

Create Heijunka 5's Matrix to Control the Dynamic Gemba as Lean Tool

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Abstract: The heijunka tracking matrix has a direct impact on turn overtimes of the inventory to revamp existing orders as well as new technique, and increase the utilization of the inventory's labors by eliminating the waste in transportation and over-processing actions. The tracking problem is interested in rearranging the location of VSM (e.g., items, pallets and stations) in a grouping of cellular aspect using 5'S concepts, which increase performance level. One of the successful recommendations used in this context is traveler salesman technique but with periodically update (i.e., Dynamic Gemba), it may be need reformulation. Its importance is the capture of work, information, and material (WIP, setup time, process time/unit, error rates, idle time, etc.) which is essential in quantifying and determining waste in terms of cost, delivery time and transportation frequency. This paper is interest in review the dynamic Gemba model to improve the inventory handling via modifying the traveler salesman model with aided proposed heuristic procedures, which are interested in arrange the inventory in minimum time and maximum flexibility in preparing the different orders. The Gemba tasks displayed via (Gemba KPI/DOE board) which contain cost and time information (NNVA: preparing tasks, VA: traveling||tracking tasks and NNVA: unloading tasks). The optimized cost and time analysis after reducing NNVA time and total VA time were sent to the central heijunka matrix. The methodology which includes elimination movements, motion and extra actions wastes are lean, and aim to increase the ability of prepare a lot of service in minimum time.

Keywords: Lean, Manufacturing Facility Layout, Gemba, Heijunka Cellular Manufacturing, KPI in Six-sigma

1. Introduction

The Gemba is a Japanese word may use in different sentence such as Japanese detectives call the crime scene Gemba, and Japanese TV reporters may refer to themselves as reporting from Gemba. In business, Gemba refers to the place where value is created; in manufacturing the Gemba is the factory floor. It can be any "site" such as a construction site, sales floor or where the service provider interacts directly with the customer [1]. In lean manufacturing, the idea of Gemba is that the problems are visible, and the best improvement ideas will come from going to the Gemba. The Gemba may be static or dynamic. The dynamic Gemba changes every visit. The Gemba walk, much like Management By Walking Around (MBWA) to study the best procedures increase performance of executing activities that takes management to the front lines to look for waste and opportunities to practice Gemba heijunka, or practical shop floor improvement. A heijunka is a concept originally created

by Toyota for achieving a smoother flow. This paper interest in creating (The heijunka DOE board matrix) which is generally a board schedule which is divided into a grid of KPI equations. Each variable of KPI representing a specific level for significant variable impact on increasing stores performance. The KPI equation contain some Colored (green: executed at the first, yellow: ready to execute, red: postpone to end of track) positions representing individual objective are placed on the heijunka board to provide a visual representation of the good track. The heijunka board make it easy to see what is the smooth track of tasks are queued for completing and for when they are scheduled.

Gemba walks denote the action of going to see the actual process, understand the work, ask questions, and learn [11][12]. It is known as one fundamental part of Lean management philosophy [13].

Gemba Walk is designed to allow leaders to identify existing safety hazards, observe human resources and equipment conditions, ask about the practiced standards, gain knowledge about the work status and build relationships with

employees [14]. It is different from classic management style of MBWA. The objective of Gemba Walk is to understand the value stream and its problems rather than review results or make superficial comments [15]. A long with Genchi Genbutsu or “Go, Look, See”, Gemba Walk is one of the 5Lean guiding principles that should be practiced by Lean leaders on a daily basis. The Gemba walk is an activity that takes management to the front lines to look for waste and opportunities to practice Gemba kaizen, or practical shop-floor improvement [16].

Dynamic Gemba may be classified an application of group technology (GT), utilizes the concept of divide and conquer and involves the grouping of resources into cells responsible for manufacturing or assembly of similar parts or products [8]. The main reason that stores are attracted towards implementing CM layout is that the benefits of CM and Layout designs, which can normally be realized with relatively low capital investment by relocating and possibly duplicating certain resource as opposed to other automated strategies.

The design for cellular manufacturing involves three stages (i) grouping of items and production equipment into cells, (ii) allocation of the orders cells to areas within the shop floor (inter-cell or facility layout), and (iii) layout of the machines within each cell (intra-cell or machine layout)[16].

Although the concept of generally out problem has been studied for decades [10] for a comprehensive review of such models, certain specific and practical constraints normally

present in a real CM environment restrict the implementation of general-purpose layout models [6].

A major difficulty with the existing CM models is that they has no leveling and consider the travelling cost as the sole criterion and the layout with the minimum cost is presented to the decision maker (DM), ignoring many real-world constraints. Because of these limitations many industrial layout designs are being developed by the companies based on their in-house expertise.

This paper demonstrates the capability of handling the inventory via the heijunka DOE board matrix which depends on dynamic Gemba for one of bathtub manufacturing company in Egypt. Furthermore, the capability of the proposed model in capturing realistic constraints such as closeness relationships, location restrictions/preferences, orientations, aisle structures and irregular site shapes is also presented. A facility layout is an arrangement of everything needed for production of goods or delivery of services. A facility is an entity that facilitates the performance of any job.

