Analysis of Information Flow for Job-Shop Production System

Zainab Taha Jabur
Production & Materials Engineering Department, University of Technology / Baghdad
Email: Zainab. Taha@yahoo.com
Dr. Lamyaa M.Dawood
Production & Materials Engineering Department, University of Technology / Baghdad

Received on:3/11/2013 & Accepted on:5/6/2014

ABSTRACT

Controlling the flow of (information /materials) inside job-shop involves several decisions such as the acceptance or rejection orders, the orders due date definition, releasing and dispatching of job. In this research the actual production system control in Heavy Engineering Equipment State Company (H.E.E.S.Co.) is followed and monitored throughout one year . Liquefied Petroleum Gas (LPG) tanks detailed processing and assembly investigated as a case study. The deviation of tanks assembly processes is about 53% from the schedule time. . Therefore, questionnaire sheet is performed including stuff of (164). Overall information flow in the company for most respondents is fair to bad (80%). communication matrices revealed that information exchange is random and inflexible through the whole production control. Gaps in communication and lack in (Computer – Computer) information exchange leading to bad communication throw the whole shop floor activities. Also results declare shop floor control in (H.E.E.S.Co.) company is offline (paper–based) and no documentation orders , that are employed by direct communications.

Keywords: Information, job-shop, material flow, communication matrix, shop floor control.

تحليل سريان المعلومات لنظام الانتاج حسب الطلب

الخلاصة

السيطرة على تدفق المعلومات والمواد في نظام الانتاج حسب الطلب يتضمن عدة قرارات صعبة منها التسليم حسب الطلب ,قبول او رفض الطلب, تحرير سرعة ارسال العمل , في هذا البحث تم متابعة الفعاليات الحقيقة لنظام سيطرة الانتاج في المعدات الهندسية الثقيلة لفترة سنة كاملة.تفاصيل خزانات ال بي جي التي تتضمن العمليات والتجميع, نسبة الانحراف عن المعدل الذي تم تخطيطه هو حوالي (53%) ولتأكيد ذلك فأن الاستفتاء الحقيقي الذي تم باخذ رأي (164) منتسب أكد ان نسبة سريان المعلومات هي فاشلة الى سيئة بسنبة (80%) , ومصفوفة الاتصال توضح بان تبادل المعلومات هو عشوائي وغير مرن خلال نظام الانتاج الكلي وهناك فراغات ونقص في العلاقة (حاسوب-حاسوب) وهذا بدوره يدي الى اتصال سئ في مختلف الفعاليات. والاستنتاجات توضح بأن السيطرة على الفعاليات الكلية هو نظام ورقي وليس متصل بشبكة ولايتم توثيق المعلومات بالحاسوب يتم نقل المعلومات بصورة عادية مباشرة.

INTRODUCTION

Job Shop manufacturing systems have a set of features, which make the production control quite difficult. Wide range of products must be made in small number of units by means of different specialized machines. The sequence in which the products pass through varied machines depends on the type of the product. Assembly of parts and alternative routes of production are also possible. A priority also exists for each product, depending on the due dates agreed on with the customer. Therefore, controlling this type of production systems is very important and complex [1,2].

Shop Floor Control System (SFCS) involves setting objectives as goals, devising methods for measuring performance against the objectives, evaluating performance (especially deviation from the planned results), and deciding on corrective actions (where this is possible) to get back on schedule. The goal of shop floor control is related to operation goals, such as: machine utilization and customer satisfaction (meeting due dates, expected quality and quantity).

Objectives of shop floor in production control may be divided into the following categories; Providing input-output control to all work centres means (developing information about how jobs are flowing among work centres); measuring and assigning priority for each order; studying the overall flow time and work in process; keeping work in progress (WIP) inventory update; issuing dispatching list to each work centre and manipulating the overall lead time [3,4].

Factors affecting production control systems are:-nature of manufacturing process, nature of production, complexity, speed of execution / magnitude of operations and uncertainty [5,6]. Shop floor control system generally consists of three phases as shown in figure (1). Order Release (OR) provides documents that are needed for a processes of production order through the factory such as route sheet ; material requisition, job - card ... etc. Order Scheduling (OS) this phase follows order release and assigns the production orders to the various work centres.

Order scheduling phase reflects dispatching lists that show which production order should be done through the work centre; and Order Progress (OP) In this phase status of various orders, Order progress reports include:- Work Order Status Reports (WOSR); Progress Report (PR) and Exception Report (ER) is monitored [7,8].

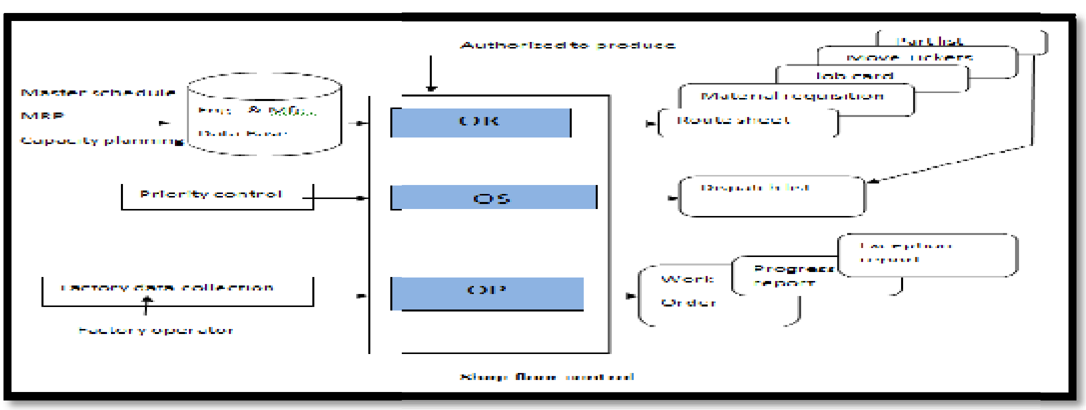


Figure (1) Phases of Shop Floor Control [4].

