Project Management Analyses in a Poultry Farm: Critical Path Analyses Approach

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Abstract: This research work explored the application of Critical Path Analysis (CPA) in the production cycle of broiler chickens, aimed at identifying bottlenecks and inefficiencies that could be mitigated to enhance productivity and profitability. Broiler chicken production, a critical component of the global agricultural sector, demands efficient management of various stages, including breeding, hatching, growing, and processing, to meet the increasing demand for poultry meat. The research utilized CPA, a time-tested project management tool traditionally applied in construction and manufacturing industries, to map out the critical and non-critical activities within the broiler production cycle. By identifying the longest path through these sequential activities, the study highlighted the minimum time required for a complete production cycle and pinpointed stages where delays could extend overall production time. This approach allowed for the precise identification of bottlenecks that impede productivity, such as the brooding phase and health management practices, which are critical for ensuring the growth and survival of broiler chickens.

Keyword: Critical Path Analysis, project management, Independent slack

I. Introduction

According to African Union (2022), Nigeria's agriculture represents 35% of the country's GDP. Agriculture was the main source of foreign currency for this country prior to its oil boom. As oil prices dropped, there was a growing call for diversification of Nigeria's economy. That has made agriculture more important, and in order to reduce the country's import bill as well as a possible major source of external currency, the Nigerian government is increasingly paying special attention to farm development.

According to NABC (2020), the poultry sector in Nigeria was well placed to take advantage of these and other measures, having the best organised subsector within the agricultural sector with a 25 % overall contribution to GDP. Farmers had been encouraged by the federal government to switch from subsistence into business farming. In this respect, the Commercial Agricultural Credit Scheme has actually been set up as a Financial Intervention Scheme. In addition, the poultry sector has seen massive technological advances in recent decades and remains a key contributor to Nigeria achieving food sufficiency and economic growth.

The broiler chicken industry plays a crucial role in meeting the growing global demand for poultry meat. Efficient production is essential to ensure a sustainable supply of high-quality broiler meat.

In this context, the application of Critical Path Analysis (CPA) is gaining prominence as a strategic management tool. CPA is a project management technique that identifies the critical activities and dependencies within a project, allowing for optimized resource allocation and scheduling. While CPA has been extensively used in industries like construction and manufacturing, its application in the broiler chicken production cycle is a relatively unexplored area.

Broilers are simply chicken raised for meat and it production is the process of rearing broiler birds for meat, a key measure of performance being the feed conversion ratio (FCR). According to Mgbakor et. al. (2013) broiler production of the poultry enterprise has great potentials for increasing protein supply in Nigeria, because of their fast growth rates and prolificacy, which can be adapted under a wide range of marginal climatic conditions and can generally be combined conveniently with other farm enterprises and/or occupation, with mutual benefits to the farmer. The importance of broiler is further noted by Ezeano et. al. (2020) to include: offer of high productiveness, fast growth rate, short generation interval and unparalleled competence in nutrient transformation to high quality animal protein. In spite of these laudable attributes of the industry, it is still faced with the following according to Ike et al (2011): poor reproductive performance, poor growth rates, diseases, mortality, predation and low level of literacy among farmers, as well as poor market for the product in small holder broiler production. According to Ettah (2021), the Nigerian‘s broiler resources consist of about 104,247,960 birds representing about 48.72 percent of the total livestock production in the country, which indicates the place of broiler sub sector in the livestock industry.

Broiler production as a subsector of the agriculture sector, has become popular industry for the small holders that have great contribution to the economy of the country. The subsector was particularly important in improving the employment opportunity and annual food production in Nigeria (Aniekan, et al 2020). A study by Ameh et al. (2016) showed that about 14% of the

Nigerian population are engaged in broiler production, mostly on subsistence and small or medium sized farms. A good number of the stock of the broiler resource in Nigeria as in most part of Africa is under commercial production for meat, raised under the intensive and semi-intensive husbandry (Emokaro et. al. 2016).

