E-Kanban Hybrid Model for Malaysian Automotive Component Suppliers with IoT Solution

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Abstract

The supply chain in the automotive component industry today had faced multiple challenges on-demand, delivery, and costs simultaneously. In order to keep up with the uncertainties on order requirement, the component suppliers need to continuously innovate their business practice to be more efficient and cheaper than competitors. Kanban is a proven lean tool for a pull production system that controls the flow of material between various workstations by using a signal or travelling card methods. As the supply chain industry has entered the new era of Industry 4.0, the concept of signalling system has been restructured along with new technologies given the advantages of the Internet of Things (IoT). This study aims to develop a concept for electronic Kanban (e-Kanban) to speed up the information and data transfer for production planning and scheduling between companies by using Hybrid e-Kanban Production Systems. The model applies an effective tool of Microsoft Excel combined with cloud database using Microsoft OneDrive. This data sharing on production planning and scheduling can reduce preparation and delivery time for the product. The supplier than can view customer's production data in real-time and respond to any changes to minimize their inventory, to avoid overproduction and wastage. The traditional travelling card method had some issues on the missing card, recording and documentation. However, the e-Kanban ensures the production database is recorded and documented with the necessary production details at real-time. The e-Kanban addresses various industrial challenges including customer satisfaction, communication, and innovation. The author demonstrates the application in a shared database. Furthermore, by implementing an e-Kanban cloud database design, it improves production efficiency, reduces material cost and labour usage. This paper discussed the potential benefits contributed by e-Kanban for cost-efficient operations.

Keywords: Lean, E-Kanban, Industry 4.0, Supply chain, Flowline.

1.Introduction

In recent era the most of the manufacturing companies attracted to world-class initiatives to develop and create themselves to recognize in competitive in market, However, lean tools are becoming a key factor to follow the overall strategic planning in manufacturing to eliminate the of wastes as "Muda". The "Muda" Japanese word meaning "waste" it is key concept in lean process thinking such as Toyota Production System (TPS).

The lean manufacturing defines as the values of the product or service from a consumer point of view. Lean manufacturing emphasis that the non-value-added activities or wastes does not add any value for the customers. It is an important factor to deploy a resilient and consistent strategic plan for better understand and implementation of a lean model. In such circumstances, a lean model will utilize the hybrid e-Kanban tools to maintain the flow of material using a signalling card consists of parts, inventory materials to balance the planning and scheduling in the production and operation management in the automotive industry. According to lean philosophy, the lean evolution was practiced by Henry Ford, later in Japan by Taiichi Ohno and Shigeo Shingo in the development of the well-known Toyota Production System (TPS). Lean discipline works in every facet of the value stream by eliminating waste in order to reduce cost, generate capital, bring in more sales, and remain competitive in the global market. The value stream is defined as "the specific activities within a supply chain required to design, order and provide a specific product or value" Hines.P. and Taylor.D (2000). The e-Kanban system of "e" stands for electronic and the Kanban system operation uses communication network and computer, whereas in terms of the e-Kanban model is operated using IoT (cloud database server) in the application and it is efficiently managed by operators using computers. This also includes all the features of a traditional Kanban system with accurate data collection and scalability. Industrial Revolution 4.0 there is a rapid growth of development and curiosity to adopt e-Kanban digitalization of manufacturing database flow and automation of manufacturing processes. S. Wijaya, F. Debora, G. Supriadi, I. Ramadhan (2019).

On the contrary, the following paper to develop an e-Kanban model with using Cloud Database based on the lean manufacturing for automotive component manufacturers. There is a classification of a case study based on IoT Implementation on an ABC Automotive Components manufacturing company in Malaysia, about operation strategy with Traditional, IoT and its sustainability impacts the differences in the automotive industry.