2. The Track of Dynamic Gemba

This section presents the track of the dynamic Gemba which impact on delivery time via the heijunka KPI/DOE board matrix. “Fig.1” reviews the formulation of the Gemba and the position of proposed heuristic procedures of 5’S in treating traveler sales man problem in heijunka layout, which has specific property as rapid modification.

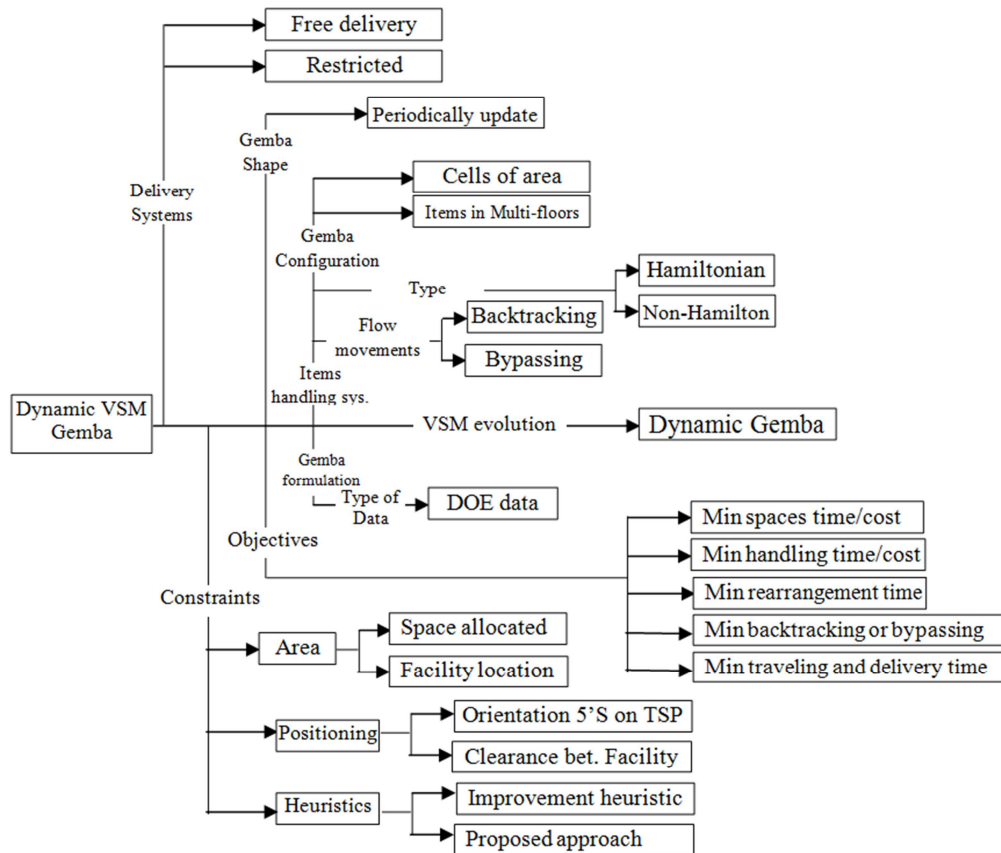


Fig. 1. The tree of the different factors for the dynamic Gemba VSM.

“Fig.1” illustrates a possible rough tree representation of the different factors for the dynamic Gemba layout and its related constraints. The proposed model is compared with its validate with the current state (as-is), this figure present a summary for the problem scope.

3. Proposed Heuristic Model

The proposed algorithm deal with movable (e.g. items) and fixed (e.g. cities) stations. The two types of stations have shared in the same objectives, which are reducing total delivery time and costs. The proposed procedures are divided into two phases, the first interested in rearrange the movable items in multi-floors depend on strongly KPI relationship using the heijunka matrix. While reducing the travelling time between the fixed stations in according to analyze the KPI of the delivery time after fed in the heijunka matrix is aim of the second phase.

A. Phase-1: Construct the Gemba Cellular Arrangement

This phase is concerned with reducing the buffers of the items between the different stations that appeared in VSM via grouping heijunka cells.

1. Determine the KPI for neighboring Hamiltonian stations
2. Construct the DOE for the KPI significant factors
3. Feeding the heijunka matrix with KPI values
4. Sum the values for every row and column.
5. Choose the largest value, whether from row or column for every station (item||city).
6. Arrange these values in ascending order.
7. Compilation of two smaller numbers, and then put the integrated station (item||city) in its position of the ascending order as done in step-3.

8. Continue until there remains not one single station (item||city), or the collected values become greater than the larger summation of all collected numbers that computed in step-1, whether for row or column.
9. Determine the cells as appeared in step-5.
10. Construct the Cells' table and its related station (item||city).
11. Arrange the related station (item||city) with respect to its strong KPI.
12. When we put the station (item||city) into place, examine the row for the executed and the extent of his KPI with other already existing, and then the level is chosen depending on the intensity of the KPI, either ground level or upper level.
13. Continue until put all station (item||city) in the 3-D studio dynamic Gemba.
14. These attempts depend on heuristic procedures as numbered in phase-1. If the utilization of the station “ $U_{m/c}$ ” and a Traveling Time $TT_{complet.flow}$ for any iteration is greater than next iteration, then go on, but if them equal then stop and become known.