The challenges of food insecurity and hunger particularly in a developing country like Nigeria have remained problems that demand serious attention. Ojo (2003) revealed that in spite of the numerous human and natural resources in Nigeria, the country still remains among the least consumers of animal protein in Africa. To increase protein intake in Nigeria, it therefore a call for urgent need to increase broiler production at both household and commercial levels.

The effect of inadequate protein intake is felt more by a large proportion of the population especially in rural areas (Chukwuji, et al 2006). Due to increase in population and high demand for animal protein, different sources of animal production has been developed and one of which is poultry (broiler production) which is presently exploited to meet the protein needs of the people.

In spite of this shift, Omolayo (2018) maintained that the output level still remains low compared to the input committed and the broiler products are grossly inadequate because the supply is lower than the demand. Hence, there is need for increase in the production of broiler. The broiler industry falls short of its aim of self-sufficiency in animal protein consumption in the country that is put at 5gm/caput per day which is a far cry from the recommended level of 35gm/caput per day (Food and Agriculture Organization (FAO, 2019). Appreciable increase in broiler production is yet to be attained in Nigeria due largely to the high cost of production. For example, broiler farmers are faced with the problem of extremely high cost of day-old chicks, drugs and other poultry inputs (Ezeano et. al. 2020). Broiler farmers, as all other farmers use profitability ratios to measure and evaluate their farm’s ability to generate income relative to their revenue and operating cost during a particular period of time. This is because it is a well-known fact that the overall essence of venturing in broiler business is to make profit.

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Broiler production in Rivers State is still very discouraging, as cost of feed alone constitutes about 70-80 percent of the total cost of production (Ironkwe and Amaefule, 2008). This high cost of feed and improper system of management could be among the causes of many failures in poultry industries. Nigerians, therefore have continued to experience increasing animal protein deficiency because of low productive capacity of the poultry industries. This is a major contributory factor to the incidence of high rate of infant mortality. Several questions have been raised with respect to the state of poultry industry in Nigeria, especially in Rivers State.

Analyzing the income remaining from the capital after subtracting all the overhead cost, will help check the business performance. And as a result, this research seeks to study the critical analysis in pourtry farming, using a case study of Kems Poultry Farm.

The broiler chicken production cycle is a complex process with multiple interdependent activities. Factors such as genetics, nutrition, housing, and disease control must be carefully managed to ensure optimal growth and profitability. The lack of a systematic approach in managing these activities can lead to inefficiencies, increased production costs, and reduced competitiveness.

Several work have been done on critical path Analyses.

Orumie (2020) studied Implementation of Project Evaluation and Review Technique (PERT) and Critical Path Method (CPM): A Comparative Study. In her study, the project evaluation and review technique (PERT) and critical path method (CPM) were applied in a building construction company. Different activities involved in the house construction project were described. The earliest events, latest commencement and completion of activities were determined using Forward and Backward pass computations in CPM. Critical paths were determined using both CPM and PERT. Based on the analysis, it was shown that the completion of the house project using CPM was almost the same with that of PERT such that the difference between both techniques was only one day. However, the results showed that the implementation of both CPM and PERT methods are effective and efficient in a house construction project.

Yanney (2009) studied critical path analysis: a case study of the construction of a resource centre at the Catholic University College of Ghana. His work looked at project scheduling (critical path analysis) for the building of the Resource Centre at the Catholic University College of Ghana, Fiapre. The method used was the Branch and Bound method of the integer programming to solve the problem at hand. A computer programme based on the Branch and Bound method was developed to solve the problem.

Danfulani et. al (2023) studied the application of Critical Path Method (CPM) to optimal project scheduling: A case of Mosul Building Company, Yola North Local Government Adamawa State, Nigeria. In their study, analytical research design was adopted for the study as the design suit the study at hand. The network activities diagram, the forward and the backward pass obtained by the temporary ordered routing algorithm (TORA) were drawn. The results showed that if CPM is applied into the project, the project can be completed in 27 weeks compared to the initial duration of 32 proposed weeks by the company.