2. Literature review:

The term "Kanban" is a Japanese term that means a signboard or card with visual information which provides a scheduling system for lean manufacturing and just-in-time manufacturing developed Taiichi Ohno, an industrial engineer at Toyota Motor Corporation, Toyota Production System (TPS), Kanban is managing the information flows in the manufacturing system to pull the material flows from initial process to end process. Kanban is a pulling signal for the demand of a specific product, in the specific quantities of components being taken away Mariam, E.A. Laila (2017). The Kanban system has variations are to practice for improvement in the individual necessities of each area of production and logistics system (Huang n Kusiak, 1996; Lage and Godindo Filh,2010). Kanban is simulated by the just-in-time theory where it creates to control the inventory levels at a minimum, whereas the planning and scheduling multi-stage operations in production and logistics. In particular, the paper focus concerned with Kanban on lean software development is the application of lean thinking to create a development process with database structure in software. In order to keep up with the uncertainty, and complexity of modern production operations, the software-based e-Kanban card is proposed.

2.1. Short run flow line:

The shorter run flow line is used to manufacture a high volume of goods with high production rate at the lowest cost, different flow line is created for every product to the dedicated machines are used to manufacture the products at high production rates. In this flow line method, the machines are costly to operate therefore, to justify the cost of expensive machines. Flow line manufacturing is most suitable to manufacture high volumes of products continuously. As shown in Figure.1.0 this layout has 0.30 seconds of cycle time in each Station, therefore, the short-run flow line manufacturing has few problems: There is no space inventory because space is limited; The Cycle time is faster in the production line; Very flexible line; easily modified to meet demand.

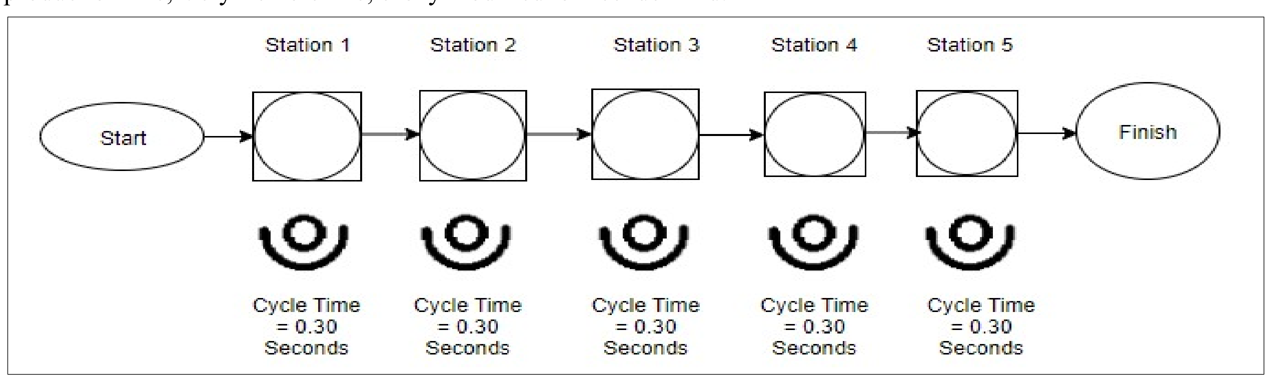


Figure.1.0: Short-Run Flow line Production Layout.

2.2. Survey Results:

The research has included an online survey questionnaire from 34 respondents of various companies to measure feedback on survey. Two questionnaires shown the results Firstly, the production key parameters of the e-Kanban model to meet overall flexibility and compatibility to industry 4.0 solution. The graph shows the production demand, batch size, throughput, lot size and inventory are the key parameters for the short run flow line production. These parameters are used to develop Microsoft OneDrive e-Kanban to replace Conventional Kanban. Figure .1.1. graph from online survey questionnaire of 34 different respondents from manufacturing companies, were given responses for Kanban operations and supply chain characteristics to provide compatibility of the Kanban framework development. Thus, the graph provides the information value of parameters related to Kanban methodology. The link forsurveybygoogleforms:https://docs.google.com/forms/d/1D2pJGZJ1q2THuCENfGA_3jyCMKTt3x3QM5uD1uN2KA4/edit.