4. The Total Cost Formulation

The objective functions studying the cost of traveling between movable or fixed stations. These functions depend on some sets such as the item type(i), intermediate buffers(b), the holding cost that appeared when stations late to pull item to serving order (h), supermarket capacity(sm), tact time(t), also have two parameters a_{ij} is the preparing time for item i on a specific station and b_{is} which denote to unit transference time for product i via supermarkets.

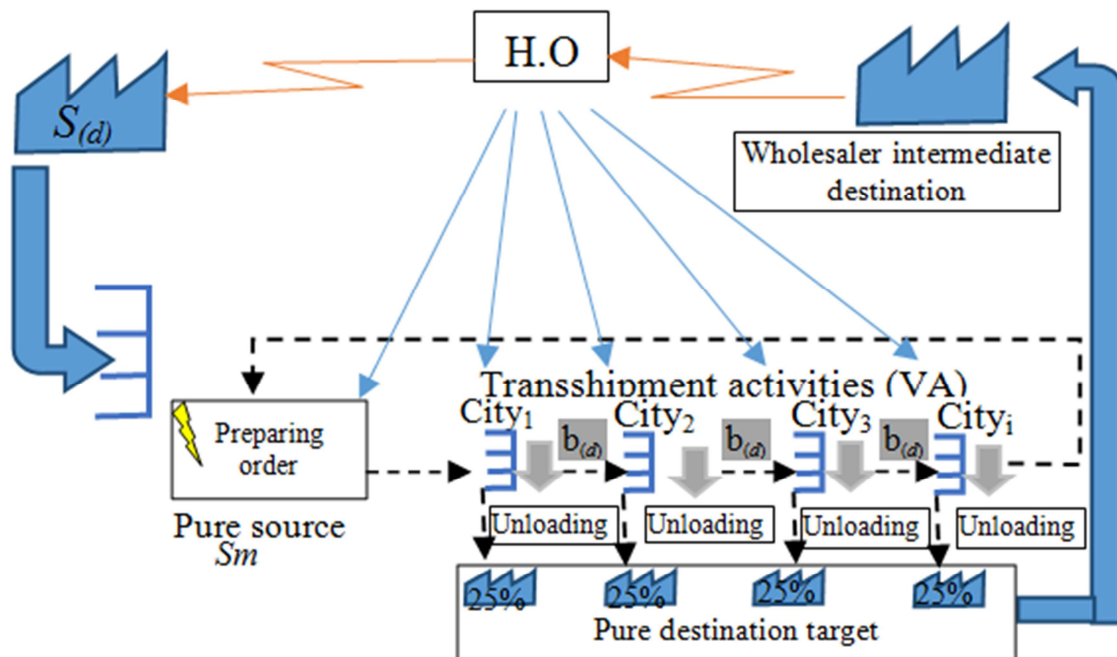


Fig. 2. Gemba of the travelling chart.

The intermediate inventories addressed as different stores as illustrate in “Fig.2”, these inventories were controlled with respect to the pulling operation. The cost computations were illustrated in four types of obj. function sand some constraints represented from “Eq.1toEq.18”.

B. Phase-2: Economic Transportation Distance and Time

The economic distance between different stations depends on the transportation cost and market profit form. If there is any units not handled weather transportation system become in position will increase transportation cost and that is a worst case.

The fixed cost of the transportation system is \$4km/day; the cost of handling items during trip is \$35km/day above the fixed cost. The historical file illustrates that there is a fluctuation between 250and 500km/trip, if the items handled in its time will save \$120/day (orders) but else if not handled in time (late, postponed or canceled) will cost company \$160 for transportation and \$45for inventory.

The next simulation code used to estimate the optimum quantity to shipping and transported during economic trip to design a suitable super-market:

```
%number of simulation runs
n=10000;
Cartons=[25:91];%%??????
```

```
order=[100:350];
minimum_move_condition=(0.175*Cartons)-(133);
fork=1:66
cum_saves=0;
form=1:n
void=91-floor(rand*(91-26));
ifvoid<=Cartons(k)
partial_saves=2.55*1.8*3*(91-Cartons(k)-order(k));
else
partial_saves=order(k)+(90*(Cartons(k)-void))-2*void;
end
saves=partial_saves-minimum_move_condition(k);
cum_saves=cum_saves+saves;
end
expected_saves=cum_saves/n;
p(k,1)=Cartons(k);
p(k,2)=expected_saves;
end
plot(p(:,1),p(:,2),'+',p(:,1),p(:,2),'-'), xlabel ('Ideal Distance
vs. void fill'), ylabel ('Transportation saves$')
“Fig.3” illustrates the ideal# of cartons save the
transportation costis more than 63 carton/trip that represents
the minimum void for the pace maker quantity.
```

