Development of Computer Aided Management for Grain Reception at Grain Storage Silos in Nigeria

Olorunfemi B.J, Adejuyigbe S.B., Adekunle A.A.

Abstract— **Modern grain storage and preservation system requires scientific and technologically skills, hence the need to incorporate the principles of good management starting from entrance of grain to the storage silos or warehouse and their release. Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM) is the integration of computers into the design and production process to improve productivity. In order to reduce to minimum level the menace of grain- product losses as it affects farmers in Nigeria, this research had made use of CAD/CAPP to solve operational and management problems associated with grain reception procedures at the National Strategic Grain Reserve program of the Federal Government of Nigeria. Computer aided management system was developed to minimize time wasted during grain reception at the 12 operational silo complexes of the Federal Government of Nigeria. Queue theory was employed to monitor the time of inter- arrival, arrival, waiting and length time of grain. The modules were coded in Pre– processor Hypertext higher programming language using Dreamweaver platform and Structural Query Language as database management system. Losses were recorded during the reception and release of grain out of the National Strategic Grains Silo Complexes in Nigeria. These losses are enormous as a result of poor and manual handlings and other human factors. The results showed that introduction of Grain Storage Monitoring Software (GSMS) to grain arrival and reception management would reduce the waiting time from 10.hrs to 1.9hrs, while queue theory analysis showed that timely servicing of suppliers of grains and food materials to the Government warehouses and silos would ensure no time loss.**

Index Terms— **Grain, CAM (Computer Aided Management), Silo, Grain arrival, SGR (Strategic Grains Reserve), Reception INTRODUCTION**

I. INTRODUCTION

The development of an appropriate food production, storage, distribution and marketing strategies continue to be of utmost importance to Nigeria's aspiration for the attainment and sustenance of national food security. A post-harvest system which encompasses processing, storage, handling and transportation of natural products are entirely man-made artificial system. Resulting from poor storage and preservation of food crops at the time of plenty, post-harvest loss is such a great concern that farmers often feel discourage to invest in large-scale production. Harvest may not yield the expected profits since half of it may spoil before reaching the consumer market. This is discouraging because most food crops, if well-stored and managed, can be preserved and made available to the consumer in fresh state even months or years after harvest (Igbeka, 2013).In spite of this huge agricultural potential, Nigeria, which used to be the major player in agriculture in the world, has lost its place in the global agricultural market (Akinwumi, 2013). Though the rate of world population growth is slowing down among the continents of the world, Africa leads with a ten- year growth rate (2000- 2010) of 26.1%. And among the ten most populous nations in the world, Nigeria leads with a 10- year population growth of 26.8% (Mbata, 2013).

It is worth mentioning that suitable policy needs to be formulated to address this imbalance. Such policies would have to include the development of technological processes that would cover the need of small and large scale farming and the application of improved storage and processing techniques, thus the need for utilization of Computer management techniques. Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM) is the integration of computers into the design and production process to improve productivity (Adejuyigbe, 2010). CAD/CAM is the technology concerned with the use of digital computers to perform certain functions in design and productivity. It is said that a grain saved is as good as an additional grain produced. In order to reduce to the minimum the menace of grain and grain product losses, as this is affecting grain farmers and grain merchants in Nigeria today. PHP is a server- side scripting language designed for web development but also used as a general-purpose programming language. It was originally created by Rasmus Lerdorf (1995),

Grain supplies to the National Strategic Grains reserve usually takes place immediately after the harvesting period. In a bid to supply the quantity awarded to the suppliers and grain merchants within the limited time, there used to be long queue at the silo locations, sometimes running into hundreds of trucks waiting for offloading. Many times, trucks that are hired to just drop consignments on their returning trips after they have offloaded do run into troubles. This often happen in a situation when the owner of the consignment might think that the consignment would be offloaded immediately they arrive at the silo complex. This agitation sometime leads to sharp disagreement and lobbying in order to get their load discharged before the trucks that have arrived before theirs. The main cause of delay during grain reception is the time required to register goods manually, dissemination of information to officers who is to take the next action and limited number of service available at the silo complex. Generally, only one service point is constructed for dried grain reception. While another service point was constructed for wet grain. Solving the problem of queuing would require a pragmatic way of fast-tracking reception procedures by good time management.

