Optimizing Lot Size of Flexible Job Shop Problems by Considering Expiration Aspect

Yenny Suzana, Herman Mawengkang, Marwan Ramli, Opim Salim Sitompul

Abstract: Production planning for manufacturing companies is an aspect to meet production needs for production process. The production need of fish canning companies is uncertainty aspect and this includes in the flexible job shop system, the issues of uncertainty. The process of fulfilling the needs with consideration of expiration in the fish canning company is to optimize lot size with an assumption that customer demand can be met on time without reducing consumer trust. Mathematical formulations used to meet the needs of the FJSS problem use lot-sizing techniques in making decisions. Stochastic programs can be used to obtain the desired formulation. Solution for ordering quantities and the number of quantities ordered plus expiration considerations are formulated with mixed integer linear programing.

Index terms: Production Planning, Fish Canning Industry, Stochastic Programing, Mixed Integer Program, Sizing Lot, Expired.

I.INTRODUCTION

Production planning has a very important role in manufacturing industries. Therefore, the company needs to design a production plan so the costs occured in the production process can be minimized. Production costs include setup costs, processing costs and storage costs. If the company wants to produce more than one product unit processed on one machine, the costs for the setup activities at each turnover production process will be high. Conversely, if the company uses more than one machine to produce several types of products, the setup costs are low but the investment costs will be high.

In their study, Gicquel et al. (2008) explaine that if production is carried out with large batches, it can minimize the setup costs. However, as the effect, the storage costs are high. Conversely, keeping a low inventory by running production on small batches will increase the setup costs. Capacitated Lot Sizing Problem (CLSP) is developed by Gicquel et al. (2008) to determine the optimal lot size that can minimize setup costs and storage costs. This is to anticipate costs rising and reduce product storage time. A planning mechanism is needed at the production scheduling step.

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Production scheduling is related to short-term production problems and this is a job shop scheduling (JSS) problem. JSS can be said as a pattern of a set of work on a set of machines. For example, there is *n job*(J_1, ..., J_n) with various sizes in each job that must be scheduled on each machine *m* (m_1, ..., m_m). Each job is operated on each machine which requires a certain period of time for each job. Flexible job shop scheduling (FJSS) is a generalization of classic job shop problems. Each operation can be processed on a particular machine selected from limited subset of machines.

In the field of engineering, the adoption and use of lot size is seen as a response to the ever changing and technology-driven world. Specifically, lot sizes aid in evaluating the physical properties of a JSS. This paper has assessed the concepts of data processing, storage, and analysis via lot size. The device has been found to play an important role in enabling the operators and field practitioners to understand vertical deflection responses upon subjecting JSSs to impulse loads. In turn, the resultant data and its analysis outcomes lead to the backcalculation of the state of stiffness, with initial analyses of the deflection bowl occurring in conjunction with the measured or assumed layer thicknesses. In turn, outcomes from the backcalculation processes lead to the understanding of the nature of the strains, stresses, and moduli in the individual layers; besides layer thickness sensitivity, the determination of isotropic layer moduli, and establishing estimates in the subgrade CBR. Overall, impositions of elastic and low strain conditions foster the determination of resilient modulus and the analysis of unbound granular materials. Hence, lot size data processing, analysis, and storage gain significance in engineering because it informs the nature of designing new JSSs and other rehabilitation design options.