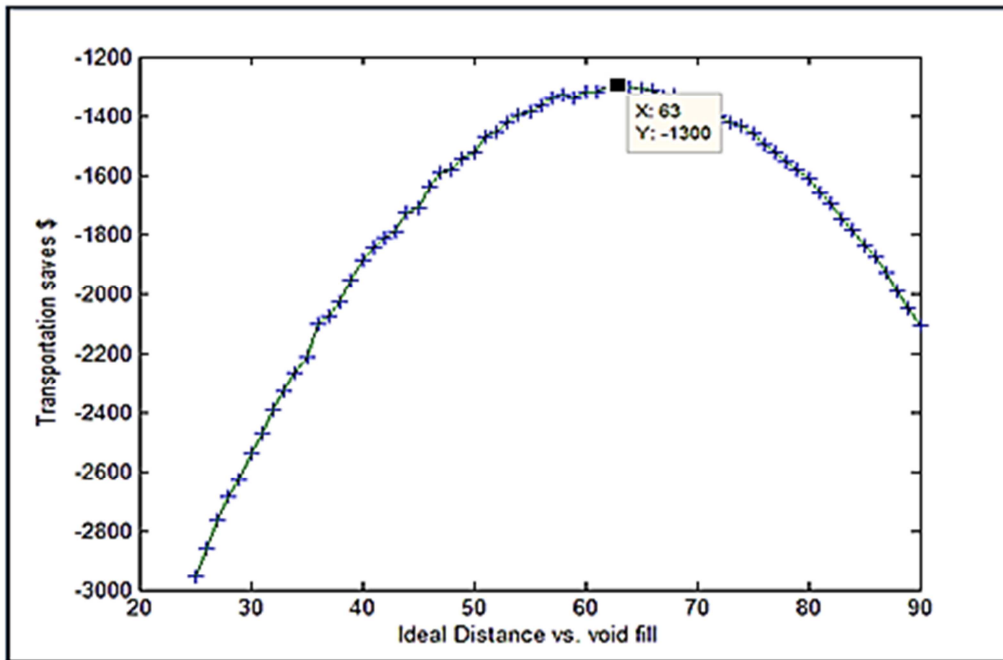


Fig. 3. The ideal trip distance vs. void sipping cost.

The Abbreviations used in the objective functions and proposed constraints:

Parameters		Decision variables	
a_{im}	Order preparing time for station i from station m	X_{imt}	Production quantity of product i produced from m in min
b_{is}	Order preparing time for station i in supermarket sm	RA_{mt}	Available time of supermarket in min .
R_{mt}	Available time of labor in min .	OA_{mt}	Over time capacity used in supermarket sm in min .
$CAPO_{it}$	Overtime capacity of order i in period t .	O_{imt}	Over time capacity of product i stay on station m in min .
$CAPOA_{it}$	Overtime capacity consumed in sm .	I_{imt}	Inventory of product i produced from m in min

Parameters		Decision variables	
PR_t	Regular time working capacity in man-hours	PL_{imt}	Amount of deficit of product i in period t in min
PO_t	Overtime working capacity in man-hours	LP_{ismt}	Amount of product i transported from m to sm
NW	Total number of workers to be assigned to sm	LQ_{ismt}	Amount of product i transported from sm to m
D_{ismt}	The quantity of items i demanded by sm	W_{smt}	Workforce assigned to pull supermarket
TQ_{sm}	Product holding capacity of sm as raw items	P_{ist}	Amount of end of period sm of product i in min
TP_{sm}	Product holding capacity of sm as semi-finish	QL_{ismt}	Amount of deficit of product i at sm in period t
TA_{msm}	Transportation time from m to sm in transshipment	Q_{ist}	Amount of sm of product i in the end
TCS_{smt}	The available distribution time of sm in transshipment	TLP_{msmt}	The number of travel needed from m to sm in transshipment
TB_{msm}	Transportation time from m to sm in pure source	TLQ_{msmt}	The number of travel needed from m to sm in pure mach.
$TCSS$	The available distribution time,	TPQ_{msmt}	The number of travel needed from m to sm in transshipment
TBS	Loading capacity of a Freight car, per travel	PQ_{ismt}	Amount of product i transported from sm to next sm
CP_{im}	Unit variable production cost of product i , on m	COW_m	Cost of the Freight car / hrs
CI_{im}	Cost of supermarket, for product i from m	CP_{im}	Cost of the supermarket in transshipment sectors
CL_{im}	Transportation cost	SQ_{ism}	Cost of holding Unit from product i , in sm
CO_m	The cost of the Overtime for m	SQQ_{ism}	Cost of shortage product i , if reduced in sm
CR_m	Cost of available regular time	$CTLQ_{msm}$	Cost of traveling needed i from sm to m

- The objective functions:

Objective-1, Profit:

$$\sum_{i=1}^{12} \sum_{m=1}^7 \sum_{t=1}^8 (X_{imt} PRC_i) - [\sum_{i=1}^{12} \sum_{m=1}^7 \sum_{t=1}^8 (CP_{im} \times X_{imt} + CI_{im} \times I_{imt} + CL_{im} \times PL_{imt}) + \sum_{j=1}^7 \sum_{m=1}^7 \sum_{t=1}^8 (CO_m \times O_{jmt})] \\ + \sum_{sm=1}^7 \sum_{m=1}^7 \sum_{t=1}^8 (CR_m \times RA_{smt} + CO_m \times OA_{smt} + COW_m \times OAW_{smt})]$$