Abeli et al. (1988) studied Improving Work Efficiency through the Application of a Critical Path Method. Their aim was to improve work efficiency by identifying the critical and non-critical activities within the project. By overlapping these activities and putting the greatest efforts on critical activities, total project duration was cut down quite considerably.

Tofy (2007) studied the Application of Critical Path Method to Water Resources Planning. His paper illustrated the effectiveness of the Critical Path Method by discussing its application to actual water resources projects. He noted that the Comprehensive planning was required in order to prevent misallocation of resources or mismanagement in resource development. With many attempts to simplify the planning process and effectively carry out the phases, the approach broke a task down into smaller units or activities for easier organization, scheduling, and performance for eventual completion of the project.

Nonetheless, Lawanrisha et al. (2018) stated that administrators of large-scale agricultural projects have the difficulty of coordinating a variety of tasks at once. Numerous elements are included in the planning phase in order to create a realistic timeline and track the advancement of any project. Over time, agriculture has progressed from basic technology to intricate project establishment that calls for careful planning, coordination, and execution by agricultural managers. A significant amount of funding is approved these days to advance agriculture in order to increase productivity.

Time management and resource allocation strategies are needed to achieve sustainable development. The agro-food chain can be effectively integrated into the global market while maintaining its importance in relation to food safety, environmental concerns, and the rising worldwide need for food. The formulated policies aim to attain sustainability objectives while competing on both quality and quantity with other countries. To do this, farmers, decision-makers, and other stakeholders must make difficult decisions while creating projects within a limited budget and time frame.

In their article, Fahimifard and Kehkha (2009) conducted project scheduling in agriculture using the CPM (Critical Path Method) and PERT (Program Evaluation Review Technique) methods for the establishment of a 300-hectare grape orchard at the University of Zabol's Agricultural Research Center. The project's minimal completion time, as determined by the PERT technique and Normal time, is 364.67 days and 390 days, respectively, according to the results. Additionally, the findings of using the CPM approach show that it will cost 23643530 Rials to shorten the project's completion time to 365 days.

Kiss et al. (1978) studied the use of the critical path method in farm planning and Management. The purpose of the paper was to present, out of the mathematical methods, the possibilities of employing the critical path methods within operation research. From their researches, it was stated that the critical path planning methods would successfully employed in horticultural production, mainly in vineyards and fruit growing farms, thus improving the level of planning and management activities of the enterprises.

Other works on CPA are the works by Ahmed (2008) who studied the impact of CPM of scheduling on on-time completion of transportation projects. The study addressed the effectiveness of Critical Path Method (CPM) scheduling on project delivery, Evaraldo (2019) that studied the assessment of the critical path analysis in construction projects in Kitwe. Gunter (2004) studied Implementation of Critical Path Method and Critical Resource Implementation of Critical Path Method and Critical Resource Diagramming Using Arena Simulation Software. Hartley et al. (1966) studied a statistical theory for PERT critical path analysis. Jain et al. (2020) studied Project Evaluation using Critical Path Method & Project Evaluation Review Technique. This research paper provided the mathematical technique which helps the several project researchers in their research and development with several direct and indirect benefits.

Therefore, there is a need to investigate the application of Critical Path Analysis in the broiler chicken production cycle to enhance productivity, reduce costs, and improve overall performance.

This study is aimed at applying CPM in Kems Poultry Farm, to investigate the feasibility and potential benefits of such an application, contributing to the advancement of both the broiler chicken industry and project management practices, and the

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objectives are:

1. To assess the suitability of Critical Path Analysis for optimizing the broiler chicken production cycle.
2. To identify critical activities and dependencies within the broiler chicken production cycle.
3. To develop a practical framework for implementing Critical Path Analysis in the broiler chicken industry.

II. Research Methodology

Introduction:

This session outlines the research methodology employed to investigate the application of Critical Path Analysis (CPA) in the optimization of poultry production. The overarching goal is to provide a detailed account of the research design, data collection methods, and analytical tools used to assess the impact of CPA on various stages of the poultry production cycle.