In job shop and discrete batch production systems, if predictive scheduling is used for generating short term schedule, then (real-time) control of production can be based on the predictive schedule with or without considering other goal functions. For small batch industries production control may be more informational since it is more personal and direct. But for job-shop production systems the production control is complex and depends upon scope of operations, layout of the units. Therefore, production control may be centralized or decentralized. Centralized control secures the most effective coordinate but as an organization grows in size , decentralization of some production control function becomes necessary[2,5]. In the next paragraph material/ information flow is overviewed so as to declare the important of material and information flow, followed by literature review declaring the different approaches of controlling the production this paragraph is followed by data collection from shop floor control in (H.E.E.S.Co.), data are analyzed according to material /information flow so as to instigate the production control in (H.E.E.S.Co)results are revealed and discussed, further research work is recommended.

Material flow and information flow

Material status information is used to discover what new operation has to be performed on material (process interpretation). Status information is also used for the monitoring function. One way of characterizing production process is by materials flow analysis. Such analysis involves process input, intermediate products or final products, and can also consider a range of mechanisms. For manufacturing processes, the principal impact is associated with the process outputs. The data obtained from material flow in this analysis characterize the loading, material flow and transport crossing, transit and other important information about the material flow [2, 9.10]. Controlling the flow of materials inside job-shops involves several decisions such as the acceptance or rejection of an incoming order, orders due date definition, the releasing and the dispatching of the job. The resource status information is used to decide what new work has to be done by a resource (allocating and sequencing) [11,12]. The goal of information flow control is to ensure the sole existence of safe, or secure, information flows through process. There are three different categories of channels which can be used. The first; is the legitimate channels (these channels are based on mechanisms intended for information transfer). The second(is concerned in storage channels; such channels make use of mechanisms which are not primarily intended to transfer data, but to store it). These channels are used in an attempt to delay time and space of the undesired flow. The last; of channels are also called convert channels (These channels use mechanisms which are not intended for the manipulation (transfer, computation or storage) of information) [13]. Information relationships are normally exist in six forms are; Man –Man, Computer- Computer, Machine-Machine, Man- Computer, Man-Machine, Computer –Machine [15]. Fig. (2) Illustrate material and information flow in job shop manufacturing system.

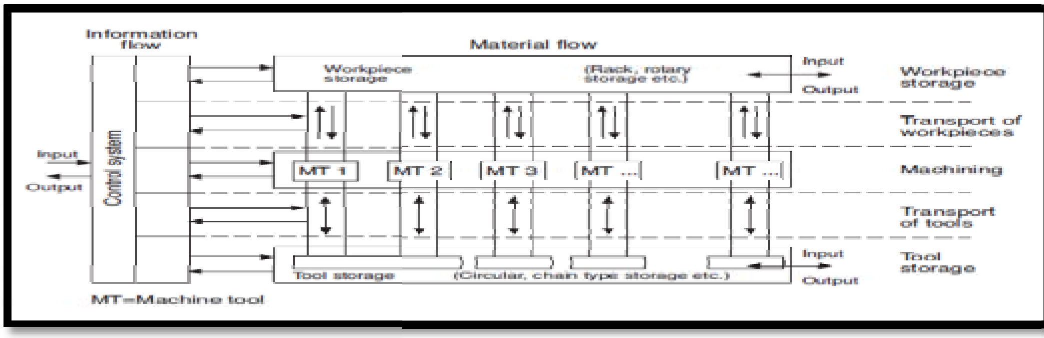


Figure (2): Material and Information Flow in Job-Shop Manufacturing System [14].

Literature Survey

W. A. Raheem , (1999), studied automated data collection system in the modern sewing company (job-shop production system) in his research he developed a prototype for automated data collection system order progress phase for the company shop floor [15].While Amitava Nandi and Paul Rogers(2003) analysed the behaviour of make-to-order manufacturing system under a control policy for both order release and order acceptance/rejection. Their developed system present better to release orders for the shop floor as soon as the orders are accepted since their objective was to minimize the sum of rejection, losses and tardiness losses [16]. He Yanli, et .al. (2006) presented flexible workflow for job shop manufacturing execution and automation system. Agent technology was applied to take advantage of distributed system architecture, reactivity, adaptability and cooperation. They claimed that their proposed system is helpful in achieving production efficiency without huge investment in industrial automation systems [17]. M. Kumar and S.l Rajotia(2006) found frame work for integration of process planning with production scheduling in a job shop environment for axisymmetric components. Their study is based on the design specifications of incoming parts, feasible process plans that are generated taking into account real time shop floor status and availability of machine tools. Their scheduling strategy prioritizes the machine tools based on cost considerations [18]. Evandro L. Silva and Alberto J. (2008) presented shop floor controller for management and control of shop floor activities to the execution of the production plans which deals with order progress for FMS. The information is received from the upper hierarchical levels, processes using heuristic approach that is previously defined. Selected tasks are dispatched to the shop floor and is monitored. Their shop floor control functionalities were subdivided into: Planning; Scheduling; Execution task [19]. Luma Al-Kindy (2010),studied concurrent scheduling at job shop manufacturing system in (H.E.E.S.Co) shop directed towards order scheduling phase. The aim of her research is to meet customer's due dates and shorten "engineer-to-delivery" so as to increase competition capabilities. She developed Decision Aided Hybrid technique DAHHM that minimizes lateness in job orders as much as possible so as to satisfy customer's due dates [20].