Objective-2, Delivery Cost:

$$\sum_{i=1}^{12} \sum_{m=1}^7 \sum_{t=1}^8 (CP_{im} \times X_{imt} + CI_{im} \times I_{imt} + CL_{im} \times PL_{imt}) + \sum_{j=1}^{12} \sum_{m=1}^7 \sum_{t=1}^8 (CO_m \times O_{jmt} + COW_m \times OW_{jmt}) \\ + \sum_{sm=1}^7 \sum_{m=1}^7 \sum_{t=1}^8 (CR_m \times RA_{smt} + CO_m \times OA_{smt} + COW_m \times OAW_{smt})]$$

Objective-3, Super-Market Cost in transshipment sector:

$$\sum_{i=1}^{12} \sum_{m=1}^7 (SQ_{ism} \times Q_{ismt} + SQQ_{ism} \times QL_{ismt}) + \sum_{j=1}^{12} \sum_{m=1}^7 (TLQ_{msmt} \times CTLQ_{msm}) + \sum_{sm=1}^7 \sum_{t=1}^8 (TPQ_{psmt} \times CTPQ_{psm})$$

Objective-4, Super-Market Cost in pure sources or destinations sectors:

$$\sum_{i=1}^{12} \sum_{p=1}^7 \sum_{t=1}^8 (SP_{im} \times P_{imt} + SPP_{im} \times WL_{imt}) + \sum_{m=1}^7 \sum_{p=1}^7 \sum_{t=1}^8 (TLP_{mpt} \times LPC_{mp})$$

- The related constraints:

$$\sum_{i=1}^{12} a_{im} \times X_{imt} - R_{jt} - O_{jmt} \leq 0 \dots \forall m, t \quad (1)$$

$$\sum_{i=1}^{12} b_{is} \times X_{imt} - RA_{mt} - OA_{mt} \leq 0 \dots \forall s, m, t \quad (2)$$

$$O_{imt} - CAPO_{it} \dots \forall i, t \quad (3)$$

$$OA_{imt} - CAPOA_{it} \leq 0 \quad (4)$$

$$\sum_i^{12} Q_{ismt} \leq TQ_{sm} \quad (5)$$

$$\sum_m^7 P_{ismt} \leq TP_{sm} \quad (6)$$

$$Q_{ist-1} + \sum_{m=1}^7 PQ_{ismt} + \sum_{sm}^5 LQ_{ismt} + QL_{ismt} - Q_{ist} = D_{ismt} \dots \forall i, sm, t \quad (7)$$

$$\sum_m^7 TA_{msm} \times TLP_{msmt} \leq TCS_{smt} \quad (8)$$

$$\sum_{m=1}^7 TB_{msm} \times TLQ_{msmt} + \sum_m^7 TC_{msm} \times TPQ_{msmt} + QL_{ismt} \leq TCSS_{smt} \quad (9)$$

$$TLP_{msmt} \geq \left[\left(\sum_i^{12} LP_{imsmt} \right) / TBS \right] \quad (10)$$

$$TLQ_{msmt} \geq \left[\left(\sum_i^{12} LQ_{imsmt} \right) / TBS \right] \quad (11)$$

$$TPQ_{msmt} \geq \left[\left(\sum_i^{12} PQ_{imsmt} \right) / TBS \right] \quad (12)$$

$$X_{imt} + I_{imt-1} - I_{imt} + PL_{imt} = Dem_{imt} \dots \forall i, m, t \quad (13)$$

$$X_{imt} + I_{imt-1} - I_{imt} = \sum_p^3 LP_{imst} + \sum_{sm}^5 LQ_{ismt} \dots \forall i, m, t \quad (14)$$

$$RA_{smt} - PR_t \times W_{smt} = 0 \quad (15)$$

$$CAPOA_{smt} - PO_t \times W_{smt} = 0 \quad (16)$$

$$\max(W_{sm}) - W_{smt} - \min(W_{sm}) = NW \geq 0 \quad (17)$$

$$P_{ist-1} + \sum_{m=1}^7 LP_{impt} - P_{ist} = \sum_{sm}^5 PQ_{ismt} \dots \forall i, sm, t \quad (18)$$

Subjectto: $X_{imt}, I_{imt}, PL_{imt}, O_{imt}, W_{smt}, OA_{mt}, D_{ismt}, P_{ist}, Q_{ist}, QL_{ismt}, LP_{ismt}, LQ_{ismt}, PQ_{imsmt} \geq 0$

5. Construct the DOE for the KPI

The DOE depends on KPI (delivery time) = $f(\text{preparing order time, travelling time, unloading time}) \times f(\text{handling factor})$. All values is divided by 10. The frequency value means the staying time in specific node, the standard staying

time have a value (1) or its multiplication.

In our problem we needed to specify the delivery time for every node and number of strokes (f) for every node on the map.

Table 1. The doe of thekpitest.