Materials and Mathods

The research design for this study adopts a mixed-methods approach, combining quantitative and qualitative data collection techniques. The quantitative aspect involves the analysis of production data from Kems Agro Farm, Aluu, KELGA, Rivers State. While the qualitative component incorporates interviews with industry experts and farm managers. This design aims to triangulate findings, ensuring a comprehensive understanding of the role of CPA in poultry production.

Data Collection:

Quantitative data is collected through a combination of on-site observations and examination of production records. To supplement quantitative data, qualitative insights are gathered through semi-structured interviews with farm managers, veterinarians, and industry experts. These interviews explore perceptions of CPA, challenges faced in poultry production, and the potential benefits of implementing critical path analysis.

Implementation of Critical Path Analysis

The application of Critical Path Analysis involves mapping the various tasks and processes involved in poultry production. This includes identifying critical tasks, estimating task durations, and determining dependencies between different activities. Farm-specific critical paths are then established to highlight the sequence of tasks that collectively define the minimum production timeline.

- **Critical Tasks:** These are the tasks within a project that must be completed on time in order for the entire project to be completed within the specified timeframe. Critical tasks have no slack or float, meaning any delay in their completion will directly impact the overall project timeline.
- **Estimating Task Durations:** This involves determining the amount of time required to complete each task within the project. Accurate estimation of task durations is crucial for creating a realistic project schedule and identifying the critical path.
- **Determining Dependencies Between Different Activities:** Dependencies refer to the relationships between tasks or activities within a project. Tasks can be dependent on one another in various ways, such as being sequential (one task must be completed before another can start), concurrent (two tasks can be performed simultaneously), or resource-dependent (one task requires resources or inputs from another).

Data Analysis:

The quantitative data was analyzed using the critical path method (CPM). Qualitative data from interviews is subjected to thematic analysis, allowing for the identification of recurring themes and insights into the perceptions and experiences of industry stakeholders.

- **Thematic Analysis**: Thematic analysis is a method used to identify and analyze patterns, themes, or trends within qualitative data. In the context of project management, thematic analysis could be applied to identify recurring issues, challenges, or opportunities across different phases or aspects of a project, helping project managers make informed decisions and improve overall project outcomes.

Network Analysis

A 'network' is defined as a graphic representation with a flow of some type in its branches. It represents nodes and branches. It is a technique used for planning and scheduling of large projects in the fields of construction, maintenance, fabrication, purchasing, computer system instantiation, research and development planning etc. There is multitude of operations research situations th at can be modeled and solved as network. Some recent surveys report that as much as 70% of the real-world mathematical programming problems can be represented by network related models. Network analysis is known by many names _PERT (Programme Evaluation and Review Technique), CPM (Critical Path Method), PEP (Programme Evaluation Procedure), LCES (Least Cost Estimating and Scheduling), SCANS (Scheduling and Control by Automated Network System), etc.

In any new venture, uncertainties are bound to creep in. PERT incorporated these uncertainties into a model, which provides a reasonable answer to these uncertainties. There are certain statistical aspects scheduling large projects consisting of numerous activities whose completion times are uncertain and are independent of one another. PERT is an event-oriented technique. By 'event' we mean reaching a certain stage of completion of the proj ect.

Another technique, Critical Path Method, abbreviated as CPM, has emerged simultaneously. It is also a network technique but it is concerned with obtaining the tradeoff, between cost and completion date for large projects. In any project consisting of several activities each activity can be completed in a normal duration with normal cost. If we employ more persons or skilled people or given overtime to the workers, the activity could be completed in a reduced duration known as crash duration. But this involves an increased cost in the form of additional resources. With CPM the amount needed to complete the various activities is assumed to be known with certainty. So, the direct costs for the activities increase and hence the cost of the project also increases. By reducing the activity duration of some or all possible completed ahead of the schedule. This will naturally reduce the overhead cost for the entire proj ect. On one hand the direct expenses increase, if we shorten the activity duration, but, the indirect expenses for the project are reduced. We have to strike a balance or an optimum time schedule, or a least cost schedule is to be obtained. This is the purpose of the Critical Path Method. Thus CPM is not concerned with uncertain job times as in PERT. PERT is useful in research and developmental projects, whereas CPM is mostly used in construction projects, or in situations already handled, so that the details like the normal completion time, crash duration and cost of crashing are already known.