Rasool T., et.al.,(2013) , defined the value of information in stochastic networks as the relative increase in the expected value of maximum flow to determine a flow after the realization of the failures in the network, rather than determining a flow before the uncertainty is revealed. Used a simulation- based approach to compute the value of information and provide some computational results to demonstrate the ability of this method. Their results show that the value of information can be around 61% on some instances [21].

Christopher Durugbo , et.al.,(2013) modelled the information flow for organisations that is motivated by the need of better understanding of ; organising and coordinating processes, eliminating redundant processes, minimising duplication of information and manage the sharing of intra- and inter-organisational information . They claimed that it is required to understand communication barriers among departments that results in sub-optimal and inflexible organisational processe. This is because models aid analysts to effectively communicate complex design issues. They concluded that better understanding of organisational processes is vital to assessing the performance of an organisation [22].G. Paredes,et.al.,(2013) investigated the relationship between the emergence of chaos synchronization and the information flow in dynamical systems possessing homogeneous or heterogeneous global interactions whose origin can be external (driven systems) or internal (autonomous systems). By employing general models of coupled chaotic maps for such systems, they show that the presence of a homogeneous global field, either external or internal, for all times is not indispensable for achieving complete or generalized synchronization in a system of chaotic elements[23].

Experimental work

Heavy Engineering Equipment State Company (H.E.E.S.Co.) is job-shop manufacturing system that is specialized in manufacturing and erecting heavy engineering equipment required in many industrial fields, with staff of about 2560 employees working at various activities engineering, marketing, administrative,.. etc.). Production rate is calculated as the total weight of products produced within the year such as [pressure vessels, all kind of storage tanks, gates (used in dams), heat exchangers, steam-boilers..etc. [24]. These products are manufactured according to ASTM standards [25]. In order to investigate the production control activities in (H.E.E.S.Co.) throughout one year, for certain products (tanks). In this research LPG five tanks(general Order Specifications) are shown in Table(1),while production details processing and assembly are revealed are in Tables (2)-(4) below.These produced tanks are of the same type, size, number of courses, same material and same scheduled time. It was observed that the shop floor control in (H.E.E.S.Co.) is (off- line), paper–based where orders are employed by direct communications and all the information in (H.E.E.S.Co.) is mostly not documented.

Order scheduling phase was monitored for these tanks and details are shown in tables (2, 3, 4) respectively. Auto CAD ((2012) software [26] is used to depict assembled tank, part details and dimensions in (mms) shown in Fig. (3).

Table (1) General Order's Specifications

Type of product	Quantity	Details	Others
LPG Tanks	5	Metal type;-C.StA516GR70	Each tank consists of: - (2) heads , one shell(each shell consist of 6 courses)

Analysis of Results and discussion

From tables (2,3,4) it can be noticed the detailed production activities for LPG five tanks that are produced concurrently. Bold columns in each of these tables indicated the actual production duration against each activity (in days).Figs.(4,5,6) shows the Gantt chart of order progress for the tank production and assembly. From these it is noticed that;-

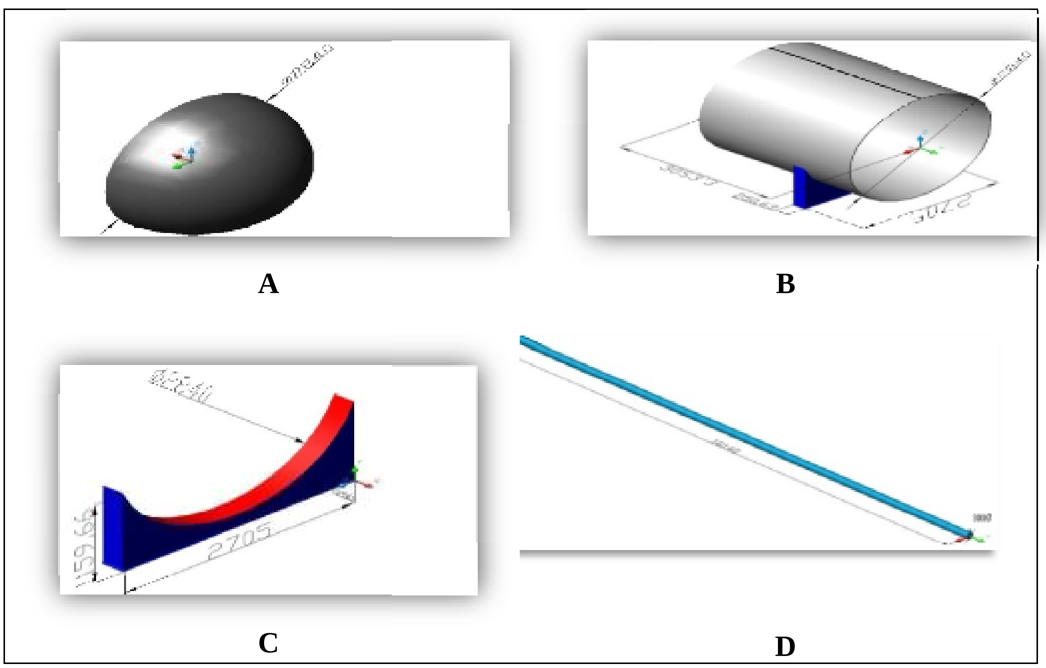
i. The total scheduled time for each tanks is (76days) while the actual production is performed in (97, 113, 106, 97, 95) days respectively. i.e. the maximum delay is 37 days.