Run number	A (min) (10 : 20) preparing time: X ₁	B(min) (50 : 240) travelling time: X ₂	C(min) (15 : 60) unloading time: X ₃	AB	AC	BC	ABC	Y [KPI: delivery time in min(four replicates, n=4)]				Total
								1	2	3	4	
1	-1	-1	-1	+1	+1	+1	-1	18.2	18.9	12.9	14.4	64.4
2	+1	-1	+1	-1	+1	-1	-1	27.2	24.0	22.4	22.5	96.1
3	-1	+1	+1	-1	-1	+1	-1	15.9	14.5	15.1	14.2	59.7
4	+1	+1	-1	+1	-1	-1	-1	41.0	43.9	36.3	39.9	161.1
summation												381.3
Effect of every variable on the target												
Sum of square for every variable (SS)												
Delivery time = 23.83 + 8.315X ₁ +3.77X ₂ -4.355X ₃ +4.355X ₁ X ₂ -23.83X ₁ X ₂ X ₃												23.83

Table 1. Continue.

Total	contract				
	A	B	C	AB	ABC
64.4	-64.4	-64.4	-64.4	64.4	-64.4
96.1	96.1	-96.1	96.1	-96.1	-96.1
59.7	-59.7	59.7	59.7	-59.7	-59.7
161.1	161.1	161.1	-161.1	161.1	-161.1
381.3	133.1	60.3	-69.7	69.7	-381.3
	16.63	7.54	-8.71	8.71	-47.66
	1107.22	227.25	303.6	303.6	9086.85
23.83	8.315	3.77	-4.355	4.355	-23.83

“Table1” illustrates the Effect of every variable is equal to $\frac{\text{contrast}}{2^{k-1} \times n} = \frac{\text{contrast}}{N \times n \div 2}$ where the N is the total number of runs.

The main effect to fA is $A = \overline{y_{A+}} - y_{A-}$ which the average response is for A at high level minus the average of response for A at low level. Therefore, the $A = \frac{133.1}{2^{2-1} \times 4} = 16.63$, Sum of

squares (SS) is the basis for the analysis of variance computation; the formula for the sum of squares is

$$SS_A = \frac{\text{contrast}^2}{2^k \times n} = \frac{(133.1)^2}{2^2 \times 4} = 1107.22$$

To complete heijunka

a matrix, we also need SS_T and SS_E. In two-level factorial design. $SS_T = \sum_{i=1}^2 \sum_{j=1}^k \sum_{k=1}^n y_{ijk}^2 - \frac{y^2}{N \times n}$, therefore the

$$SS_T = (18.2)^2 + (18.9)^2 + \dots + (39.9)^2 - \frac{(18.2+18.9+\dots+39.9)^2}{16} = 1709.83$$

and the sum of square error is $SS_E = SS_T - SS_A - SS_B - SS_C - SS_{AB} - SS_{ABC}$, $SS_E = 1709.83 - 1107.22 - 227.25 - 303.6 - 303.6 - 9086.85 = -9318.69$

Then the KPI of the heijunka a matrix will be adjusted according to this equation to calculate the KPI from node(i) to node(j), Delivery time_{itoj} = 23.83 + 8.315X₁ + 3.77X₂ - 4.355X₃ + 4.355X₁X₂ - 23.83X₁X₂X₃. “Fig.5” illustrates the ideal time for preparing orders is 1.6464 hrs, if the labors work 5 hrs after finishing their loading tasks, this means they can prepare between 39:54 orders/day. The best utilization for the drivers comes from working 8.0182hrs/trip plus unloading time to become 9.5182hrs.

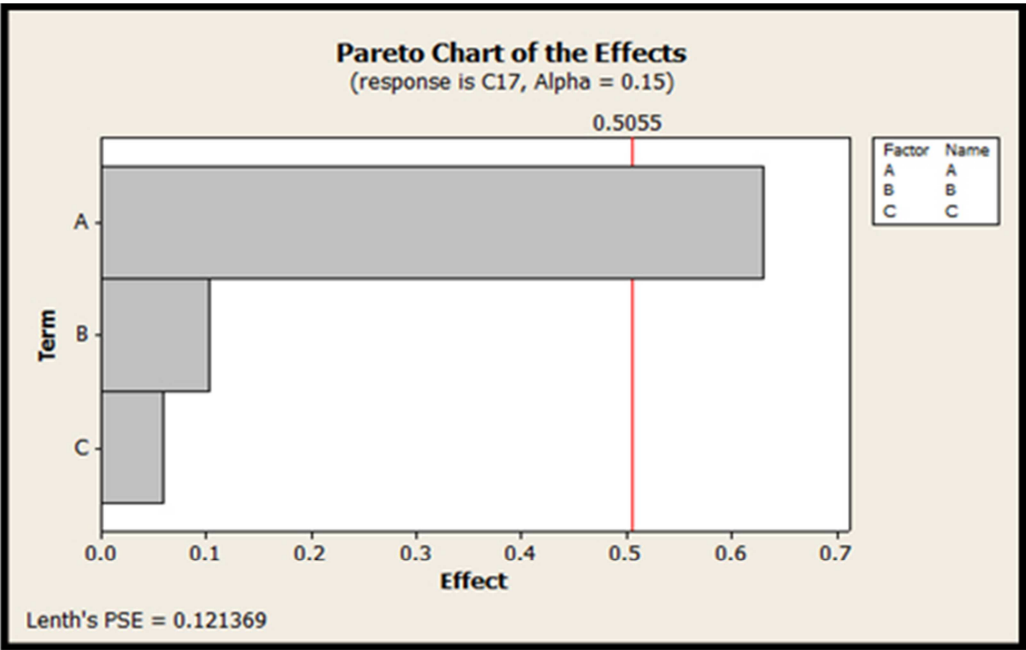


Fig. 4. The significant factor of KPI.

