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Evaluation of Layout Design, Operation and Maintenance of Multi Automated Systems Guided Vehicles (AGV): A Review

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Automated Guided Vehicle (AGV) is a type of vehicle that is driverless and is programmed to run on a predetermined route to transfer loads. Thus, the aim of this work is to improve the layout, operation, and maintenance. the results of these objectives explain that many are used in AGV systems for modern material handling due to the ability of this technology to increase the efficiency and productivity of the system and reduce human labor. Flow paths or layouts are fixed guided routes where vehicles can travel to various points of collection and delivery of cargo. Avoiding collision and deadlock situations, traffic management is required. To prevent physical collisions and obstacles in the path, sensors must be installed AGV. Automatic vehicle maintenance, we must remain vigilant when the AGV is operating, therefore we are very wary of accidents, as explained above that autonomous car will be programmed to follow the flow path rules and reduce the number of accidents but apply to the safety of the driver and look for situations which is less dangerous. After analyzing the situation and doing so choose the best option. Thus, the maintenance of the AGV must be intensive so that automotive vehicle accidents cannot occur again.

Keywords: *Automated Guided Vehicles, AGV, Maintenance, Operating,* System.

1. INTRODUCTION

In the past, the moving of industrial goods from one location to another used manual transport by one driver. To fulfill these needs, the company must find a worker who mastered the transportation equipment. It is undeniable because it is controlled by humans who can often be negligent and this is one of the causes of workplace accidents. Actually, if the operation is replaced by automatic transportation means the time will be more effective, efficient and the number of work accidents can be minimized.

According to Ramesh R [1] demand in manufacturing is prosecuted continuously because they save energy and materials to improve quality, accuracy, qualification, and efficiency. Ivanov D [2] provides examples of smart factories, some advanced technologies such as cyber-physical systems (CPS) are used to monitor physical processes through the creation of a virtual world so that manufacturing automation can be achieved by modulated units and structured. Lee J, [3] provided a statement that the manufacturing system using CPS technology played an important role in the intelligent factory. In such a system, information from all related production activities will be synchronized and monitored carefully between the physical plant floor and cyber computing space. One of the key features of the Smart Factory is the logistics automation that allows the delivery of various components in the plant efficiently as a workshop.

Automated Guided Vehicle (AGV), a type of vehicle that is driverless and programmed to perform running on a predetermined route to transfer load. While it is widely used in modern material handling systems because it is for their ability to improve the efficiency and productivity of the system and reduce human work. The functions of the AGV are aimed to drastically reduce the time, cost and personnel involved in the industry according to Patric Beinschob, [4]

The high level of ICT (information and communication technology) such as AI (Artificial intelligence),

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IoT (Internet of Things), Big Data. The cloud system will be converged and enveloped with all communities that may lead to Innovative changes in our lives. Especially, automatic driving is one of the most representative keywords of the fourth Industrial Revolution. Automatic driving is not only an advanced application for but also an essential solution for vehicles, called AGV, in manufacturing factories Hee-Woon Cheong [5].

With the continuous improvement and modernization of the AGV system in recent years, now they are designed to deliver more complex tasks. Thus, uncertainty problems are observed in the system. For this reason, the failure management and maintenance of the AGV strategy are identified as challenging issues that need to be addressed. As the level of application of AGV continues to increase and the need to resolve such problems has become an urgent task. Several studies have been carried out in this literature study Trenkle [6].

According to Franke J, Lu¨tteke F [7] Automatic Guided Vehicle (AGV) with autonomous behavior is suitable for use in logistics. For easy natural communication, decentralized human-machine interactions (HMI) may involve speech control and gestures. Speech orders are more efficient to issue orders (e.g. AGV 3, grab pallets from the floor). Conversely, reference (deictic) arm gestures are optimal for placing objects (e.g., pallet-coated goods on the floor) of storage) to AGV in its mobile coordinate system. Meanwhile, according to Strayer DL (2015), the combined speech and motion control is the current state of the art in many respects to the application. While the movement controls primarily require physical effort, the speaking controls involve dominant cognitive efforts, as demonstrated earlier in regard to mobile speech control during driving tasks. In the year 2013, more than ten thousands of industrial accidents involving forklift trucks were reported in Germany, about a third with fatal consequences. The potential cause lies in an excessive cognitive user workload, for example, in the form of insufficient alertness or undisturbed mind conditions according to Standke W [8].