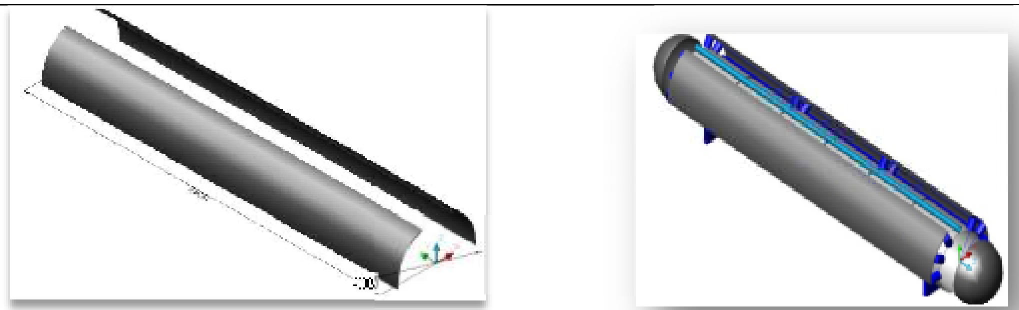
ii. Shell processing scheduled time for each tank is (27) days but actually it is processed in (31, 38, 35, 34, 33) days respectively.

iii. From Table (5) that shows summery of Production/Assembly activities it is noticed the highest delay time(128 days) is at assembly processes, while production of the five heads of the five LPG tank is earlier by 5 days thus rescheduling may be reconsidered.

iv. The total schedule time (180) days for the five tanks, while the real production time is(275) days total delay time is 95 days i.e. (3 month delay). And the deviation of total tanks from programmed schedule at the assembly processes is about 53% of the total delay.

v.Therefore, the total schedule time for the five LPG tanks is (380) days **but** the real total production time is (508) days. Hence, the deviation from scheduling is (128) days as shown in table (5).





E F

Figure(3):Detailed LPG Tank Components and Dimensions(mm)

Where:-

A: Tank Spherical Head B: Single Course of tank Shell. C: Tank Stand D: Shower Tube E:cover of the tank. F:Final Shape of assembeled Tank.

Table (2) LPG Tanks Head Production Activities.

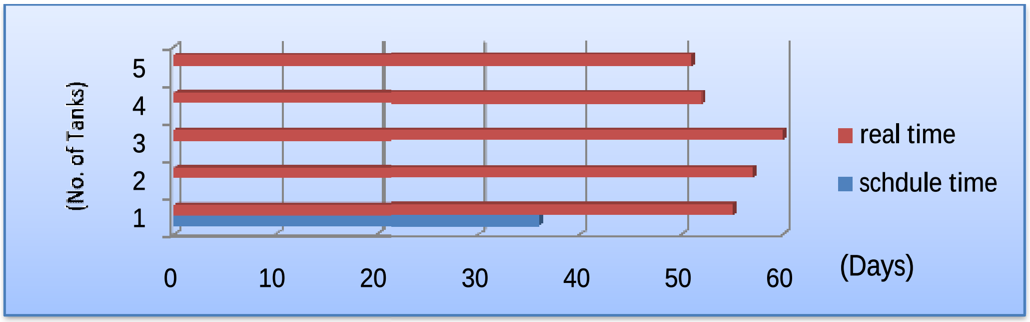
Processes	Head of tank1 (days)		Head of tank.2 (days)		Head of tank3(days)		Headof tank 4 /(days)		Headof tank 5 (days).	
1-clean & inspect	1\2	1\2	1\2	1	1\2	1	1\2	1	1\2	1
2- *defining dimension.	1\2	1\2	1\2	1	1\2		1\2		1\2	
3-inspection	1\2	1\2	1\2	1\2	1\2		1\2		1\2	
4-cutting&cleaning the end to Equipped for welding.	1\2	1\2	1\2	1\2	1\2	1\2	1\2	1\2	1\2	1\2
5- *fitting	1\2	1\2	1\2	1	1\2	1\2	1\2	1\2	1\2	1\2
6- inspection	1\2	1\2	1\2	1\2	1\2	1\2	1\2	1\2	1\2	1\2
7- welding	2	1	2	2,1\2	2	2	2	2	2	2
8-inspection	1\2	1\2	1\2	1\2	1\2	1\2	1\2	1\2	1\2	1\2
9- *fit the size of diameter.	2	1	2	1	2	1	2	2	2	2
10-pressing	1\2	1\2	1\2	1\2	1\2	1	1\2	1\2	1\2	1\2
11-inspection	1\2	1\2	1\2	1\2	1\2		1\2	1\2	1\2	1\2
12- *make the center hole in head to fixed it in flanging machine.	1\2	1\2	1\2	1\2	1\2		1\2	1\2	1\2	1\2
13-inspection	1\2	1\2	1\2	1\2	1\2		1\2	1\2	1\2	1\2
14-flanging	1\2	1\2	1\2	1\2	1\2	1	1\2	1\2	1\2	1\2
15-inspection	1\2	1\2	1\2	1\2	1\2	1	1\2	1\2	1\2	1\2
16-close the hole & inspect	1\2	1\2	1\2	1\2	1\2	1\2	1\2	1	1\2	1
17-marking	1\2	1\2	1\2	1	1\2	1	1\2		1\2	
18- inspection	1\2	1\2	1\2	1	1\2		1\2		1\2	
19- clean the cutting end .	1\2	1\2	1\2	1	1\2		1\2		1\2	
20- inspection	1\2	1\2	1\2	1	1\2		1\2		1\2	
Total Time	13 days	11 days	13 days	16 days	13 days	11 days	13 days	11days	13 days	11 days