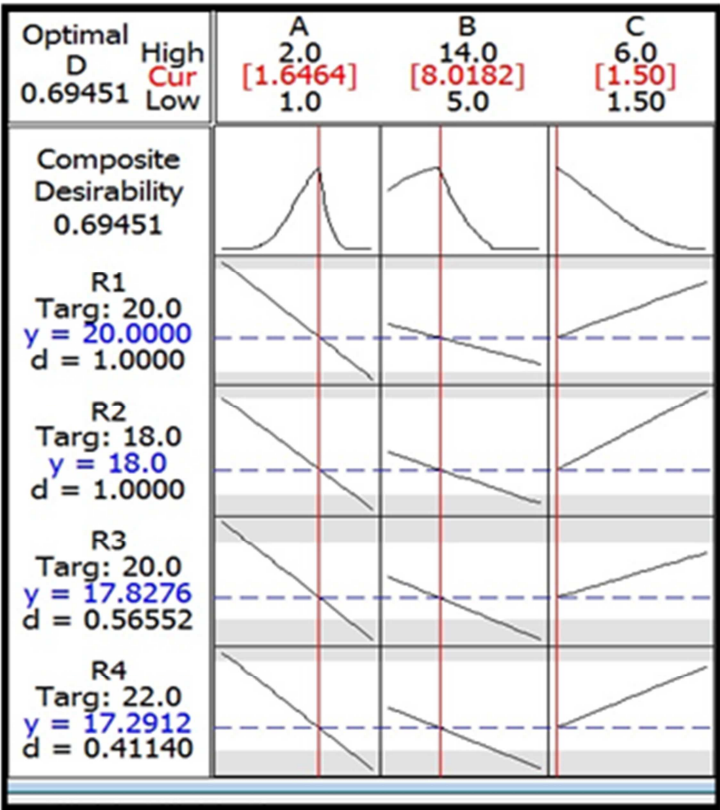


Fig. 5. The optimum values of KPI factors.

6. Applying the Proposed Algorithm

“Table2” states the logistics frequency between different stations. Where X_{ij} is number of trips moved from station(i) to station(j), symbol A is preserved to pure source node. The numbers appeared in “Table2” illustrate the KPI (delivery time)= $f(\text{preparing order time, travelling time, unloading$

time)* f *handling factor. The frequency is considers, how many time will stay in this node. Any negative value is refused. The maximum values indicate the preferred place to start distribution from it. While the minimum values indicate the cells of cities (stations) that increase the efficiency of the delivery action.

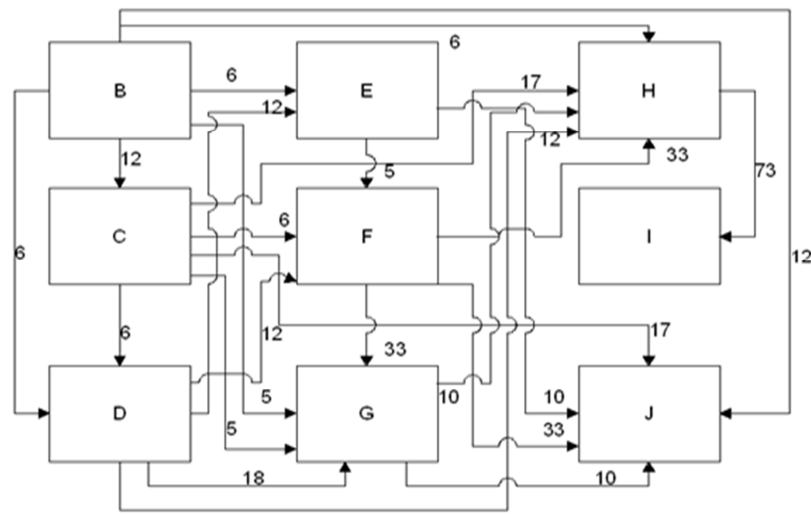


Fig. 6. The spaghetti diagram of "as-is".

Table 2. Heijunka tracking matrix: The delivery time among stations ||nodes||cities.

Direction of trip		Bypass between stations(مشوار الذهاب)								
		S ₁	S ₂	S ₃	S ₄	S ₅	S ₆	S ₇	S ₈	Σ
backtracking	S ₁		40	70	38		50	63		273
	S ₂	6				28	39	41		131
	S ₃				37	29	18	19		103
	S ₄			37			21		45	113
	S ₅		6	29			33	33		134
	S ₆		5	18				46		79
	S ₇		17				46		73	209
	S ₈				45			21		66
	S ₉	12	17					73		102
	Σ	18	85	154	120	57	207	296	118	155

Transporting Cost_(as-is)==£756.2. The travelling distance for "Fig.6" is 470km for single trip; this travelling is consumed 470*250day/year=117,500km/year.