Olorunfemi B. J. Mechanical Engineering Department, Federal University Oye Ekiti, Nigeria. +2348036061994.
Adejuyigbe S. B. , Mechatronics Engineering Department, Federal University Oye Ekiti, Nigeria., +2348034740386
Adekunle A.A, Mechatronics Engineering Department, Federal University Oye Ekiti, Nigeria., +2348033807942

Computer aided grain reception is another laudable way to capture all activities involve at the goods arrival stage of grain storage. The application is used with the aid of computer networking and sometimes internet service to enhance proper connection between different branches of the silo locations and all users. The predominance and importance of grains in Nigeria in terms of seasonal production, production potential and consumption demands make storage an imperative task for all (FAO 2005).

II. METHODOLOGY

Programming the computer to handle a design work involves the development of a set of instructions (program) in line with the design procedures, coding the instruction set with a high level programming language and using a compiler, which serves as an interface between the computer and user, to enable user supply various inputs or parameters of the design. The compiler translates the written program (high – level language) to a machine – readable program (low – level language) (Adekunle *et al* 2012*)*.

Available data generated during the previous grain reception at the National Strategic Grain Silo complex, Akure, Ondo State Nigeria were collected for analysis using query theorem. Table 1 presented the grain arrival data It revealed the date of loading, arrival date, time of arrival, offloading date and time, waiting time, service time, and inter- arrival time. These data were obtained before the introduction of computer aided management to facilitate quick operations.

Notations for the equations (eqn. 1- 5) used for the analysis are summarized as follows**:**

n=	number of customers in the system (waiting line + service facility) at line tλ
λ=	mean arrival rate (number of arrival per unit of line)
μ=	Mean service rate per busy server (number of customers served per unit of time)
L_q=	expected (average) number of customers in the queue.
L_s=	expected number of customers in the system (waiting + being served)
W_q=	expected waiting time per customers in the queue (expected time a customer keeps waiting in line.
W_s=	expected time a customer's spend on the system (in waiting + being serve).
L_n=	expected number of customers waiting in line excluding those times when the line is empty i.e. expected number in non-empty queue (expected number of customers in a queue that is formed from time to time).
W_n=	expected time a customer wait in line if he has to wait at all i.e. expected time in the queue for non-empty queue.

A. Analysis of goods arrival before the introduction of computer software for grain management:

Expected time per unit in the system i.e. expected time in a unit spends in the system

$$W_s = \frac{Expected\ number\ of\ unit\ in\ the\ system}{Arrival\ rate}$$

$$= \frac{L_S}{\lambda} = \frac{\lambda}{(\mu-\lambda)\lambda} = \frac{1}{(\mu-\lambda)} \qquad (1)$$

The mean arrival rate (λ) for data collected before the introduction of Computer software was 2.05. Mean service time (μ) = 1.95

Expected numbers of units in the queue Lq,

$$L_q = \left(\frac{\mu-\mu+\lambda}{\mu(\mu-\lambda)}\right) = \frac{\lambda}{\mu}.\frac{\lambda}{\mu-\lambda}$$

$$L_q = \quad 2.05 \times \frac{2.05}{0.19} = 21.54 \qquad (2)$$

Average length of non-empty queue L_n, for a non-empty queue, should be at least 2 (one being served and the other in the queue).

$$L_n = \frac{Average\ lenght\ of\ queue}{prob\ of\ non-empty\ queue} = \frac{\frac{\lambda}{\mu}\frac{\lambda}{\mu-\lambda}}{\left(\frac{\lambda}{\mu}\right)^2} = \frac{\mu}{\mu-\lambda}$$

$$= 19.5 \qquad (3)$$

Hence, Average waiting time in non-empty queue (expected waiting time per busy period)

$$W_n = \frac{1}{\mu-\lambda} = 10\text{hrs} \qquad (4)$$

Expected waiting time per unit in the queue:

W_q=Expected time in system-time in service

$$W_q = W_s - \frac{1}{\mu} = \frac{1}{\mu-\lambda} - \frac{1}{\mu} = \frac{\lambda}{\mu}.\frac{1}{\mu-\lambda} \qquad (5)$$

2.05 /1.95 (0.1) = 10.75hrs

B. Analysis of goods arrival after the introduction of computer software for grain management

Following the queue formula used above,
Mean arrival time= 0.39
Mean service time= 0.918
L_q= 0.3138
Waiting time = 1.9hrs
Average length of queue= 1.772hrs

When the demand for a service/facility exceeds the supply, queues are formed. Likewise queues are formed when the number of customer is greater than the number of severs or service facilities. A customer gets an immediate service if the number of customers is less or equal to the servers. Queue occurs everywhere imaginable; loading points, in-transit, packing, sampling for laboratory analysis, weighing, offloading and computation of reception documents. But for the purpose of this work, queue occurs at different storage locations which increase the waiting time of suppliers.

The flow chart that the grain arrival was shown in Fig.1. It was observed that both arrival and service rate are independent of the number of customers in the waiting line. Also the arrival rate λused to be less than the service rate μ.The flow chart that shows the various stages that the grain consignment would go through at the reception is shown below. It starts with the decision to supply the grain at the point of loading truck with grain to the stage where the

consignment would be certified by necessary officials at the point of delivery.

III. RESULTS AND DISCUSSION

Analysis of goods arrival after the introduction of computer software for grain reception (Table 2) showed that: Mean arrival time was 0.39, Mean service time was 0.918, Waiting time was 1.9hr and Average length of queue was 1.772 and the Expected number of unit in the queue was 0.3138 per hour (20minutes). Data of goods arrivals at the Akure silo complex, Ondo State for twenty trucks with grains were obtained for the analyses of the arrival time, waiting time, service time and inter-arrival time. The values obtained were used for the calculation of: Expected time per unit in the system, Average length of non-empty queue and expected waiting time per unit in the queue. The same activities were carried out when the computer software installed was used for the recording of registration and other procedures during grain reception exercise. The results showed that the waiting time was reduced from 10 hours to 1.9 hrs.

A computer system is required to be provided at the reception office, and another one at the manager's office, as well as the store office. All of them are to be connected together through networking. Unit (these are suppliers contracted to supply grain to each silo location) enters the station from an input source or Calling population (list of all beneficiaries to supply grain). The members of the calling population arrive at the service facility (silo location) for service (reception of grain). These calling units produce the demand for service. Whenever the service facility is not available for service, the calling unit forms a queue. Members of the queue are serviced according to the prescribed rules of a queue discipline or service is performed by service mechanism or service facility and finally, service unit leaves the system:

(1) Input process: i.e. how unit joins the queue could be by regular arrival, purely random arrival or general Independence arrival.
(2) Queuing Discipline: how units are selected for service could be any of the followings: First come, first serve (FIFO was adopted). Other alternative methods are; First come, last serve, priority service and erratic service.
(3) Service Mechanism: here we consider: capacity of the system i.e. number of the server available, length of the service with respect to time, and service availability, that is server is always on seat or not on seat (servers on seat means complete service availability whereas servers not on seat means incomplete service availability).

Development of computer aided management system

Software was developed using PHP high language programming. It has three sections; the graphical user interface which the users could interact with was developed using Dreamweaver 8, the coding section was developed using PHP codes, and the database was generated using MySQL. The data were coded in Pre – processor Hypertext higher programming language using Dreamweaver platform and Structural Query language as database management system.

.

Fig. 1: The Landing Page. Fig. 1 is the users' friendly landing interface for the grain arrival.

Fig. 2: System Login Page

This interface is the log in page where the user enters his name and password. The administrative page contains the following links: Laboratory Analysis, Admin Area, and Logout.

Fig. 3: Good Registration Login Page

The goods registration login page contains the following links: Add Goods, Change Password, and Logout. This is where all the users log in with their assigned user's name and password.