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The first step in the application of CPM / PERT is to develop a network representation of the project plan.

- **A node:** is the intersection of the two branch lines. It is denoted by a circle. Each branch represents an activity. Each node represents an event, which is a specific definable accomplishment recognizable at a particular instant of time. The arrowheads indicate the sequence in which events must be achieved. Thus an event is the completion of all the activities leading into that node and this event must precede the initiation of the activity leading out of the node.
- **An activity:** denotes the work to be carried out. It is represented with an arrow in network diagram
- **An arrow diagram:** represents a project graph. An arrow connecting two nodes, representing two events, represents each activity. The head of the arrow identifies the start of the activity.

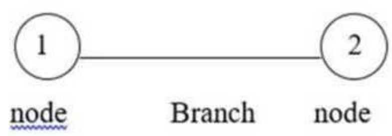

Fig. 1

Rules for Construction of Network

a) Each activity is represented by one and only one arrow. This means that no single activity can be represented twice in a network.

b) No two activities can be identified by the same end events. This means that there should not be loops in the network.

c) Time follows from left to right. All the arrows point in one direction. Arrows pointing in opposite direction must be avoided.

d) Arrows should not cross each other.

e) Every node must have at least one activity preceding it and at least one activity following it, except for the nodes at the very beginning and at the very end of the network.

Dummy Activities

There is a need for dummy activities when the project contains groups of two or more jobs which have common predecessors. The time taken for the dummy activities is zero.

Suppose we have the following project of jobs with their immediate predecessors.

Dummy arrow represents an activity with zero time duration. It is represented by a dotted line and is introduced in a network to clarify activity pattern under the following situations.

i. It is created to make activities with common starting and finishing events distinguishable.

ii. To identify and maintain the proper precedence relationship between activities those are not connected by events.

Early start and early finish

We define the 'early start' of a job in a project as the earliest possible time when the job can begin. This is the first number in the bracket. The early finish time of a job is its early start time plus the time required to perform the job. We put this as the second number in the same bracket.

Late start and late finish

We define the late start of an activity as the latest time that it can begin without pushing the finish date of the project further into the future. Similarly, late finish of an activity is the late start time plus the activity duration. We have seen that the early start and early finish time of activities are calculated in the forward direction from left to right.

The activities not on the critical path can be delayed without delaying the completion date of the project. A normal question may arise at this juncture as to how much delay can beallowed for non-critical jobs. How late can a particular activity be started and still maintain the length of the project duration? For answering these questions, we find the late start and late finish times for each activity in the project graph.

Slack or float

This difference between late start of the job and the early start of the same job is called as 'slack' or 'float'. It is also termed as 'total slack' or 'total float'. This denotes the maximum delay that can be allowed for this job.

Finding the Critical Path

After listing all the activities with their precedence relationship we project these activities in a project graph represented by arrows or Activity On Node diagram (AON). Now we have to find the minimum time required for completion of the entire project. For this we must find the longest path with the sequence of connected activities through the network. This is called the critical path of the network and its length determines the time for completion of the project. The activities in the critical path are so critical that, if they are delayed, the project completion date cannot be met and the project finish time will have to be extended. We shall now see how to identify the critical path, the critical activities and the duration of the project. The meaning of path and length of a path should first be made clear.

Independent slack

It is that portion of the total float within which an activity can be delayed for start without affecting slacks of the preceding activities. It is computed by subtracting the tail event slack from the free float. If the result is negative it is taken as zero.