Table (3) LPG Tanks Shell Production Activities

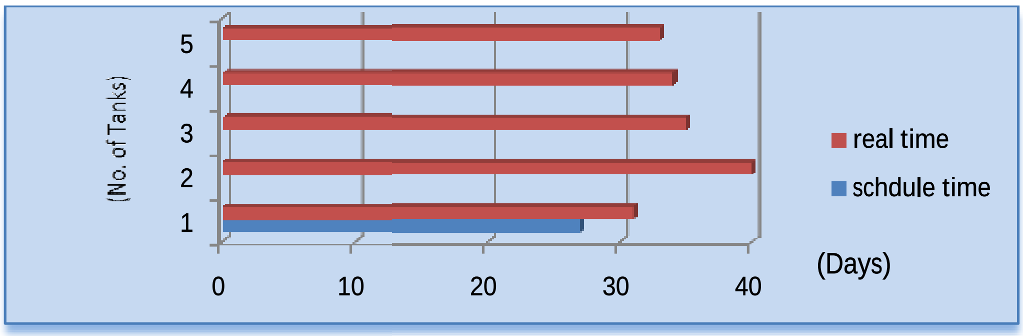
processes	Shell of tank1 (days)		Shell of tank 2 (days)		Shell of tank 3 (days)		Shell of tank 4 (days)		Shell of tank 5 (days)	
	scheduling	real	scheduling	real	scheduling	real	scheduling	real	scheduling	real
1-Clean with Sand Plast & Inspection.	3	3	3	3	3	3	3	3	3	3
2- Defining Dimension	1	1	1	1	1	1	1	1	1	1
3- Inspection .	1	1	1	2	1	1	1	2	1	1
4-*Cutting &Repair E Welding End.	4	6	4	5	4	5	4	4	4	4
5- Inspection	1	1	1	1	1	1	1	1	1	1
6- Rolling Of Shell	2	1	2	3	2	3	2	2	2	3
7-*Fitting	3	4	3	5	3	4	3	3	3	3
8-Inspection	1	2	1	2	1	1	1	1	1	1
9-Welding	6	8	6	9	6	8	6	9	6	8
10-Inspection	1	2	1	2	1	1	1	1	1	1
11-Re-Rolling	2	3	2	4	2	3	2	2	2	2
12- Inspection	2	2	2	3	2	4	2	5	2	5
Total time	27 days	31 days	27days	40 days	27days	35 days	27 days	34 days	27 days	33 days

Table(4) LPG Tank Assembly Activities

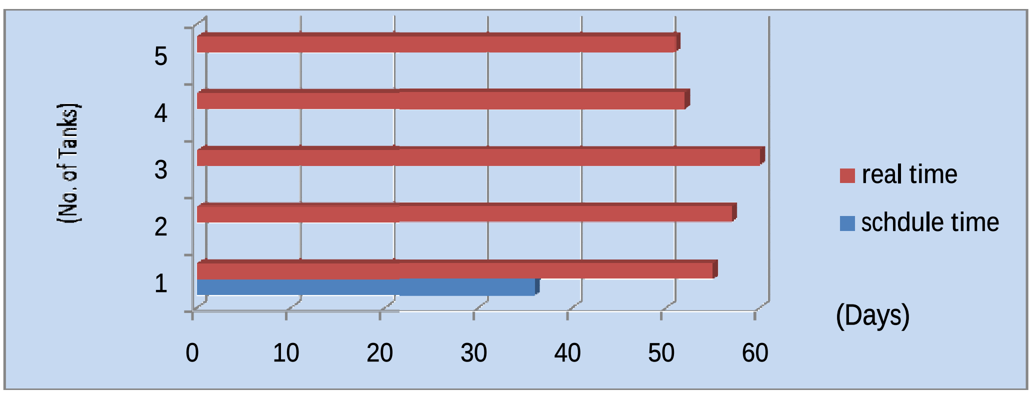
Processes	Tank 1 (days)		Tank .2 (days)		Tank .3 (days)		Tank .4 (days)		Tank .5 (days)	
	scheduling	real	scheduling	real	scheduling	real	scheduling	real	scheduling	real
1-*Connect the 1'st end with shell by point of welding	1	3	1	2	1	3	1	2	1	2
2- Inspection	1	1	1	1	1	1	1	1	1	1
3-Welding.	3	8	3	8	3	10	3	8	3	12
4- Inspection.	1		1		1		1		1	
5-*Identification nozzle places on shell.	1	1	1	2	1	2	1	1	1	1
6- *Inspection.	1	1	1	1	1	1	1	1	1	1
7- *Marking.	1	1	1	2	1	1	1	1	1	1
8-*Inspection.	1	1	1	1	1	1	1	1	1	1
9- Assembly (connect the 2'nd end with shell & welding)	3	5	3	10	7	8	3	9	3	6
10- Inspection	1		1		1		1		1	
11-Welding the others courses of shell	3	10	3	7	3	10	3	8	3	10
12- Inspection	1		1		1		1		1	
13- Accessories assembly	15	18	15	17	15	16	15	15	15	10
14- stand welding	1	3	1	2	1	3	1	2	1	2
15- Inspection	1	1	1	2	1	2	1	1	1	2
16- *Painting	1	2	1	2	1	2	1	2	1	2
Total time	36 days	55 days	36 days	57 days	36 days	60 days	36 days	52 days	36 days	51 days