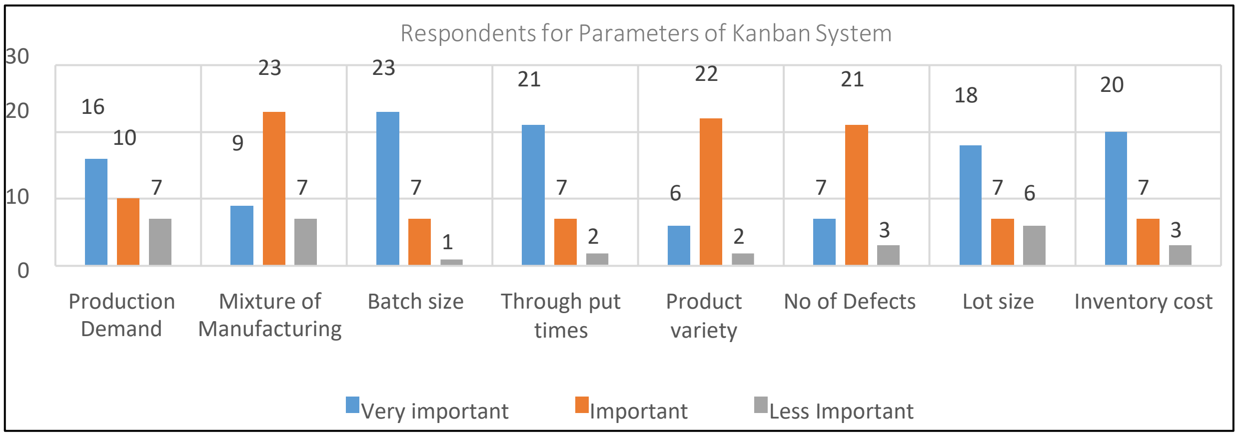


Figure 1.1. Bargraph for 34 Respondents of Basic Parameters in Kanban. (P. Shiva Prakash;2019)

S.no	Parameters of Kanban Systems	Very important	Important	Less Important
1	Production Demand	16	10	7
2	Mixture of Manufacturing	9	23	7
3	Batch size	23	7	1
4	Through put times	21	7	2
5	Product variety	6	22	2
6	No of Defects	7	21	3
7	Lot size	18	7	6
8	Inventory cost	20	7	3

Table.1.1. Respondents answers for 34 Respondents of Basic Parameters in Kanban Design.;(P.ShivaPrakash;2019).

As seen on table.1.1. Most of the importance of parameters are “Important” for respondents to maximize level hence At least few numbers of employees chose to “Less important.” The data illustrates about values of respondents given in percentages and number of responses.

The parameters of Kanban system is to design and optimize the performance of the actual requirements of Kanban visualization output for suitable hybrid model which improves the overall quality and cost savings in the Mixed-model of Kanban operations, thus there an endurance of Kanban parameter to support the supply chain process in automotive manufacturing company, although the importance of Kanban incorporate with IoT Cloud database with improve and solve major drawbacks in visualize the manufacturing systems that can sustain quality efficient use of managing resources.