PERT was developed for the purpose of solving problems in aerospace industries, particularly in research and development programmes. These programmes are subject to frequent changes and as such the time taken to complete various activities are not certain, and they are changing and non-standard. This element of uncertainty is being specifically taken into account by PERT. It assumes that the activities and their network configuration have been well defined, but it allows for uncertainties in activity times. Thus the activity time becomes a random variable. If we ask an engineer, or a foreman or a worker to give a time estimate to complete a particular task, he will at once give the most probable time required to perform the activity. This time is the most likely time estimate denoted by t_m. It is defined as the best possible time estimate that a given activity would take under normal conditions which often exist. But he is also asked to give two other time estimates. One of these is a pessimistic time estimate. This is the best guess of the maximum time that would be required to perform an activity under the most adverse circumstances like; supply of materials not in time, non-cooperation from the workers and the transportation arrangements not being effective etc.

Thus the pessimistic time estimate is the longest time the activity would require and is denoted by tp. On the other hand if everything goes on exceptionally well or under the best possible conditions, the time taken to complete an activity may be less than the most likely time estimate. This time estimate is the smallest time estimate known as the optimistic time estimate and denoted by to. Thus, given the three time estimates for an activity, we have to find the expected duration of an activity or expected time of an activity as a weighted average of the three time estimates. PERT makes the assumption that the optimistic and pessimistic activity (to and tp) are occur. It also assumes that the most probable activity time t_m, is four times more likely to occur than either of the other two. This is based on the properties of Beta distribution. Beta distribution was chosen as a reasonable approximation of the distribution of activity times. The Beta distribution is unimodel, has finite non-negative end points and is not necessarily symmetrical-all of which seen desirable properties for the distribution of activity times. The choice of Beta distribution was not based on empirical data. Since most activities in a development project occur just once, frequency distribution of such activity times cannot be developed from past data.

III. Data collection and Analysis

Overview

This sessionr presents the data as collected from Kems Poultry Farm, and the results obtained by applying Critical Path Analysis (CPA) to the production cycle of broiler chickens. The study focused on identifying the critical path through the sequence of activities required for broiler production, from site preparation to marketing and sales. By applying CPA, the research aimed to uncover potential inefficiencies within the cycle and propose optimizations to enhance productivity and reduce production time.

Identification of the Critical Path in Broiler Chicken Production

In the production cycle of broiler chickens, several critical activities must be carefully managed to ensure the efficient and effective production of poultry. Here are the key activities involved:

Site Preparation and Setup: This initial phase involves preparing the broiler farm, which includes setting up brooding facilities, ensuring the availability of water and feed systems, and creating optimal environmental conditions for the chicks.

Acquisition of Chicks: Sourcing healthy chicks from reliable hatcheries is crucial. The timing must be carefully planned to synchronize with the preparation of brooding facilities.

Brooding Phase: This critical early-life stage involves maintaining optimal temperature, humidity, and ventilation conditions for the young chicks. The brooding phase is vital for the chicks' survival and growth.

Feeding and Nutrition Management: Developing and implementing a nutrition plan tailored to the growth stages of broilers is essential. This includes the timely provision of starter, grower, and finisher feeds.

Health Management and Biosecurity Measures: Regular health checks, vaccinations, and disease prevention practices are crucial to maintain flock health. Implementing strict biosecurity measures prevents disease outbreaks.

Environmental Management: Continuous management of the living environment, including temperature, humidity, and cleanliness, to ensure optimal growth conditions.

Growth Monitoring: Regular weighing and monitoring of broilers to track growth performance and adjust management practices as necessary.

Processing and Packaging: Once broilers reach the market weight, they are transported to processing plants for slaughtering, processing, and packaging.

Marketing and Sales: Activities related to marketing the broiler chickens and selling them to retailers, wholesalers, or directly to consumers.

Cleaning and Disinfection: After each batch is processed, thorough cleaning and disinfection of the facilities are necessary to

Table 4.2 Critical Activities for Broiler Chicken Production

S/n	Activities	Description	Dependencies	Duration (in days)
1	A	Site preparation and setup		14
2	B	Acquisition of chicks	A	1
3	C	Brooding phase	B	21
4	D	Feeding and Nutrition Management	C	42
5	E	Health management and Biosecurity Measures	B	38
6	F	Environmental management	B	35
7	G	Growth Monitoring	B, D, E, F	40
8	H	Processing and packaging	G	2
9	I	Marketing and sales	H	30
10	J	Clearing and Disinfection	H, I	14

Figure 4.2 Network Diagram

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prepare for the next cycle.