1. Sum the relationships for every row and column.
2. Choose the smallest value, whether from row or column for every node and arrange these values in ascending order.

	S ₈	S ₅	S ₂	S ₄	S ₉	S ₃	S ₆	S ₁	S ₇
row	66	134	131	113	102	103	79	273	209
column	118	57	85	120	155	154	207	18	296
Σ الرحلتين	184	191	216	233	257	257	286	291	505

1. Compilation of two smaller numbers, and then put the integrated nodes (cities in the same trip) in its position of the ascending order as done in step-2.

iteration	S ₂	S ₄	S ₉	S ₃	S ₆	S ₁	S ₈ S ₅	S ₇
1	216	233	257	257	286	291	375	505
	S ₉	S ₃	S ₆	S ₁	S ₈ S ₅	S ₂ S ₄	S ₇	
2	257	257	286	291	375	449	505	
	S ₆	S ₁	S ₅ S ₈	S ₄ S ₂	S ₇	S ₃ S ₉		
3	286	291	375	449	505	514		
	S ₅ S ₈	S ₄ S ₂	S ₇	S ₃ S ₉	S ₆ S ₁			
4	375	449	505	514	577			
	S ₇	S ₃ S ₉	S ₆ S ₁	S ₅ S ₈ S ₄ S ₂				
5	505	514	577	824				
Cell	S ₃ S ₉	S ₆ S ₁	S ₇ S ₅ S ₈ S ₄ S ₂					
	514>505	577	1019					

2. Continue until there remains not one single node, or the first cell for the collected values become greater than the larger summation of the end value for the delivery time for this city, whether for row or column. This number in this case is 505.
3. Determine the cells as appeared in step-4.

Cells	S ₃ S ₉	S ₆ S ₁	S ₇ S ₅ S ₈ S ₄ S ₂
-------	-------------------------------	-------------------------------	--

4. Construct the Cells' table and its related nodes.

Cell_1	Related nodes cities				
S ₃	S ₄	S ₅	S ₇	S ₆	
S ₉	S ₇	S ₅	S ₂	S ₁	
Cell_2	Related nodes cities				
S ₆	S ₁	S ₇	S ₂	S ₅	S ₄
S ₁	S ₃	S ₇	S ₆	S ₂	S ₄
Cell_3	Related nodes cities				
S ₇	S ₉	S ₁	S ₆	S ₂	S ₈
S ₅	S ₇	S ₆	S ₃	S ₂	
S ₈	S ₇	S ₄			
S ₄	S ₈	S ₁	S ₃		
S ₂	S ₇	S ₆			

5. Arrange the related nodes with respect to its strong

delivery relations, and construct the multi-floor trip, which depends on TPS. Which suggest to build the store in S₇ position,

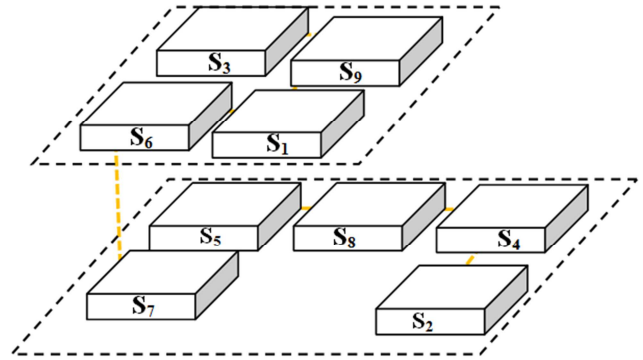


Fig. 7. New 3-D Gemba stations "Should-be".

Transporting Cost (heijunka) = 80,000 km/year, these procedures which present "Fig.7" were save 30% of costs. "Table3" illustrates the developing occurred by applying proposed procedures than current as-is situation.

Table 3. The Comparison between "proposed algorithm" and "as-is" state.

Attributes	As-is	To-be	Developing%
Delivery Lead Time "min"	713	595	16.5%
Travelling distance for trip km/year	117,500	80,000	32%
Travelling cost for complete trip£	645.6	482.6	30%
Fatigue and strength	High	Very Low	
Utilization to meet target	X	Up	28%
Inter-cell material handling turns	Complex	good	
Trip utilization	Low	enhance	
Number of cells	None	deterministic	
Quality feedback	Days	Minutes	
The Profits relate void cost	1227123	2001983	63%
The Delivery Costs	315,234	147,235	53%

7. The Conclusion

The dynamic Gemba VSM procedures are affected by the delivery time and costs. The proposed procedures are compared with *as-is* situation and aid the TSP to enhance the solution. The Delivery lead time was developed by 16.5%, the travelling time (NNVA) was developed by 32% and the travelling cost was reduced in average by 30%. The proposed procedures present a cellular of items, which increase from the labor utilization and quality feedback. Also increase the profits by 63%, all this information was illustrated in "Table3".

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