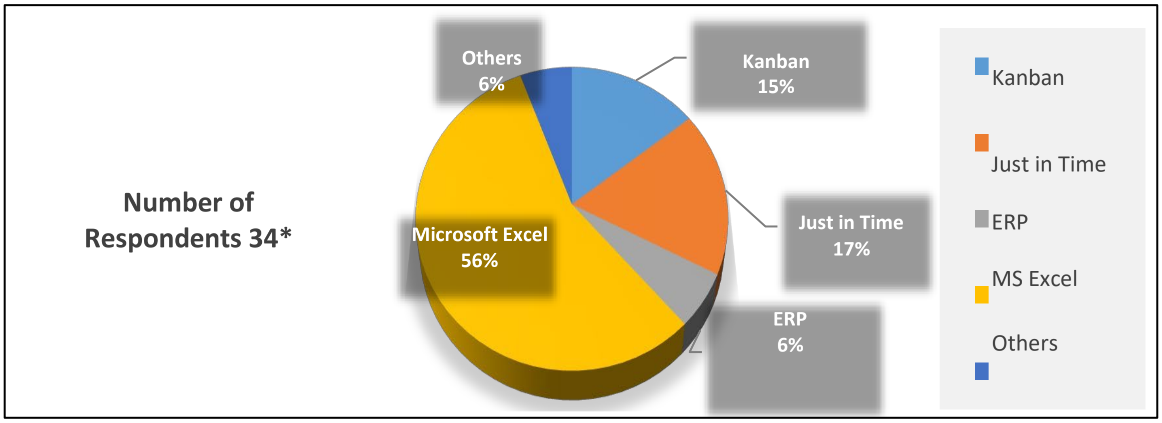


Figure.1.2. A list of common tools for planning and scheduling in respondent's organization.

S.no	List of common tools for planning and scheduling	Respondents	Percentages (%)
1	Microsoft Excel	19	56%
2	ERP- (Enterprise Resource Planning)	2	6%
3	JIT (Just in Time)	6	17%
4	Kanban	5	16%
5	Others	2	6%

Table.1.2. A list of respondents for using of common tools for planning and scheduling

From figure.1.2. shows the survey results of 34 respondents from different companies shows the list of common tools for planning and scheduling in lean manufacturing, where the most popular tools for planning and scheduling is Microsoft Excel, while JIT and Kanban are similarly equal percentages. The design of framework on Kanban card operations are coordinated to develop with Microsoft Excel sheets to create Kanban design and its operations by using Industry 4.0 solutions, Cloud applications to share the Kanban Database with effective visualization of an automotive parts manufacturer as well as supplier in Automotive industry.

2.3. Lean Implementation Tools:

There are different ways and approach, tools, and techniques of tackling Muda although many companies are unable to achieve the desired results. If the lean tools are not utilized properly; it is also focused on some specific applications and benefits which will assist starting improvement processes, increase the overall awareness of quality, and enhance the attitude of employees. Tools and techniques used for this thesis are considered carefully to design lean model framework. As per our study, a lean model framework tools below can be considered to reduce the waste and will create a hybrid environment.

a. Kanban Card
b. EOQ (Economy Order Quantity)
c. ERP (Enterprise Resource Planning).

2.4. E-Kanban System:

In this technological era, IT systems have developed to electronic Kanban system E-Kanban which is a computerized Kanban handling system with a graphical user interface (GUI) deployed with web-based application technologies manufacturing flow line's Kanban card data acquisition is done (EDI)Electronic Data Interchange or Barcode. The e-Kanban system would be the best solution and an extension of the traditional Kanban system M.T.M. Ramadan (2016). Many studies have shown that e-Kanban is economical H. Mariam, E. A. Laila, A. Abdellah; A. N. Nida, J. Roseleena, H. Nurul (2016). The e-Kanban system improves the plant operation by reducing the problem of lost Kanban cards, minimizing material shortage, increasing supply chain transparency, correcting the size of inventory based on demand changes S. Jarupathirun, A. P. Ciganek, T. Chotiwankaemanee, C. Kerdpitak (2009); nevertheless, some important aspects are considered, as a constraint on the financial aspects, and the development time including integration with others.