II.LOT-SIZING

Lot size yields an understanding of vertical deflection responses upon subjecting surfaces to impulse loads. As such, the device is used by civil engineers and its data aids in estimating the structural capacity of a job shop scheduling (JSS) in terms of overload possibilities and informing the overlay design .Some of the sites at which lot size gains application or usage include railway tracks, harbor areas, airport JSSs, local roads, and highways. According to Choubane and McNamara (2000)[4], load impact systems of lot size exist in two forms. These forms include the double-mass (such as KUAB) and the single-mass that includes PaveTesting, Carlo Bro, and Dynatest. In the single-mass system, weights can be dropped onto single buffers and the latter have connections top load plates that, in turn, rest on surfaces to be tested. As such, the force of the load is transferred via this plate to create deflections responsible for stimulating wheel loads [3].However, the double-mass system operates in such a way that weights are dropped onto double-buffer systems. Indeed, the system constitutes first buffers that precede second weights that eventually culminate into second buffers. The implication is that lot size's double-mass systems tend to produce extended loading durations that represent wheel loads in a more precise manner[1]. Similarly, double-mass systems have been observed to exhibit higher reproducibility while yielding more accurate outcomes on soft-soil JSSs. From this documentation, it remains inferable that single-mass systems are likely to overestimate JSS capacities in regions found to contain soft soils. Despite this limitation, single-mass systems have been vowed to be faster, cheaper, and smaller .

III.EXPIRATION

In the JSS design industry, lot size gains application for various reasons. For example, the device aids in identifying regions of weak JSS, aids in backcalculating layer properties to inform the perceived utilization of overlay designs, and aids in the estimation of the remaining life of a given structure.When lot size is used on JSSs, the operators apply impulsive loads on road or JSS surfaces before adjusting the area of loading, the duration, and the magnitude of the load. The aim of this procedure lies in the need to allow the load to correspond to the loading effect arising from in-service JSS's standard axle [3]. In turn, the road surface's instantaneous deflections are measured at various points and distances. As noted by Choubane and McNamara (2000)[4], these measurements are done radially outward, with the falling weight's centre being the focal point. The aim of this procedure is to obtain the shape of deflection bowls while lot size data backcalculation forms an analysis through which the operators obtain results on structural health condition .

IV.SHELF-LIFE

Primarily, the role of backcalculation lies in the need to establish different JSS layers' in-situ elastic moduli (E) [2]. Indeed, the operators calculate the outcomes of deflection values in relation to the assumed elastic moduli results before comparing the findings with the deflection values that have been observed. In turn, adjustments are made to the assumed moduli values for iterations that follow[1]. It is also worth highlighting that the iterations continue up to a point where a closer match is obtained for the observed and calculated deflection values. As documented by the State Highway Administration (2016), thickness values of the JSS layer may also be unknown. As such, the operators estimate these values iteratively via the backcalculation procedure.

Indeed, an analysis of the structure of a JSS involves idealizations. The implication is that iterations are likely to introduce numerical errors. The problem's inverse nature has also made it difficult to attain a unique solution during the backcalculation procedure. However, recent observations suggest efforts being made to develop and implement a backcalculation scheme perceived to be robust and capable of reaching the solution quickly, reliably, and accurately .

The main methods of backcalculation include optimization techniques and the regression methods. Whereas the former approach takes lengthy iteration processes, the latter technique has been found to be fast but remains prone to the provision of inaccurate outcomes .

V.DEVELOPING MODEL

As mentioned earlier, lot size simulates JSS surface deflections to reflect a similar situation as that which may be felt in the case of a fast-moving truck. Upon dropping a weight, lot sizes generate load impulses. In turn, these load pulses are transmitted to the JSSs via circular load plates expected to be 300 millimeters in diameter . According to Lee (2014), lot size's generation of load pulses yield momentary deformations of JSSs beneath the load plates and end up forming bowl or dish shapes. When envisioned from side views, shapes of the deformed JSS surfaces can be likened to deflection basins [5].

Indeed, JSS stiffness can be estimated based on the deflection basin's shape and the stiffness of the JSS being investigated. Knowledge of individual layer stiffness can also lead to the calculation of the stiffness of those layers. Furthermore, lot size aids in determining degrees of interlocks between adjacent slabs. However, this degree is mostly achieved on JSSs perceived to constitute Portland adjacent cement (PCC). Often referred to as the load transfer efficiency (LTE), the degree of interlock is achieved through the placement of lot size's load plate tangents to the side of joints being examined [6],[7]. Afterward, load pulses are generated before measuring equidistant deflections on either side of the joints. The expectation is that equal deflections result when joints are perfectly efficient. However, some studies reveal that most of the joints would have deflections on the loaded slabs being higher than the unloaded slabs .