Chauhan, [9] did research on the implementation of AGV in transferring goods in an effort to improve efficiency and production. The scheduling of operations on the machine and AGV is crucial for the efficiency of the flexible manufacturing system (FMS). In this study, the work schedule was conducted for a particular type of FMS environment by using the genetic algorithm (GA) approach. Material handler activity during AGV's loading and unloading process has a very important role. The conclusion of this research is AGV can be used to increase production within a certain period of time in various modern manufacturing industries. AGV must be suitable for carrying a unit load or mass load.

Dai and Lee [10] performed an economic analysis. Evaluation conducted to assess the economic feasibility is to calculate the internal rate of return (IRR) and the period payback (PBP) and the result. Of the application of flexible material handling resulted in IRR 36.37% for fixed-track MHS and 33.47% for Free-ranging MHS with a minimum attractive rate of return (MARR) of 15%. While the resulting PBP is 3.5 years of fixed-track MHS and 2.9 years for free-ranging MHS with the age of business for 10 years, so investing in the use of free-ranging AGV can be said to be worthy and promising.

With the results of economic analysis, maintenance needs to be done so that it will extend the life of the AGV tool. Rundong, [11] said that the simulation results were obtained clearly showing that the location maintenance strategy and site maintenance had a significant influence on the performance of multi-AGV systems. Where corrective maintenance is an effective measure for maintaining a long-term system. reliability and stability.

From the description above it is known that the Automatic Guided Vehicle (AGV) will experience a variety of loading and repeating along with the loading and unloading of goods. The even more so on the Frame that will hold the entire weight of the AGV, then in terms of operation must really optimize the accuracy of the AGV. Therefore it is necessary to evaluate the layout design, operation, and maintenance. The determine the ability and security of components in carrying out their functions so that certainty in operations and preventive measures can be obtained in the form of design improvements.

2. AVAILABLE TECHNOLOGY

2.1 Automated Guided Vehicle

The AGV definition by Groover [12] is a vehicle that operates unfastened and automatically guided by a track and using battery power. The types of AGV and its use according to Groover [12] such as driverless trains, pallet trucks, and unit load carriers. Figure 2 shows the difference between driver-less trains, pallet trucks, and unit load carriers.

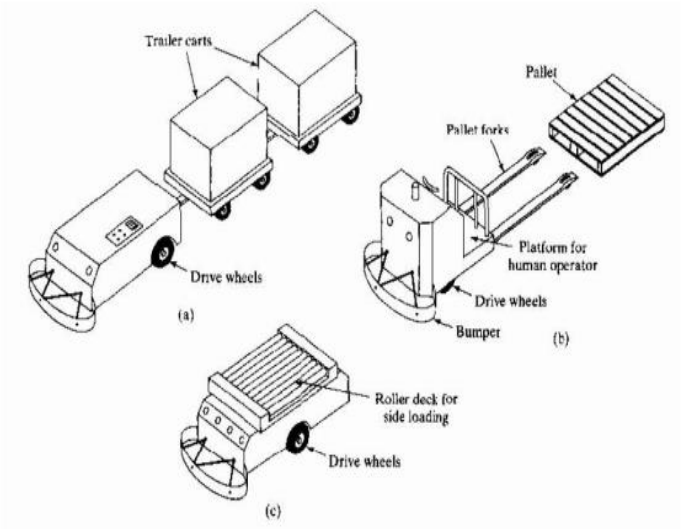

Figure 1. Type of AGV (a) *driver-less trains*, (b) *pallets truck* dan (c) *unit load carriers* [12]

The following is a description of the types of AGV driver-less trains, pallet trucks, and unit load carriers.

1. Driver-Less trains
   This AGV will draw one or several trailers which will then form the train. This type of AGV is used to move heavy loads with considerable distances in a warehouse or factory. In its application, can be determined the location of the capture and decrease of load along the route passed.
2. Pallet Trucks
   The AGV is used to move the load in the form of pallets along a predetermined route. In its application, the pallet retrieval process and the lifting of the cargo using the forklift will be carried out by an operator. Then, the operator will drive this AGV heading to the guide path, after which the operator will program to where the payload will be headed and AGV will run automatically to the place to do the unloading. The capacity of this type of AGV can reach a few kilograms, even some of which can transport more than one pallet. In its development, the AGV forklift has made progress by having a vertical velocity (forks) that can put or take pallets on a shelf.
3. Unit load Carriers.
   This type of AGV is often used to move the load unit from one station to another. This AGV can do the loading and unloading automatically by using rollers, moving belts, mechanized lift platforms or other tools that can move the pallet up to the AGV. The AGV-transportable payload is usually mild (250 kg or less). AGV is designed to have a small width shape, so it can be used to move small loads and can pass through a factory that has a limited width of the path. The usual payload is a sub-assembly that will later be assembled into a product.