Fig. 4: The Goods Registration Page

Our concern here is that, Fig. 4 interface is where all the suppliers are registered. For example, after registration, the manager will confirm if the name of supplier corresponds with the list from headquarter. Before getting to this page, the user must have password and unique username to avoid mix-up in the bio-data. Once the good meet the requirements, the confirmation beams with the caption "confirm". Then the truck will be allowed to come into the silo complex or warehouse for offloading. But at the initial, once the good supply is registered, it will appear in the administrative page as "not confirm". A contract number would be awarded automatically. This number cannot be erased or changed.

Table 1: List of registered goods at arrival

S/N	ContractNo	Date	Vehicle	Driver	Truck Reg	Goods	Quantity	Officer	Report
1	1556	20:1:2013	Truck	Gbenga	XA697KST	Millet	21.44	Ajayi A. A	ACCEPTED
2	7603	20:1:2013	Truck	akeem	GBY75XA	Maize	20.52	Ogunyanju Matthew	ACCEPTED
3	1931	20:1:2013	911	Sunday	XH783ABC	Maize	17.13	Ajayi A. A	ACCEPTED
4	2787	21:1:2013	Truck	Isak Gniya	XG736MNA	Maize	31.09	Ogunyanju Matthew	ACCEPTED
5	2141	1:2:2013	911	Abbass	BDG131XA	Maize	21.44	Ogunyanju M	ACCEPTED
6	1965	20:1:2013	Truck	Gbenga	XA697KST	Maize	21.44	Ajayi A. A	ACCEPTED
7	1189	4:2:2013	Truck	Umaru	XF 937 MKA	Maize	30.02	Ogunyanju M	ACCEPTED
8	1266	5:2:2013	Truck	Rafiu	WSN83XA	Maize	24.03	Ogunyanju Matthew	ACCEPTED
9	1395	20:1:2013	Truck	Garba	XA582KTA	Maize	30	Ajayi A. A	REJECTED
10	9841	1:2:2013	Truck	mohd	XEI53DKA	Maize	30	Ajayi A. A	REJECTED

Table 1 shows the list of grain goods that were received with detailed of contract number, date of reception, Driver's name and truck number. It also indicated the type of goods, the remark on its acceptability, and the officer who took delivery of the goods.

.

Fig. 5: Report generating page for goods received

Details reports of goods that have been received could be generated from the report page shown in Fig. 5 by clicking on 'view registered goods' or 'stock update'.

IV. CONCLUSION

Relating the three values obtained from the queue calculations to our work, the way queue is formed is by purely random arrival, the queuing discipline is by first come first served and the number of servers is one, while the length of service and service availability are shown in the grain arrival analysis table Table 1. It should be noted that waiting time involves the time spent on the queue and the time taken to service the customer. Also, inter arrival time is the amount of time between the arrival of one and the arrival of the next customer. It is calculated for each customer after the first customer. It is often averaged to get the mean inter arrival time, represented by lambda(λ). The analysis of queue theory showed that timely servicing of supply would ensure no query at the silo locations.

Computer aided management would ensure timely registration of goods; enhance human efficiency and effective managerial decisions. Manual computations always give positive statements due to human error. Results indicated that the package would save time and give pictorial view of the movement of the grain during registration and grain reception processes. Time used in queue will reduce drastically when the goods that arrive at the silo complex are registered on the software interface pages.

REFERENCE

[1] **Adejuyigbe, S. B. 2002.** Computer Aided Design and Computer Aided Manufacturing (CAD/

a. CAM) for manufacturing. Topfun Science and Engineering books. Pp 20- 53.

[2] **Adekunle A.A, Olubo A.S ,and Afolabi Olamide** "Need for CAD Software Development for Chisel Plough" –ASABE Proceedings,Canada,2014

[3] **Agricultural Transformation Agenda (ATA) 2012.** New Agricultural Policy Thrust. Published by the Federal Ministry of Agriculture and Rural Development. Nigeria. Pp 4- 34.

[4] **Akinwumi, A. 2013.** Unlocking Nigeria's Agricultural Potential to Create Wealth. Foundation day lecture.Federal University of Technology, Akure. Pp 6- 13.

[5] **Food and Agriculture Organization 2005.** Training the Trainers.A Training Manual for Strategic Grain Reserve Department, Federal Ministry of Agriculture, Nigeria.