It is further notable that primary measurement devices for lot sizes exist in two forms. The first type constitutes load cells located directly above load plates. The role of these cells is to obtain measurements of forces being imparted to the surface. The second category involves deflection sensors or deflectors (State Highway Administration, 2016). In situations where Long-Term JSS Performance (LTPP) operates lot sizes, deflection sensors come in the form of geophones. To measure the deflection basin's shape, the geophones are placed at fixed distances from load plates (Shirazi, Abdallah and Nazarian, 2009). One of these additional devices is the distance measurement instrument (DMI) whose role lies in obtaining distances that the lot size covers along a given roadway; also acknowledged as a high-accuracy odometer [4]. The second and additional type of measurement device is the temperature sensor (infra-red surface-temperature sensor and the air temperature sensor). In conjunction with

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information from the nearest weather stations, the results of temperature sensors aid in estimating values in different materials of the JSS structure . According to Varma, Kutay and Chatti (2013), an understanding of the JSS structure material temperatures is critical for the analysis process. The importance is demonstrated in the example whereby asphalt tends to be ductile and soft when temperatures are high while low temperatures make the material to be brittle and hard. Thus, this knowledge allows the lot size operators to correct the stiffness calculated in relation to such temperature effects [13]. Lot size testing also attracts manual measurements by the LTPP lot size operators. An example is a case in which the load-transfer testing process prompts the taking of joint width measurements and the use of a hand-held device to take subsurface temperature measurements. Non-equipment related conditions attract additional operator comments in relation to their implication on anomalous measurements. Some of these site-specific and non-equipment related conditions include cracks and other related distresses experienced on the JSS surface (Varna, 2015).

Before the mathematical model formulation is made to make optimal decisions, it is necessary to make a model notation first. The model notation is as follows:

A.Index:

- r amount of items ordered
- j raw material unit
- i unit, product (state, item), i $\epsilon I = \{1, 2, . . . NI\}$
- k unit, k□$\epsilon K = \{1, 2, . . . NK\}$
- l machine
- t time period
- s sub periode

B.Parameter:

- I_{i0} Initial inventory of products
- v_{i0} Initial raw material inventory
- q_{jt} Ordering raw materials *j* at time *t*
- d_{it} Request product *i* at time *t*
- $b_{j,i}$ Number of units of raw materials *j* needed for the production process *i*
- a_j Shelf-life raw material *j*
- a_i Shelf-life product *i*
- S_j Size of ordering raw material for unit *j*
- l_j The grace period for ordering raw material for unit *j*
- $x_{l,i,s}$ Production time of product *i* on machine *l* in sub period *s*
- $t'_{t,i,k}$ The setup time changes over the product *i* to product *k* at time *t*
- f'_i Product return costs *i* /cans
- f_j Disposal cost of raw material unit *j*
- c_j Raw material costs for unit *j*
- p_i Production costs for product *i*
- h_i Cost of storing production inventories for product *i*
- m_j Cost of storing raw material inventory unit *j*
- A_i Fixed production costs for product *i*
- g_j Fixed costs for raw materials ordering for unit *j*
- $\delta_{i,k}$ Cost of setup change over from product *i* to product *k*
- K_i Production capacity for product *i*
- L_i Ordering capacity for products *i*
- $K'_{l,t}$ The capacity of the machine *l* in period *t*
- $M_{l,i,t}$ Upper bound $x_{l,i,s}$ or upper limit of production time of product *i* on machine *l* in sub period
- $s\pi_{j,t}$ Possible units of raw materials *j* at intervals of production *t*

C.Variabels:

- $x_{i,t}$ The number of units *i* produced at time *t*
- $I_{i,t}$ Inventory of production for product *i* at time *t*
- $Q_{j,t}$ Ordering raw material for unit *j* at time *t*
- $V_{j,t,r}$ Inventory of raw material unit *j* at time *t* based on the number of items ordered
- $C_{j,r,t}$ The use of raw materials for unit *j* is based on the number of items ordered at time *t*
- Y_i Number of returns for products type *i*
- Z_j Amount of disposal of unit raw material *j*
- $y_{i,t}$ Binary variable of ordering product type *i* at time *t*
- $w_{j,t}$ Binary variables of scheduling the order of raw materials for unit *j* at time *t*
- $W_{j,t}$ Binary variable of fixed order of raw material unit *j* at time *t*
- $\alpha_{l,i,k,s}$ Binary variable if there is a change over type *i* product to type *k* product on machine *l* in the sub period *s*
- $\beta_{l,i,s}$ Binary variable if the process setup of machine *l* for type *i* products in the sub period

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Prior to the arrival at the site, lot size operators fill out copies of forms referred to as lot size Operations Planning and the filling process is specific to the individual or separate test sections. Afterward, the arrival at the site is followed by inspections of test sections to establish evidence of maintenance activities. In turn, possibly defaced or missing site markings are replaced. An evidence of recent maintenance requires one to contact regional support contractors to confirm the effectiveness of the maintenance (Tarefder & Ahmed, 2014). In turn, the before-operations checks are conducted and include the removal or trays, unlocking transport locks, ensure that the geophones remain well-seated in their holders, checking the level of hydraulic oil, confirming the level and tightness of buffers that ought to be free of silts and cracks, and removing hitch pins from the front sensor guides (Domitrovic & Rukavina, 2013). The process is followed by preparations of temperature gradient holes, buffer warm-up sequences, position the lot size to allow the load plate's center to lie on section start limits, and set the "Test Setup" before opening new data files in the data collection software. The testing sequence starts after entering lane specifications. Upon completion, the operators move to the next point and the procedure is repeated until all the test points are examined. Later, the data file is closed and followed by after-operations activities such as engaging transport locks, replacing hitch pins in front of sensor bar guides, securing and replacing pans, locking the trailer access doors, stowing other supplemental testing equipment, and filling out, dating, signing, and filing paper forms (Lee, 2014).

D.Formulation:

Minimize:

$$\sum_{j=1}^{J}\sum_{t=1}^{T} g_j W_{j,t} + \sum_{j=1}^{J}\sum_{t=1}^{T} g_j w_{j,t} + \sum_{j=1}^{J}\sum_{t=1}^{T} \pi_{j,t} \left[\sum_{j=1}^{J}\sum_{t=1}^{T} c_j Q_{j,t} + \sum_{j=1}^{J}\sum_{t=1}^{T}\sum_{r=0}^{R} m_j V_{j,t,r} + \sum_{j=1}^{J} f_j z_j\right] \quad (1.A)$$

Minimize:

$$\sum_{i=1}^{N}\sum_{t=1}^{T} p_i x_{i,t} + \sum_{i=1}^{N}\sum_{t=1}^{T} A_i y_{i,t} + \sum_{l=1}^{L}\sum_{i=1}^{N}\sum_{k=1}^{N}\sum_{s=1}^{S} \delta_{i,k}\alpha_{l,i,k,s} \quad (1.B)$$

Minimize:

$$\sum_{i=1}^{N} f_i Y_i + \sum_{i=1}^{N}\sum_{t=1}^{T} \pi^*_{i,t}\left[\sum_{i=1}^{N}\sum_{t=1}^{T} h_i I_{i,t} + \sum_{i=1}^{N}\sum_{t=1}^{T} K_i I_{i,t}\right] \quad (1.C)$$