Figure(4) : Gantt order Progress of LPG Tank(Head)



Figure(5) : Gantt Chart Order Progress of LPG Tank(Head).



Figure(6):- Gant Chart Assembly Activities Progress for LPG Tank

Table (5) Summery Of Production/Assembly Activities for (5) LPG Tanks.

Production processes	Total Scheduled time(days) for (5) tanks	Total actual time (days) for the 5 tanks	Status of order (days)
Head	65	60	5 before scheduled date
Shell	135	173	38 late
Assembly	180	275	95 late
Total time	380	508	128 late

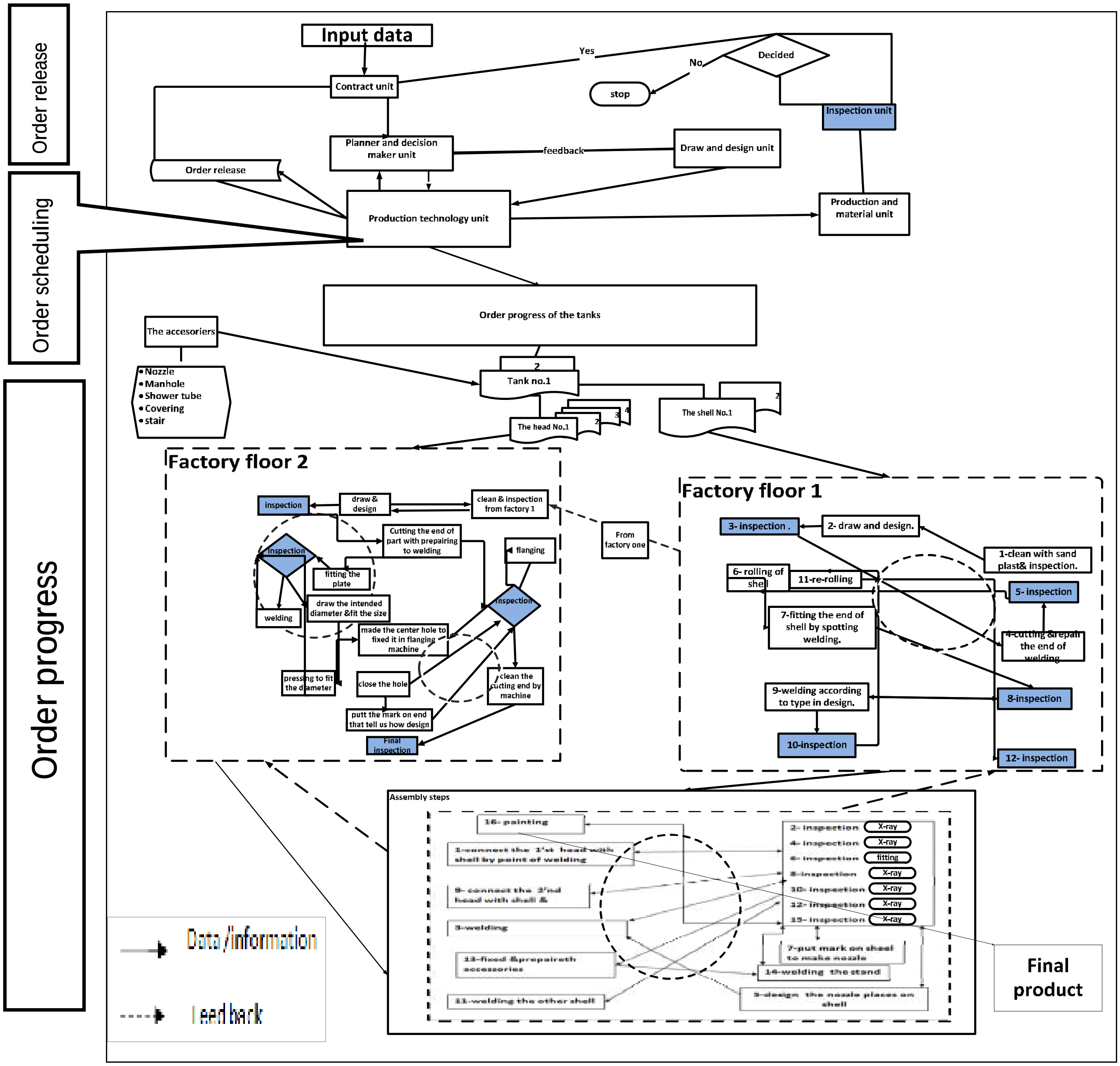


Figure (7): Material and Information flow of production control in (H.E.E.S.Co) for tanks

Analysis of Information /material flow.