The critical path for the broiler chicken production cycle was determined by mapping out all activities involved in the cycle, their respective durations, and dependencies based on past experience.

Represention of Table 4.2 in Network Diagram.

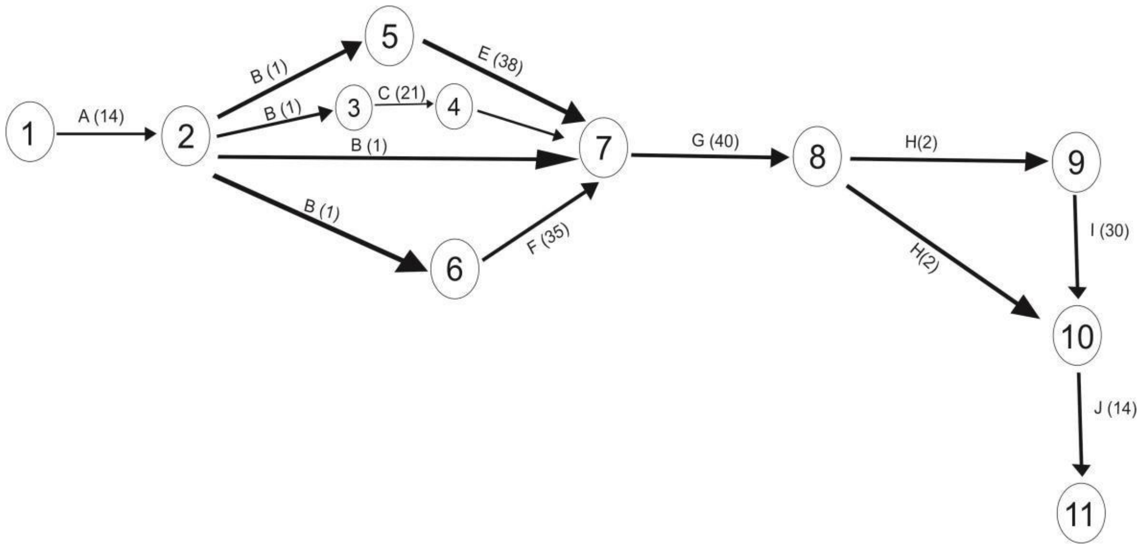

Figure 4.2 Network Diagram

Forward pass computation; using $E_j = Max_j \{E_i + t_{ij}\}$

Where E_j = earliest start of an activity

E_i= lastest start of an activity

t_{ij}= the time required for an activity

$E_1 = 0$

$E_2 = E_1 + t_{1,2} = 0 + 14 = 14$

$E_3 = E_2 + t_{2,3} = 14 + 1 = 15$

$E_4 = E_3 + t_{3,4} = 15 + 21 = 26$

$E_5 = E_2 + t_{2,5} = 14 + 1 = 15$

$E_7 = \max (E_5 + t_{5,7,} E_4 + t_{4,7} E_2 + E_{2,7} \; E_6 + t_{6,7})$

$= \max (15 + 38, 26 + 42, 14 + 1, 15 + 35)$

$= \max (53, 68, 15, 50) = 68$

$E_6 = t_2 + t_{2,6} = 14 + 1 = 15$

$E_8 = E_7 + t_{7,8} = 68 + 40 = 108$

$E_9 = E_8 + t_{8,9} = 108 + 2 = 110$

$E_{10} = \max (E_8 + t_{8,10}) \; E_9 + t_{9,10})$

$= \max (108 + 2) (10 + 30)$

$= \max (110, 140) = 140$

$E_{11} = E_{10} + E_{10,11}$

$= 140 + 14 \quad = 154$

Backward Pass (Latest Occurrence times, L)