Constraints:

$$I_{i,t} = I_{i,t-1} - X_{i,t} - d_{i,t}^{\sigma}, \forall i \in N, \forall t \in T, \forall \sigma \in \quad (2)$$

$$\sum_{r=0}^{t} V_{j,t,r} = v_{i,0} + S_j q_{j,t} - \sum_{i=1}^{N} b_{j,i} X_{i,t}, \forall j \in J$$

$$\forall t \in T, \forall r \in T, t = 1 \quad (3)$$

$$\sum_{r=0}^{t} V_{j,t,r} = \sum_{r=0}^{t-1} V_{j,t-1,r} + S_j q_{j,t} - \sum_{i=1}^{N} b_{j,i} X_{i,t}, \quad \forall j \in J, \forall t \in T, 1 < t < a_j, t \le l_j \quad (4)$$

$$\sum_{r=t+1-a_j}^{t} V_{j,t,r} = \sum_{r=t+1-a_j}^{t-1} V_{j,t-1,r} + S_j q_{j,t} - \sum_{i=1}^{N} b_{j,i} X_{i,t}, \quad \forall j, t \in T, T \ge a_j, t \le l_j \quad (5)$$

$$\sum_{r=0}^{t} V_{j,t,r} = \sum_{r=0}^{t-1} V_{j,t-1,r} + S_j Q_{j,t-l_j} - \sum_{i=1}^{N} b_{j,i} X_{i,t}, \quad \forall j, t \in T, 1 < t < a_j, t > l_j \quad (6)$$

$$\sum_{r=t+1-a_j}^{t} V_{j,t,r} = \sum_{r=t+1-a_j}^{t-1} V_{j,t-1,r} + S_j Q_{j,t-l_j} - \sum_{i=1}^{N} b_{j,i} X_{i,t}, \quad \forall j, t \in T, T \ge a_j, t > l_j \quad (7)$$

$$\sum_{i=1}^{N} b_{j,i} X_{i,t} = \sum_{r=0}^{t} e_{j,r,t}, \quad \forall j \in J, \forall t \in T, t < a_j \quad (8)$$

The next is obstacles to maintain the availability of raw materials

$$V_{j,t,r} = S_j q_{j,t} - e_{j,r,t}, \quad \forall j \in J, \forall t \in T, \forall r \in T, r = t, t \le l_j \quad (9)$$

$$V_{j,t,r} = S_j Q_{j,t-l_j} - e_{j,r,t}, \quad \forall j \in J, \forall t \in T, \forall r \in T, r = t, t \le l_j \quad (10)$$

$$V_{j,t,r} = V_{j,t-1,r} - e_{j,r,t}, \quad \forall j, t, r, t - r < a_j, 1 \le j \le J, 1 \le r \le T \quad (11)$$

Constraints in the disposal of raw materials because of shelf-life exceeding

$$Z_j = \sum_{t=a_j}^{T} V_{j,t,t+1-a_j}, \quad \forall j \in J \quad (12)$$

For capacity of processed fish production can be written as follows

$$Y_i = \sum_{t=a_i}^{T} I_{i,t,t+1-a_i}, \qquad \forall i \in I \qquad (13)$$

$$X_{i,t} \le K_i, \qquad \forall i \in N, \forall t \in T \qquad (14)$$

$$\sum_{i=1}^{N} \sum_{s \in S_t} x_{lis} + \sum_{i=1}^{N} \sum_{j=1}^{N} \sum_{s \in S_t} st_{ik} \alpha_{lijs} \le K'_{lt} \qquad \forall t = 1, \dots, T; l = 1, \dots, L \qquad (15)$$

$$x_{lis} \le M_{lit} \beta_{lis} \qquad \forall l = 1, \dots, L ; i = 1, \dots, N ; t = 1, \dots, T ; s \in S_t \qquad (16)$$