Materials/Information flow between department and inter- connections is investigated in (H.E.E.S.Co.) and depicted as shown in Fig. (7). In this figure shop floor inspection activities are marked bold, only two dimensions flow data and information (forward / backward) are revealed. This Figure shows the current connection between departments where traffic of information flow and interconnection between different activities, factories in (H.E.E.S.Co.) is indicated as a dotted circle(shows material / information jam) on producing these tanks. The three phases of production control system are also indicated in this Figure.

Assessment of current information flow in (H.E.E.S.Co) production control is s crucial therefore, questionnaire sheet is prepared is performed including (164) workers where they are devided into; (51) engineers, (47) workers,(20)technitions and (46) management members . The investigation results are revealed below in Fig (8) .

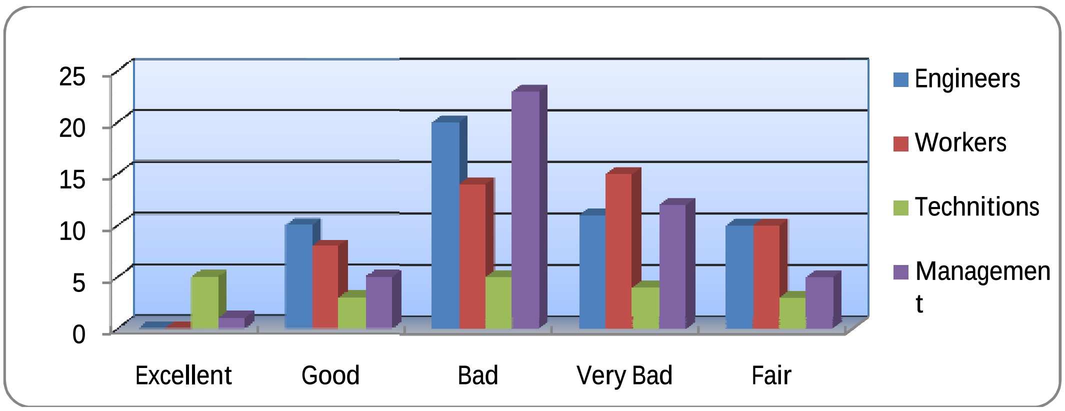


Figure (8): Current Information Flow in Production Facilities of (H.E.S.S.Co.).

From this Figure the percentage of staff who believe that information flow is excellent (3.65 %) , while staff who believe that information flow is good (15.83 %), bad (37.8%), other workers believe that information flow is very bad (25.6%). Remaining staff of (17.0%) believe that the information flow is fair. According to the investigation the workers are aware that overall information flow in the company is bad in fact most respondents who rated it as fair to bad is (80%) . These results highlight the need to improve poor information / communication flow.

Matrix relationship between different information stock holders are ; Man –Man, Computer- Computer, Machine-Machine, Man- Computer, Man-Machine and Computer –Machine is performed so as to define information flow in the order of progress therefore, traffic points are realized through processes ,activities, also there are information gaps in production system of (H.E.E.S.Co.). Tables from (5) to (7) reveal the status of information flow between these six categories for different activities for one product at a time. Check point (√) indicates the presence of communication.

Table (5) Tank Head Information Matrix

Tasks of head	Man –Man	Computer-Computer	Machine-Machine	Man- Computer	Computer –machin	Man-machine
1	✓					
2	✓					✓
3	✓			✓		
4			✓			
5	✓					
6	✓					
7			✓			✓
8			✓			
9	✓					
10			✓			
11						✓
12	✓					✓
13	✓					
14			✓			
15			✓		✓	
16	✓		✓			
17	✓					
18			✓		✓	
19	✓					✓
20			✓		✓	

Where :- (√) is information ralationship exchanger

Table(6) Tank Shell information Matrix

Tasks of shell	Man –Man	Computer-Computer	Machine-Machine	Man- Computer	Computer –machin	Man-machine
1	✓					✓
2	✓					✓
3						✓
4			✓			
5						✓
6			✓			
7						✓
8			✓			
9						✓
10			✓			
11			✓			
12			✓			

Table (7) Tank assembly Information Matrix

Tasks of assembly	Man –Man	Computer-Computer	Machine-Machine	Man- Computer	Computer –machine	Man-machine
1						✓
2	✓					
3					✓	✓
4			✓		✓	
5	✓					✓
6	✓					
7						✓
8	✓					
9			✓			✓
10			✓	✓		
11					✓	✓
12			✓	✓		
13						✓
14					✓	✓
15	✓					✓
16	✓					✓

These matrices are (2D) information exchange and at the same place .i.e. information exchange between factories (matrices) as in assembly processes is not depicted (2D or 3D). Results revealed from these matrices are:-

i. Information exchange is random and inflexible through the whole factory.

ii. The lack in (Computer – Computer) information exchange as noticed in Tables from(5) - (7) .This gap is due to the lack of employing computers that are already available at the work shop to save, retrieve, and edit of information .There are also CNC,NC machines in factory but there is no (Machine – Computer) information exchange. That's led to bad communication throw the whole shop floor activities.

iii. It was noticed in producing shell(s) that there is no indication more than (Man-Man) or (Man - Machine). Thus for order progress phase communication depends almost upon face-to-face ,therefore, there is no feedback on documented order progress, instructions etc. which led to non-systematic order progress consequently production control system.

iv. Machine –Machine information exchange through these matrices range is weak to none as seen in matrices (5) – (7).