2.5. Hybrid Model using database (ERP), E-Kanban card and OneDrive:

The framework as shown in Figure.1.3 is developed introduced a lean hybrid model which incorporates with lean and industry 4.0 (cloud technology) to store the Kanban card database, which involves to manage the pull system in the automotive assembly line up and store data in the cloud data to supply chain management by incorporating with GUI Tools for efficient and effective the attention towards economic cost, and highly encrypted data secured applications within industries to industries processes this feasible development to re-initiate the impact on adoption of ERP systems and Kanban. As per developments the in e-Kanban systems this model is compatible store the data in system software to manage the machinery, utilization of equipment, services, and human resources. The framework ensures the correct movement of information and goods within the production line. The material is to be replenished and transferred to the preceding process where it is then produced and delivered. It is developed with a friendly graphical user interface (GUI) enables all levels of workers to use Therefore, human error can be avoided. The proposed e-Kanban system is designed to the production needs of the automotive manufacturing company which has several features are followed as simple and easy for workers to usage on interface of framework is designed smart and understandable to all levels of workers with less knowledge and monitoring. This persistence to reduce the training session for the employees. The Hybrid lean model for E-Kanban card framework and workflow Yasin (2016).

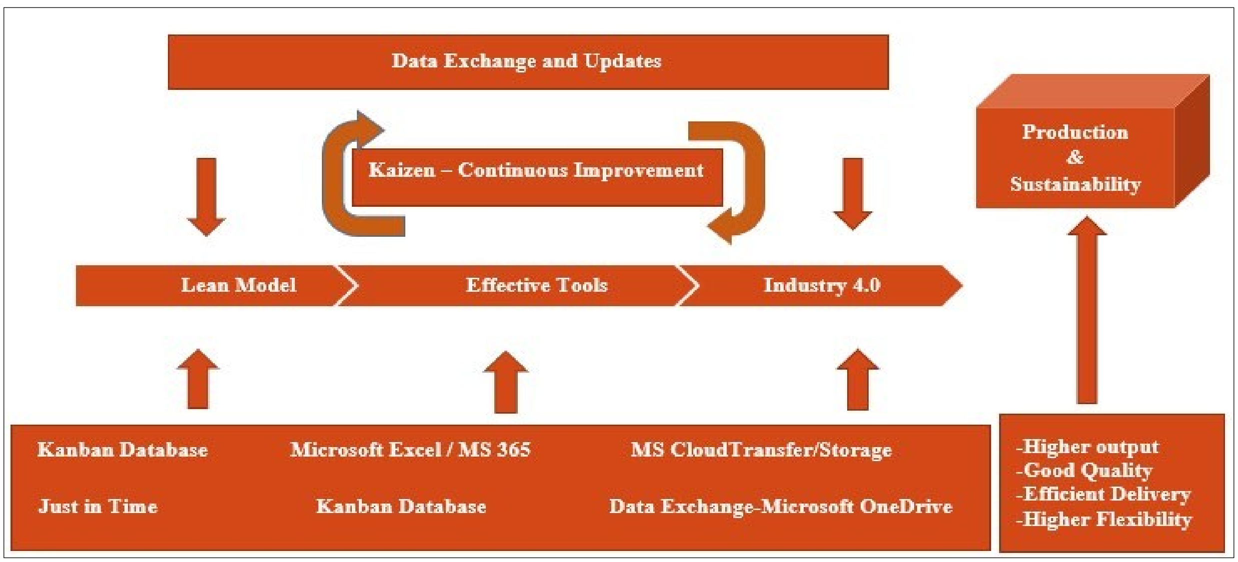


Figure.1.3. Lean hybrid model framework for E-Kanban. (P. ShivaPrakash; 2019)

The lean hybrid model which database (ERP) which is developed in our framework and created a Kanban card model design to improve the pull production system in the automotive manufacturing operation that can give few advantages they are given below:

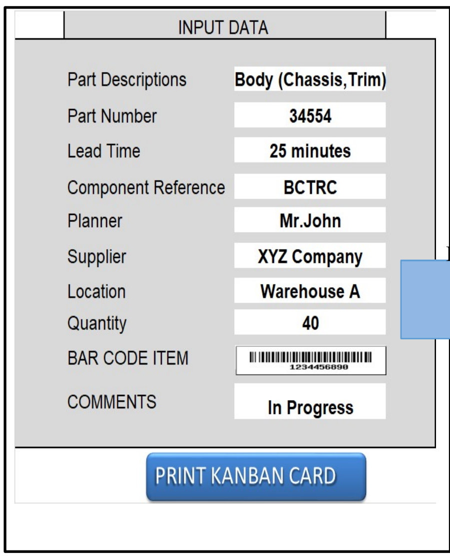
a. Cost-effective and efficient work.

b. The ease of training and employing a low trained worker.
c. E-Kanban improves flexibility to customize operations as per the requirement of company or supplier information/data in their computers.