The capacity constraints of the order can be written as follows

$$Q_{j,t} \le L_j, \qquad \forall j \in J, \forall t \in T \qquad (17)$$

Constraints on binary variables preparation and ordering costs can be written as follows

$$X_{i,t} \le M_{yi,t}, \qquad \forall i \in N, \forall t \in T \qquad (18)$$

$$Q_{j,t} \le MW_{j,t}, \qquad \forall j \in J, \forall t \in T \qquad (19)$$

$$q_{i,t} \le Mw_{j,t}, \qquad \forall j \in J, \forall t \in T \qquad (20)$$

Constraints of negativity and binary can be written as

$$X_{i,t}, I_{i,t}, Q_{j,t}, V_{j,t,r}, C_{j,r,t}, Z_j \ge 0, \forall i, j, r \qquad (21)$$

$$y_{i,t}, W_{j,t}, w_{j,t} = 0 \qquad (22)$$

$$M_{lit} = Min\{K'_{lt}, maks_{k:p_{ki} \ne 0} \frac{\sum_{h=t}^{T} d_{kh}}{p_{ki}}; \qquad \forall l = 1, \dots, L ; i = 1, \dots, N; t = 1, \dots, T \qquad (23)$$

Constraints (4.23), (4.24) and (4.25) the relation between the setup of two successive sub-periods, thus determining changeover turn and maintaining the setup.

$$\sum_{i=1}^{N} \alpha_{liks} \le \beta_{lis} \qquad \forall l=1,\dots,L \; ;k=1,\dots,N;s=1,\dots,S \qquad (24)$$

$$\beta_{li(s-1)} = \sum_{j=1}^{N} \alpha_{liks} \qquad \forall l=1,\dots,L \; ;i=1,\dots,N;s=1,\dots,S \qquad (25)$$

$$\sum_{j=1}^{N} \alpha_{liks} = \beta_{lis} \qquad \forall l=1,\dots,L \; ;i=1,\dots,N;s=1,\dots,S \qquad (26)$$

VI.ALGORITHM DEVELOPMENT

A JSS's detailed structural analysis has insights about its detailed structural analysis gained from the shapes of deflection bowls. Basically, subgrade stiffness is defined by outer deflections [5]. On the other hand, bowls that are broad with little curvatures depict stiffness in the JSS's upper layers (in relation to the subgrades) (Shirazi, 2015). In addition, bowl shapes found to be close to lot size's loading plates support JSS analyses of near surface layers. Related observations by Tarawneh and Nazzal (2014) indicated that bowls found to have high curvatures around lot size's loading plates but with same maximum deflections suggest weaker upper layers in relation to the subgrades. Upon identifying critical layers, potential or existing distress mechanisms are established and pave way for the design of treatments that are the most fitting.

Backcalculations of layer stiffness are preceded by initial analyses of the deflection bowl in conjunction with the measured or assumed thickness of the layers. This step is important in understanding the strains, stresses, and moduli in the individual layers. An accurate modeling of the stiffness of the subgrade is observed to be important because a failure to achieve accuracy implies that disproportionately large errors are likely to arise during the backanalysis. Notably, the latter is applicable in for the provision of the upper layer moduli (State Highway Administration, 2016). With the existence of packages that aid in bob-linear subgrade analysis, the use of a system such as the ELMOD package uses deflections for calculating "n" and C. the relationship holds:

E = C $(\sigma_z/\sigma')^n$ where n and C refer to constants

σ_z = vertical stress

σ' = reference stress

E = modulus of elasticity

The approach enables accurate and quick modeling while offering an additional advantage in such a way that it allows for the broad identification of the subgrade soil type. On the other hand, "n" refers to the subgrade modulus' measure of non-linearity (Shirazi, Abdallah and Nazarian, 2009). In situations where "n" is zero, the outcome suggests linear elastic material. An example of such materials lies in hard granular components. On the other hand, markedly non-linear and soft cohesive soils reveal "n" values that lie in the range -1 to -0.3. In turn, an iterative process leads to the determination of the moduli of an intermediate layer and an upper stiff layer (if present) [4].). Specifically, the iterative process utilizes the deflection bowl's shape and the total central deflection under lot size's loading plates.