[6] Igbeka, J. C. 2013. Agricultural Processing and Storage Engineering. Ibadan University Press. Pp. 99- 140.

[7] **LerdorfRasmus 2007.** PHP on Hormones- history of PHP presentation by RasmusLerdorf given at the MySQL conference in Santa Clara, California. The Conversations Network.Retrieved 2009.

[8] **Mbata, G. N. 2013.** Eradication of Global Hunger with Emphasis on Africa: Role in Post- harvest Integrated Pest Management. Fulbright specialist lecture. The Federal University of Technology, Akure, Nigeria. Pp 3- 17.

[9] **Olorunfemi, B. J. 2014**. Computer Aided Management of Grain Storage in Nigeria. Unpublished Ph.D thesis. Federal University of Agriculture, Abeokuta.

[10] **PHP Manual 2009.** Introduction: What can PHP do? PHP Manual. Retrieved, 2009.

Engr. Dr. Olorunfemi Bayowa Julius was born in Ikere Ekiti in Ekiti State, Nigeria. He is a Lecturer I in the Department of Mechanical at Federal University Oye Ekiti. He has his Ph.D in Mechanica at Federal University of Agriculture, Abeokuta, Ogun State.l. He wsas formally an Assistant Director at the Federal Ministry of Agriculture, Akure in Ondo State.

Prof. Adejuyigbe Samuel Babatope was born in Efon Alaaye in Ondo State, Nigeria. He is a Professor of CAD/CAM with many publications in related area. He is a Professor at Federal University Oye Ekiti in Ekiti State, Nigeria. He attended Federal University of Technology, Akure, Nigeria. 2002, Federal University of Technology, Akure, Nigeria,1997, Enugu State University of Science and Technology, Enugu, Nigeria, and 1992, Ondo State Polytechnic, Owo, Nigeria. 1983

1. ADEJUYIGBE, S.B. (2008a) Ownership and Leadership in Manufacturing. Au Journal of Technology, Assumption University (ABAC), Hun Mak Bangkok, Thailand. Accepted on 20th June 2007 - 11(4) pp 256-260. - Foreign Publication
2. ADEJUYIGBE, S. B. (2008b) Our Homes in All Seasons. Topfun Science and Engineering Books Publication, Akure, Nigeria. A Christian Textbook Publication for All Christians, ISBN 978-34859-9-7.
3. ADEJUYIGBE.S.B. (2008c) Evaluation of Small-Scale Industrial Set-Up and Their Profits (A Case Study of Akure South Local Government, Nigeria). Journal of Science and Technology Research. An interdisciplinary approach to Science and Technology Research for Development. An Official Publication of the International Research and Development Institute. Department of Mechanical Engineering. University of Uyo, Akwa Ibom State, Nigeria- Accepted on 12th July, 2007. Published.

Engr. Dr. Adekunle Adefemi Adeyemi was born in Ede in Osun State, Nigeria and had his B.Tech degree in Mechanical at Ladoke Akintola University of Technology, Ogbomoso, Nigeria, in 2000, he had his Masters at Federal University of Technology, Akure, Ondo State, Nigeria in 2008, and his Ph.D in Mechanical at Federal University of Agriculture Abeokuta, Ogun State Nigeria in 2014.

1. A.A. Adekunle and S. B. Adejuyigbe, **(2012)** "Construction of Plastic Water Filter" International Journal of Scientific and Engineering Research (IJSER Volume 3, Issue 3, March 2012 Edition) (ISSN 2229-5518)

2. A.A. Adekunle and S. B. Adejuyigbe**.(2012) "**Computer Aided Design and Drafting (CADD) Modeling for Gas Welding Process". *J Am Sci* 2012;8(7):87-93].(ISSN:1545-1003). http://www.jofamericanscience.org

3. A.A. Adekunle and S. B. Adejuyigbe.(**2012**) **"**Computer Aided Design Software development for Welding hollow cylinder." *J Am Sci* 2012;8(7):82-86]. (ISSN: 1545-1003). http://www.jofamericanscience.org