3. Results:

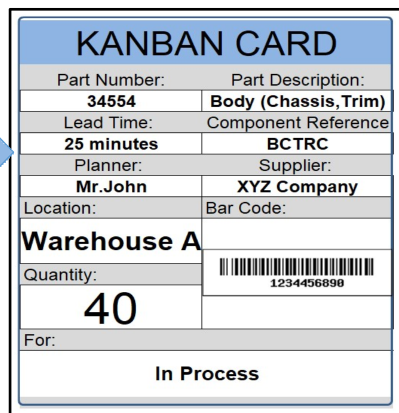
3.1. The Kanban data integration with Microsoft One Drive cloud design:

As per Fig.1.3 The Kanban input data sends the information to integrate with suppliers, production engineers and worker (foreman), The Kanban input data is created in Microsoft Excel while input data would be stored to Kanban card as in Fig.1.3 and Kanban Database from Fig. 1.4, provides the overall track on the supply chain of supplier part or inventory, as result the planning of requirements for the material supply line in the industry by using Just in Time Production methods, although this JIT production, the database will ensure better planning and scheduling. The process to briefly distributing and visualize the procurement of inventory and assembling line processes in the industries. The Kanban card is developed using Excel software where, our data is stored improve the visualization of information and sharing them to industrial employees for further improvements, as we determine the sharing, or synchronize information using cloud application such as Microsoft One Drive, Google Drive storage, With cloud applications, larger size of data can be stored and optimized the file size, in real-time information visualized and updated according to need of company/supplier's data requirements.



Analyzing of Kanban data in the flow line

Data sent



Analyzing data

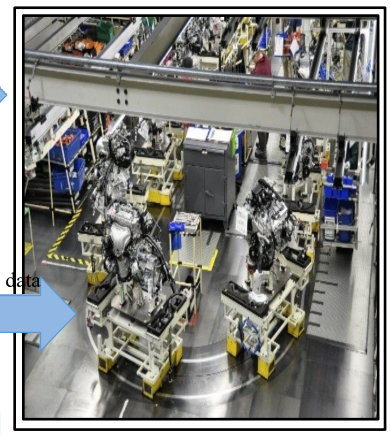


Figure 1.6: Flow line assembly

Figure.1.4: Kanban Input Data

Figure.1.5: Kanban Card

Kanban card lists into Database management

Saved Kanban Database into flowline assembly.

Production Line/ Supplier	Production line color	Responsible to maintain Kanban cards	Component type	Component reference	Product Number	Product Description	Number of pieces per card (Qty)	Batch time in min (Lead Time)	Number of card to be printed	Card symbol	Status next line	Number of storage rows	Weight of the card (2 loops Kanban)	BAR Code ITEM NC	BARCODE
Supplier A	Red	Mr.John	Body components (Trim, Chassis)	B.C,T.R,C	34654	trim, Chasis	1200	50	10	!	InProcess	10	2kg	14134134	BCTRC14134134
Supplier B	Green	Mr.Yusof	Doors	D	35342	All doors	400	50	20	@	InProcess	10	2kg	14135312	D14135312
Supplier C	Yellow	Mr.Roswell	Windows	W	13441	Window Screens	400	50	10	#	InProcess	10	2kg	14144143	W14144143
Supplier D	Magenta	Mrs.Mariam	Auxiliary Electrical and Electronic System	A.E & E.S	47659	electrical Devices &wir	400	50	10	$	InProcess	10	2kg	14252345	A,E,S14252345
Supplier E	Blue	Mr.Effendi	Chassis Components	C.C	13114	Body chassis	40	50	20	%	InProcess	10	2kg	12414316	C,C12414316
Supplier F	Pink	Ms.Alyssa	Interior and Cab Design Components	I	79097	Interior	40	50	10	^	InProcess	10	2kg	13142359	I13142359

One Drive Cloud

Figure 1.7: Kanban database integration using OneDrive cloud app in automotive company.