Primarily, approaches such as the Odemark method do not consider the moduli directly. Rather, they consider layer stiffness. To determine the isotropic layer moduli, the overall stiffness of layers is determined as $h^3 E/(1-\mu^2)$ where,

h = Assumed layer thickness

E = Layer modulus

μ= Poisson's ratio

With an assumed layer thickness (h) and the layer modulus (E), backanalyses imply that small errors in the thickness of the layers are likely to cause significant or large errors in modulus (Varma, Kutay and Chatti, 2013). A similar sensitivity or trend is also observed after adopting and implementing other analysis techniques (such as CIRCLY); with these alternative approaches affirmed to utilize numerical integration. Imperative to highlight is that there is a need to consider general orders of the magnitudes of the moduli of layers because a failure could translate into inaccurate results (Kutay, Chatti and Lei, 2011). However, the trend does not necessarily apply in situations involving subgrade moduli because values in the latter are established explicitly, yielding reliable outcomes. The observation is also informed by the fact that in situations involving subgrade moduli, the attribute of stiffness is used in the place of layer modulus; translating into minimal effects to the design overlay thickness.

Whereas load application to subgrades seeks to determine resilient modulus through the imposition of elastic and low strain conditions, the CBR test is adopted in imposing plastic and high strain deformation (Wang and Al-Qadi, 2013). However, modulus-CBR correlations have been documented to only be indicative because of variations of a factor of three or two in the modulus (slope of stress-strain curves) for cohesive soils.

From these outcomes, it becomes critical to consider the modulus and resultant degrees of non-linearity while evaluating the rehabilitation design options and JSS distress mechanisms (Varna, 2015). Thus, the CBR parameter plays the important role of informing the nature of the design of new JSSs.

During the application of lot size, unbound granular surfacing on JSSs poses the complication of basecourse modulus non-linearity. The most adopted relationship states E = K1θK2 where:

θ = Total principle stresses

K1 and K2 = Material parameters

Notably, the total principle stresses are witnessed when the deviatoric stress is at the maximum (Tarefder & Ahmed, 2014).

From the outcomes, basecourse materials attract non-linear elastic models. However, Domitrovic and Rukavina (2013) recommended the need for the division of granular basecourses in a quest to achieve sub-layers that would reduce the impact of stress dependency introduced by backcalculated moduli. Given an unbound basecourse with the top and bottom layer differing by 125 mm, the moduli mainly range from 200 to 300 MPa. However, a substantially higher value is likely to result when the lot size test is applied on good quality basecourses with sustained field trafficking (Lee, 2014).

Imperative to note is that the modulus of unbound layers does not hold a sole dependence on the component material function. Rather, the nature of the underlying material (in terms of stiffness) shapes the nature of unbound layers' moduli to a significant degree [6],[7]. A linear elastic analysis by Park, Park and Hwang (2009)[5] indicated that multilayer systems have ratios of E moduli in unbound base layers E_i to those of the underlying soils E_i+1 revealing the outcome of E_i /E_i+1 < 2.5. This outcome was informed by documentation that unbound materials (on soft subgrades) are unlikely to be compacted properly. An alternative explanation for these results is that the placements of stiff dense layers on yielding foundations imply that the upper layers are likely to de-compact due top the development of tensile strains. The practical explanation was supported by the findings of Tarawneh and Nazzal (2014), who noted that the development of tensile horizontal stresses is likely to be witnessed in the bottom layers "i" if the ratio E_i /E_i+1 > 2.4. Therefore, repeated loading is likely to de-compact unbound layers that are overlying to such an extent that the level of stiffness translates into limiting values where the occurrence of tensile stress is unlikely .

Stage I:
Complete the problem in equation (1) to equation (26) with the integer relaxation conditions. If the optimal solution with an integer condition is continuously fulfilled, stop. So that an optimal solution is obtained that is feasible. If not, continue the step 1.

Step 1. Get row i* the smallest integer infeasibility, such that $\delta_{i^*} = min\{f_i, 1 - f_i\}$

(This choice is motivated by the desire for minimal deterioration in the objective function, andclearly corresponds to the integer basic with smallest integer infeasibility).