Using

$L_j = Min_i (L_i – t_{ij})$

Where;

L_i = the earliest completion of an activity

L_j = the latest completion of an activity

$L_{11} = 154$

$t_{10} = L_{11} – t_{10,14} = 154 – 14$

$t_9 = t_{10} – t_{9,\,10} = 140 – 30$

$= 110$

$L_8 = \min (L_{10} – t_{8,10}, L_9 – t_{8,9})$

$= \min (140 – 2, 110 – 2)$

$= \min (138, 108) = 108$

$L_7 = L_8 – t_{7,8} = 100 – 40$

$= 68$

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$L_6 = L_7 – t_{7,8} = 100 - 40$

$= 68$

$L_6 = L_7 - t_{6,7} = 64 – 35$

$= 29$

$L_5 = L_7 – t_{5,7} = 68 – 38$

$= 30$

$L_4 = L_7 – t_{4,7} = 68 – 42$

$= 26$

$L_3 = L_4 – t_{3,4} = 26 – 21$

$= 15$

$L_2 = \min (L_7 – t_{2,7}, L_3 – t_{2,3}, L_5 – t_{2,5}, L_6 – t_{2,6})$

$= \min (68 – 1, 15 – 1, 30 – 1, 29 – 1)$

$= \min (67, 14, 29, 8) = 14$

$L_1 = L_2 – t_{1,2}$

$L_1 = 14 – 14$

$= 0$

Activity	1	2	3	4	5	6	7	8	9	10	11
Forward	0	14	15	26	26	15	68	108	110	140	154
Backward	0	14	15	26	30	29	68	108	110	140	154
Slack	0	0	0	0	4	14	0	0	0	0	0

The critical point consists of all activities whose slack is zero, That is $L_i — E_i$

Thus, the critical path is 154 days.

The critical activities include; Site preparation, Acquisition of chicks, Brooding phase, Feeding and Nutrition management, Growth Monitoring, Processing and packaging, Marketing and sales and then Cleaning and Disinfection

IV. Discussion of Findings

Using CPA, the study found that the sequence from site preparation, chick acquisition, brooding, through to processing and packaging forms the backbone of the production cycle, with a total duration of approximately 49 to 56 days. This sequence was identified as the critical path, as delays in any of these activities directly impact the overall cycle time. The analysis revealed that dependencies between activities, such as the need to complete site preparation before chick acquisition and brooding, are critical points where delays can occur. Bottlenecks were particularly noted in the brooding phase, where optimal conditions are crucial for chick survival and growth. This phase requires precise environmental control, which can be susceptible to disruptions. These activities are crucial for preventing disease outbreaks, which can cause delays and affect the entire production cycle. The application of CPA highlighted opportunities for shortening the production cycle and improving efficiency.

V. Conclusion and Recommendations

Summary

This study embarked on exploring the application of Critical Path Analysis (CPA) in the production cycle of broiler chickens, with the aim of identifying bottlenecks and inefficiencies that could be optimized to enhance productivity and reduce costs. The findings have provided valuable insights into the critical activities within the cycle and their impact on the overall production timeline. The application of CPA revealed the sequential nature of the broiler chicken production cycle, highlighting several critical stages, including site preparation, chick acquisition, brooding, feeding, health management, and processing. The brooding phase was identified as a significant bottleneck due to its strict temperature and environmental controls necessary for chick survival and growth.

Conclusion

The application of Critical Path Analysis to the broiler chicken production cycle offers profound insights into optimizing agricultural production processes. By identifying critical activities, bottlenecks, and inefficiencies, CPA provides a strategic framework for enhancing productivity, reducing costs, and improving overall efficiency in broiler production. This study underscores CPA as an essential tool in the agricultural sector, facilitating informed decision-making and strategic planning for sustainable and profitable poultry production.

This study has demonstrated the value of CPA in uncovering critical dependencies and bottlenecks that, if optimized, could significantly enhance production efficiency. By adopting a strategic focus on critical activities, poultry producers can ensure that resources are utilized effectively, leading to improved productivity in broiler production.

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