3.2. Integration of e-Kanban information on GUI Tools in Supply chain for Automotive Component industry:

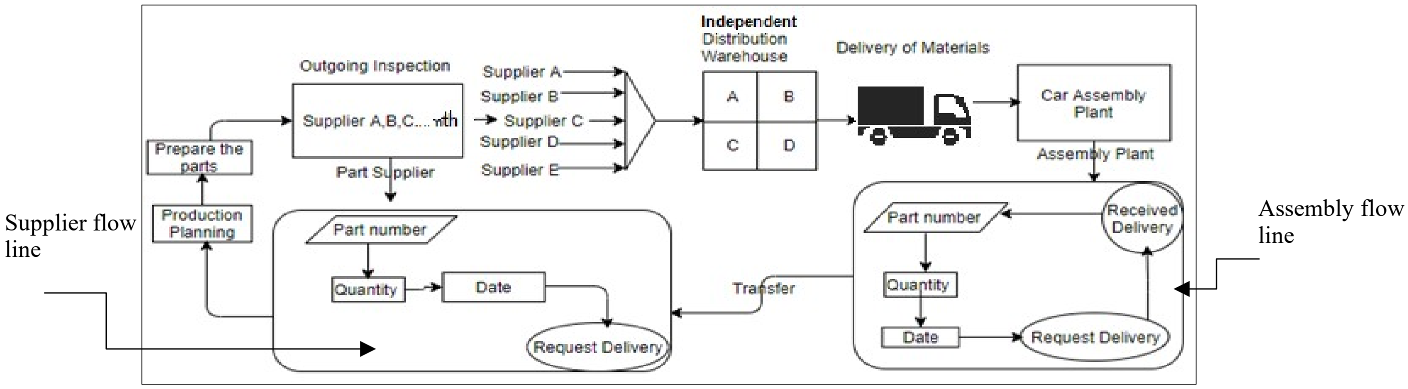


Figure 1.6. Flowchart for GUI Tools to Integrate of Kanban Supply Chain

Figure.1.6. shows the process of supply chain in Kanban operations are integrated to as Graphical Interface Tools (GUI) where, the process of various suppliers A, B, C, D, E of automotive components thoroughly with the outgoing inspection, then suppliers are classified into groups, all supplier's materials are going to Independent Distribution warehouse, It stores the materials to supply a single flow line into the car assembly plant when the material arrived in the assembly plant it is being manufactured, while part number, quantity of materials to be indicated in Kanban card.

Thus, all information of materials is dated to the actual day of received goods, then finally it goes to request delivery, where the next Kanban operations are engaged, as it back to receive the delivery. Secondly, from Assembly flow line, the Kanban operations are transferred next to supplier flow line, where the part number analyses the number of materials also to be dated to perform the request of delivery materials, if needed then this information is Lean approach, maintenance, Environment, Sales marketing, finance. Finally, the survey includes some advantages in manufacturing company to source into production planning stages to prepare the parts for the supplier and rework on inspection to ensure that production components are supply back into the manufacturing flowline until the car assembly plant has the all the data and operations of E-Kanban system to work in production flow line. The benefits of implementing of IoT tools shown below: a) Good design and safety, b) Price competitiveness, data accuracy, cost-effective and control, c) Real-time monitoring on operational costs