Concluding Remarks and future work:-

i. The shop floor control in H.E.E.S.Co. company is paper–based, orders are employed by direct communications. So the need for new solution is important to solve this problems by use collaborative system software.

i. Information exchange in (H.E.E.S.Co.) is off- line , random and inflexible through the whole production system.

ii. Since controlling the flow of materials inside job-shops involves several decisions such as acceptation or rejection of an incoming order, the order's due date , dispatching of job and in order to integrate these departed activities throughout the whole production system.

iii. Collaboration of shop- floor is an integrating methodology that boost communication, and enforce interaction regardless the geographic dispersion of production/ assembly activities, therefore, it is recommended for this dynamic complex production system.

REFERENCES

[1] Fogarty, D.W., J.H. Blackstone, And T.R. Hoffmann, (1991), Production And Inventory Management, 2nd ed., McGraw-Hill, New York,USA.

[2] Koichi Murata Hiroshi Katayama,(2009), An Evaluation Of Factory Performance Utilized Kpi/Kai With Data Envelopment Analysis, Vol.52, No. 2, PP. 204-220, j. Op Res. Soci. of Japan.

[3] Dan Floroian ,(2009) , Multi-Agent Systems for Shop Floor Architecture Management, Review of General Management , Vol. 10 , No. 2, PP. 66-78.

[4] V. Vinoda, R. Sridharanb , (2007), Scheduling A Dynamic Job Shop Production System With Sequence-Dependent Setups: an experimental study,Vol.3,No.12 ,PP. 12-25.

[5] J .D. Edwards, (2007) ,"Shop Floor Control, United States Government, USA.

[6] K. Murata,(2009), An Evaluation Of Factory Performance Utilized Kpi/Kai With Data Envelopment Analysis, Vol. 52, No. 2, 204-220, Jo. Op. Res. Soci. of Japan.

[7] E. Scherer, (1989), Shop Floor Control-An Integrative Frame Work From Static Scheduling Models Towards And Agile Operations Management, (IEEE),Vol.1 , No. 23, PP.1-30.
[8]S.K. Sharma, (2009), "Industrial Engineering And Organization Management" , New Delhi, India.
[9] S.K. Sharma, (2009), "Industrial Engineering And Organization Management", New Delhi, India.
[10] N. Broberg ,(2011), PhD thesis, Practical, Flexible Programming With Information Flow Control, University Of Technology , Goteborg University, Goteborg, Sweden.
[11] P. Kostal And A. Mudrikova , (2010), Material Flow In Automated Manufacturing , Vol.4,No. 12, PP.331-334.
[12] H. Cho, J. S. Smith, And R. A. Wysk , (1997), An Intelligent Workstation Controller For Integrated Planning And Scheduling Of An FMS Cell ,Vol. 8, No.90, PP.1-13.
[13] J. kelly, (1995) , Manufacturing, engineering council. Vol.6 , PP.1-12.
[14] S.H. Lim and A de Pennington, (1997), A role of Interaction Approach to Support Manufacturing Enterprise Integration, Vol.212, part B.
[15] W. A. Raheem, (1999), MSc Thesis, Automation Data Collection System for Modern Sewing Company, University of Technology, Baghdad, Iraq.
[16] A. Nandi and P. Rogers,(2003), Behavior Of An Order Release Mechanism In A Make-To-Order Manufacturing System With Selected Order Acceptance, , Proceedings of the 2003 Winter Simulation Conference17-10-Dec , Vol. 20,No.3 ,PP.1251-1259/ IVSL .
[17] H. Yanli1, Y. Haicheng, H.Weiping1**..etal**, (2006), Flexible Workflow Driven Job Shop Manufacturing Execution and Automation Based on Multi Agent System, Proceedings of the IEEE/WIC/ACM Int. Conf. of Inte. Agent Tech. ,Hong Kong,Vol. 6, No.5, PP.7547-7595.
[18] M. Kumar , S. Rajotia, (2006), Integration of Process Planning and Scheduling in a Job Shop Environment, Int. J .Adv. Manuf. Technol. ,Vol. 28, PP109–116.
[19] E. Leonardo, S.Teixeira And A. J. Alvares , (2008), Web Shop Floor Controller For A Flexible Manufacturing Cell , ABCM Symposium Series in Mechatronics, Brasilia, Vol. 3 pp.679-687.
[20] Luma Al-Kindy , (2010), PhD Thesis,Concurrent Scheduling In Dynamic Job Shop Environment, university of technology, Baghdad, Iraq.
[21] Rasool T., EbrahimN., S.MehdiHashemi,(2013), The Value of Information in Stochastic Maximum Flow Problems, J . Com. & Op. Res. Vol. 40,No. 31 , pp. 1744–1751/ IVSL .
[22] Christopher D., Ashutosh T. , Jeffrey R.,(2013), Modelling Information Flow for Organisations: A Review of Approaches and Future Challenges.. Int, J. of Info. Manag. Vol . 33 , PP.597– 610/IVSL .
[23] G. Paredes,1 O. Alvarez-Llamoza, and M. G. Cosenza,(2013), Global Interactions Information Flow, and Chaos Synchronization, Vol :1307. PP. 4804-4811/ IVSL .
[24] http://www.heesco.oil.gov.iq/
[25]ASTM/ American society for Testing and Material. http://www.astm.org/
[26] http:// www.autodisk.com , Auto CAD (2012) software.