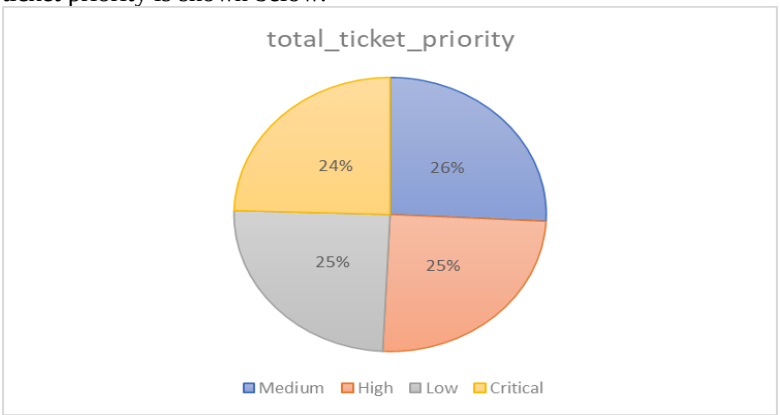
The dataset contains about 8,430 records of customer support ticket requests which represent activities likely to be carried out by customer support. Out of the 8430 records present in the population, a sample of 2819 records had an open ticket status. A purposive sampling technique will be utilized to capture relevant customer support cases. 10 records will be chosen to carry out the research.

- **Data Analysis**

The sample data containing 2819 records contains five ticket types, which are Technical issue, Cancellation request, Refund request, Billing inquiry and Product inquiry. The distribution of ticket types are shown below:



The ticket priority used by the support team includes Medium, High, Low and Critical. The distribution of the ticket priority is shown below:



3 sets of customer genders were captured in the records which are male, female and those who choose not to disclose their gender to the customer support team. The distribution of gender in the records is shown below:

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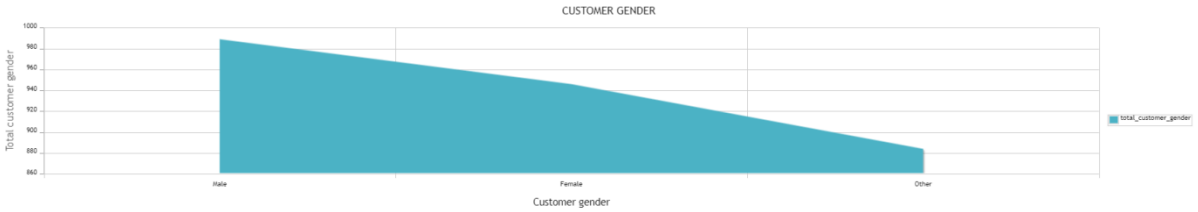

The sample data chosen for the study is shown below:

S/N	Customer gender	Product purchased	Ticket type	Ticket priority	Ticket channel	Ticket status
1	Male	Microsoft Office	Cancellation request	Low	Social media	Open
2	Other	Microsoft Surface	Product Inquiry	Critical	Social media	Open
3	Male	Philips Hue Lights	Refund request	Critical	Social media	Open
4	Male	LG Washing Machine	Product Inquiry	High	Social media	Open
5	Female	Xbox	Cancellation request	Medium	Social media	Open
6	Male	Amazon Kindle	Product inquiry	Critical	Email	Open
7	Other	Fitbit Charge	Cancellation request	High	Phone	Open
8	Other	Adobe Photoshop	Billing Inquiry	Low	Email	Open
9	Female	Amazon Kindle	Product inquiry	Medium	Chat	Open
10	Female	iPhone	Technical issue	Low	Email	Open

Results

- **Task Overview**

We will take the serial number of the selected tasks as the task id. We will now show the analysis for the work:

PERT Analysis

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ACTIVITY	OT	MT	PT	AT	S.D	VAR
1	2	4	7	4.17	.83	.69
2	1	3	5	3	.67	.44
3	3	6	9	6	1	1
4	2	4	6	4	.67	.44
5	2	5	8	5	1	1
6	1	4	7	4	1	1
7	2	4	7	4.17	.83	.69
8	3	5	8	5.17	.83	.69
9	1	3	6	3.17	.83	.69
10	4	6	9	6.17	.83	.69
Results of the Project						
The sum of critical actual variance						3.53
Square root of Total					1.88	

CPM Analysis

Activity	Activity time	Early Start	Early Finish	Late Start	Late Finish	Slack	Standard Deviation	Variance
Project	23.5						1.88	3.53
1	4.17	0	4.17	0	4.17	0	.83	.69
2	3	4.17	7.17	4.17	7.17	0	.67	.44
3	6	4.17	10.17	10.33	16.33	6.17	1	1
4	4	7.17	11.17	9.17	13.17	2	.67	.44
5	5	7.17	12.17	7.17	12.17	0	1	1
6	4	10.17	14.17	16.33	20.33	6.17	1	1
7	4.17	11.17	15.33	13.17	17.33	2	.83	.69
8	5.17	12.17	17.33	12.17	17.33	0	.83	.69
9	3.17	14.17	17.33	20.33	23.5	6.17	.83	.69
10	6.17	17.33	23.5	17.33	23.5	0	.83	.69

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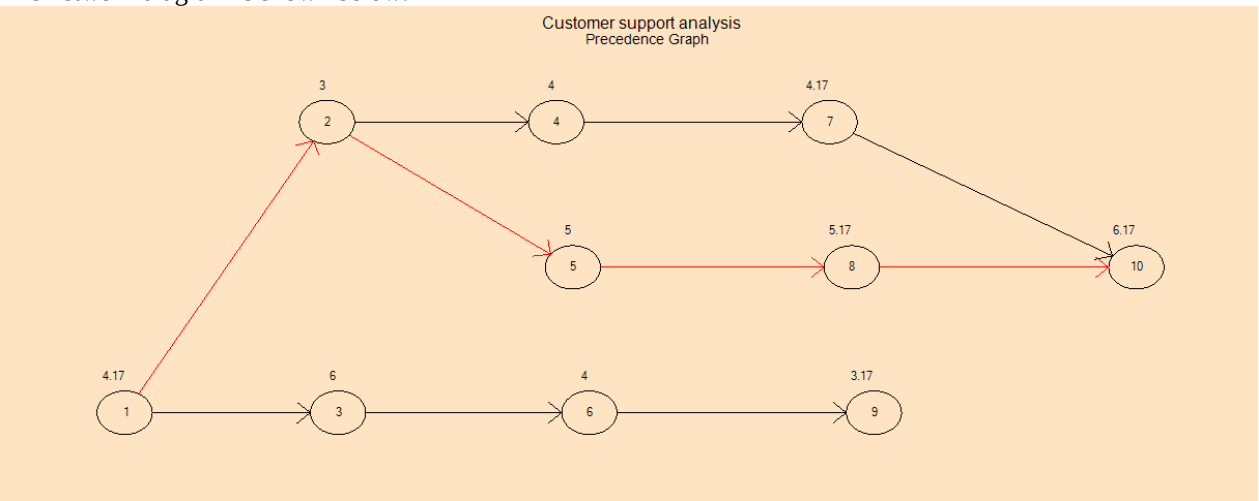
The network diagram is shown below:



Critical Path Findings

The critical path from the project is determined by identifying the sequence of tasks with zero slack. Based on the CPM analysis, the critical path for this project is: $1 \rightarrow 2 \rightarrow 5 \rightarrow 8 \rightarrow 10$.

Time Estimation Insights

The time estimates derived from PERT analysis provide a range of possible completion times for each task, incorporating uncertainties. The CPM analysis further refines these estimates, identifying the critical tasks that directly impact the project's overall duration.

Based on the data given and the PERT and CPM analyses performed, several time estimation insights can be drawn:

1. Average Time (Expected Time) Estimations:
   - The PERT analysis provided expected time (TE) estimates for each activity, which combines optimistic, most likely, and pessimistic time estimates to give a more accurate average duration.
   - For instance, Activity 1 has an expected time of 4.17, which takes into account variations in the optimistic, most likely, and pessimistic times.