3.3. Evaluation on the survey interview for an Automotive Components Company in Malaysia.

The evaluation on an Automotive supplier in Malaysia which is a leading manufacturer to supply all sorts automotive components and subassembly parts. This company has 85 years of experience with constantly deployed in latest solutions to enhance the value change for benefits of their customers. As shown in Table1.3.The survey interview was conducted with company's manager to share their experience the impact of IoT operation strategies to the analyze the effectiveness of Kanban operations and regulating and monitoring of automotive suppliers in Industry 4.0 methods to compare with traditional methods and also how the organization is sustainable and their impact in industry to improve the all factors such as, Productivity, Global sourcing, project management, Forecasting, Design of Goods and Services, Quality, Process and Capacity design, Layout strategy, Human Resource and Job Design, Supply chain, scheduling investment. to implementation this factor. Therefore, survey interview shows about the operation strategy to classify the parameters to resolve the IoT (Industry 4.0 Revolution) developments and to support the company's functional improvements compared to traditional methods, the study also illustrates on sustainability studies to manipulate the strategies to helps to understand the features of each operations in automobile component company for a valued information about on traditional, IoT and sustainability its impacts.

Operations Strategy	Traditional Methods	IoT	Sustainability	Impact
Productivity	-	√	√	• Use RFID/Sensors which allows interdepartmental connectivity for higher output.

				• Increase sales/ revenue.
Global sourcing	√	-	-	-
Project Management	√	-	-	-
Forecasting	√	-	-	-
Design of goods and services	-	√	√	• Use of Catia and Solid works • Optimise material and process • One product - one personal ID-RFID.
Managing quality	-	√	√	• Use of RFID for tracking. • Reduce defect and respond time.
Process and capacity design	-	√	√	• Use of visual control and real time operations planning & monitoring. • Increased output.
Layout strategy	-	√	-	• Cellular assembly line.
Human resources and job design	-	√	√	• Reduce manpower with automation. • Faster decision making. • Less manual tasks.
Supply-chain management	-	√	-	• Auto ordering. • JIT/Kanban.
Inventory management	-	√	√	• ERP - reduce cost, traceability, and tracking. • Online receipt. • Increased data accuracy.
Scheduling	-	√	-	• ERP - optimised labour resources.
Lean Approach	-	√	√	• Use of camera for visual control. • Reduce downtime.

Table.1.3. Comparison on Implementation of IoT, Traditional and sustainability with impacts on the ABC Auto Components Company.

4. Conclusions and Future work:

In the conclusion, the paper involves an online survey with a collection of data from 34 different respondents to answer their opinion for development and design of Lean hybrid e-Kanban framework and online survey is created in google forms data is distributed different company of automotive industries managers provided a lean model survey to create Hybrid Kanban model by using the surveys.

This research is to develop the Kanban model to design using Microsoft Excel to visualize the manufacturing data by creating, the Kanban Input card, Kanban card and Kanban Database. Then, it will send to a cloud database in Microsoft OneDrive application thus, this data modified to the development of e-Kanban information flow line with GUI tools to improve the supply chain in the automotive component industry, to improve the planning of materials, preparation of parts and inspection to provide feedback in the Kanban card database. Finally, this paper shows the Survey interview operations strategies in ABC Automotive Components Company in Malaysia to show the information data to support IoT methods in the industrial production process.

Hence, this survey interview research is successful in IoT implementation methods. The future work of the research to apply hybrid push or pull systems in Kanban systems or lean hybrid models to improve operational efficiency in industries, where factories can harness Artificial Intelligence technologies as an integral part of lean methodologies to minimize the waste and continuous improvements are implemented, future work of our study is to focus on lean Kanban technologies support with Industry 4.0 tools using the heuristic algorithm to optimize the Kanban delivery model to cost optimization. Secondly to design and development of algorithms for lean technology which can be compatible with visualization techniques, and improvements to support for the internet of things within manufacturing industries.

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Acknowledgements

The authors would like to thank for support for this research paper for the financial support for *Proceedings of the International Conference on Industrial Engineering and Operations Management* held at Dubai, UAE, March 2020

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