Step 2. Perform operations for pricing

$$v_{i^*}^T = e_{i^*}^T B^{-1}$$

Step 3. Calculate$\sigma_{ij} = v_{i^*}^T \alpha_j$ with corresponds to $\underset{j}{min}\left\{\left|\frac{d_j}{\alpha_{ij}}\right|\right\}$

Calculate the nonbasic movement j of the maximum lower bound and upper bound.

Otherwise, go to nextnon-integer nonbasic or super basic j (if available). Finally, the j*column will be raised lower or lowered the upper bound. If there is no variable, go to the next proceed to i*

Step 4. Solve$B\alpha_{j^*} = \alpha_{j^*}$for α_{j^*}

Step 5. Perform a ratio test for basic variables by taking the limits to be feasible due to nonbasic release$j$*.

Step 6. Exchange base

Step 7. If line i* = {∅} continue to Phase 2, if there is no variable, repeat step 1 again

Stage II:

Pass 1: Move an infeasible superbasic integer with fractional steps to achieve a feasible complete integer.

Pass 2: Adjust integer superbasic. The purpose of this phase is to conduct a local neighborhood search to verify optimal locality.

From the findings, one of the aspects depicting the critical application of lot size data lies on the issue of residual life. According to Shirazi, Abdallah and Nazarian (2009), residual life refers to the number of equivalent standard axles (ESAs) that a given JSS can accommodate prior to its declaration as one that is no longer serviceable. Through lot size data, the terminal roughness condition can be compared with the existing roughness and establish the correlation between the number of load repetitions and the allowable material strain [4],[6].

Another merit of lot size data lies in the mechanistic design that informs processes and the nature of establishing rehabilitation treatments. Upon completing the process of deflection bowl analysis and establishing the test point's layer moduli, operators can evaluate the rehabilitation options. One of the techniques that have been observed to gain application in this procedure is that which involves CIRCLY, a forward-analysis program [2]. In turn, suitable overlay thicknesses can be established before confirming the extent of acceptability in the layer strains. In summary, lot size is an important aspect because of the significance arising from its data processing, analysis, and storage. The significance is felt in terms of understanding the residual life of a surface by calculating the number of ESAs a given JSS can accommodate before being declared as one that is no longer serviceable. Indeed, the application aids in curbing potential adversities such as accidents and other related environmental concerns that are likely to accrue from the continued use of an unworthy JSS.

VII.CONCLUSION

This paper presents a mathematical model of lot size optimization from FJSS problems by considering the expiration date in the fish canning industry. The model is a large scale mixed integer program. To solve this problem, the concept of the exploited superbasic variable algorithm is developed.Indeed, technological advancements in civil engineering have seen the construction industry embraces technology in managing, controlling, and assessing the state of the existing infrastructure. One of the applications that have continued to gain adoption is the lot size, which refers to a testing device responsible for evaluating physical properties of a JSS. Particularly, lot size yields an understanding of vertical deflection responses upon subjecting surfaces to impulse loads. This paper has assessed the processing and analysis of data received from lot size, upon which implications for practice (upon storing the data) have been highlighted. One of the important attributes of lot size outcomes concerns the basic calculations. The role of these calculations lies in the backcalculation of the state of stiffness, with initial analyses of the deflection bowl occurring in conjunction with the measured or assumed layer thicknesses. Indeed, backcalculation is critical because it aids in understanding the strains, stresses, and moduli in the individual layers. Another lot size aspect concerns layer thickness sensitivity. One of the methods, Odemark, has been found to play an important role in fostering the determination of isotropic layer moduli; leading to the establishment of the overall stiffness of layers. This study has also established that lot size data has its application lying in the estimation of subgrade CBR. By imposing elastic and low strain conditions, resilient modulus is determined. Coupled with the additional application of analyzing unbound granular materials, lot size data processing, analysis, and storage has been found to be of significance due to its capacity to give an insight into rehabilitation design options and informing the nature of designing new JSSs.

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