2. Uncertainty and Variability:
   - The standard deviation and variance for each activity highlight the uncertainty and variability in task durations. Activities with higher standard deviations and variances indicate greater uncertainty and potential risk.
   - For example, Activities 1, 7, and 10 have relatively higher standard deviations, suggesting these activities have more variability and potential for delays.

3. Critical Path Analysis:
   - The critical path identified through the CPM analysis ($1 \rightarrow 2 \rightarrow 5 \rightarrow 8 \rightarrow 10$) indicates the sequence of tasks that directly impact the overall project duration. Any delay in these activities will directly delay the project completion time.
   - Understanding the critical path will make project managers to focus on the key activities to ensure the project is completed on time.

4. Slack Time Analysis:
   - Activities not on the critical path (such as Activity 3, 4, 6, 7, and 9) have slack time, meaning they can be delayed without affecting the overall project completion time.
   - For example, Activity 3 has a slack time of 6.17, providing flexibility in scheduling and resource allocation.

5. Project Duration:

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- The total project duration is estimated at 23.5 units of time, as calculated by the CPM analysis. This duration reflects the time required to complete all tasks in the project, assuming optimal scheduling and resource allocation.
- The variability in project duration can be assessed by the total variance (3.53) and its square root (1.88), providing an estimate of the potential range of project completion times.

6. Impact of Delays:
   - Activities with higher variances and standard deviations are more likely to experience delays. Managing these activities effectively can help mitigate risks and ensure smoother project execution.
   - For instance, closely monitoring and controlling Activities 1, 7, and 10 can help minimize overall project risk.

7. Efficiency Gains:
   - By identifying and focusing on critical path activities, project managers can optimize resource allocation and scheduling, potentially reducing project duration and costs.
   - The identification of non-critical activities with slack time allows for flexible scheduling, reducing the risk of resource bottlenecks.

- **Comparison with Traditional Approach**

Using PERT and CPM methodologies offers a systematic approach to scheduling and managing project timelines, as opposed to traditional methods which may rely more on expert judgment and experience. This data-driven approach provides more accurate time estimates and helps identify potential delays before they occur. The critical path also gives insights as to which tasks the customer support should address methodically.

- **Challenges**

Estimating optimistic, most likely, and pessimistic times for each task required input from multiple stakeholders. Constructing an accurate network diagram to reflect the dependencies among tasks was complex. Aligning the estimated schedules with available resources posed practical challenges.

Conclusion

This research underscores the value of applying PERT and CPM methodologies to the domain of customer support services within a software development agency. The study demonstrates that these techniques, traditionally used in other industries, can be effectively adapted to optimize task scheduling and improve overall service efficiency in customer support operations. Key findings from the analysis include the identification of critical tasks that directly impact project timelines, the quantification of task variability and risk, and the practical application of slack time for better resource management. The integration of advanced technologies, such as neural networks, with PERT and CPM further enhances the potential for precise time estimations and improved project outcomes. By adopting these methodologies, customer support managers can achieve more accurate scheduling, better resource utilization, and higher levels of customer satisfaction. The contributions of this research provide a foundation for further exploration and application of network analysis tools in the customer support domain, paving the way for more efficient and effective service delivery.

Recommendations

Based on the discussion of results and their implications, below are some recommendations that can be adopted to in optimizing customer support services using PERT (Program Evaluation and Review Technique) and CPM (Critical Path Method) methodologies.

1. This research extends their application to the customer support domain, providing a novel perspective on how these methodologies can be utilized to enhance the efficiency and effectiveness of customer support operations. Companies can venture in this area to maximize customer support and care
2. Companies embarking on new projects can incorporate PERT, thereby providing a structured approach to estimating task durations with greater accuracy, taking into account optimistic, most likely, and pessimistic scenarios. This can lead to more reliable project scheduling and planning in customer support environments.

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