2.2 Advantages of AGV

There are many advantages for the manufacture of AGV as brand new this vehicle can be more secure than in a vehicle that is driven by humans because they are made with pre-set program that is able to react much better than humans ' The car without the driver is designed to have almost capabilities such as human super to recognize the world around them. this is because they use a lot of sensors to collect a lot of data about the environment, they are so that they bias a operates with seamless in the environment that continues to change [13]. However so , this improvement does not resolve a problem major that is associated with then cross because things another important factor that needs to be remembered is that because not every vehicle that is traveling on the road is AGV is made more difficult for vehicles autonomous to predict vehicle what are now '- the vehicle autonomously - will conduct . the device else like lights and traffic connected to the pus network at for keep running. Furthermore, if every vehicle that is traveling on the road AGV, they will be connected to the network and traffic to avoid collisions, and make a decision with easily if the case of accidents. The advantages of AGV according to Groover [12], among others.

1. Flexible because it has a guide path, so it can be adjusted to the needs.

2. Improve reliability because AGV drive battery is designed to reach the station to be addressable AGV, so that the material can be timely.
3. Increase efficiency because AGV does not require operators, so it can reduce the number of workers, especially in terms of material transfer.
4. AGV can be integrated with other components.
5. AGV is suitable for low production level to medium, distant displacement distance, as well as the presence of various products and processes.

2.3 Weaknesses

One major weakness of an automatic vehicle during an accident is that unlike humans or drivers who can decide how to crash in real-time, automatic vehicle decisions about how to do it crashes are defined by a programmer beforehand " [13]. Ergo, we can conclude that the machine was not able to think as a man will do for a decision they will be based on information that has been determined previously applied to the situation when this and if the system is failing for any reason, an accident it will be not inevitable while humans will analyze the situation and then react in just a few seconds .

Besides that, as a brand vehicle is recently is new, is not there a lot of information about the law. Especially in the US, there is some sort of regulation, but kept continued without answering the questions important such as: if the case of accidents, who are held responsible? Clearly, the business will be accused together with Elon Musk, who said that "Tesla simply will take responsibility on the incident when the system autopilot failed " By because of it, the necessary legislation that covers all cases of accidents, which is provoked by a car, the driver or system.

Losses another attend AGV is that the driver will lower the vigilance of them on the street because they are governed by a system that is capable of driving a vehicle without the need of a rider. As a result, if the driver relied on the device auto- this and lowered his protector on the road if it happens accidentally, if the system fails, they are not going to have much time to react because they did not pay attention to the road. Precisely, 1 st July 2016, the New York Times published a piece of news the following : Joshua Brown died because of an accident when driving alone was driving a Tesla Model S. [14] suggests that mobility crashed into a truck that turned to the left and to the rear that it crashed into a fence and pole electricity . Besides that, The Guardian went farther and explained that Brown was " plays Harry Potter on-screen TV during the collision ". According to a statement that is spoken by the Board of Safety Transportation National: the accident was produced by the " failure of the driver truck to yield the right of way and a lack of attention of the driver's car because it was too reliant on automation of the vehicle ". By because of it, accidents Brown strengthens AGV it provokes a lack of attention of the driver on the road.

When we are dealing with an accident, the vehicle when it relies on the ability of humans to make decisions to avoid collisions, and if not inevitable, to crash as safe as possible. However, AGV must decide the best way to crash. This has become a moral decision, a decision that humans can not make in a few seconds. With an offensive example of which is described by Well, if the AGV traveling in lane two lanes when the vehicle else traveling to a direction that is opposite and suddenly swung to the track, the vehicle automatically should decide how to react based program that has been defined previously. Program preset it will analyze all alternatives to choose anyone that provokes more bit number of the injured. It is important to clarify that the prediction is not sure because it is based on statistics and probability. In concrete, in the example it appears the three alternatives are different: the first, to swivel to the left and off the road to avoid a collision between two vehicles; the second, crashing into both vehicles; and third, to accelerate and pass other vehicles to avoid falling.

As a result, we can relate this example to the Trolley Problem. In paradox philosophical explained that there was a trolley on the outside of the control to the bottom Canada five people were tied. You stand on the side lever that can change its direction to the train fire elsewhere only there is one person in the belt. There are two options: do not any anything else and trolleys that killed five people, or pull the lever so that the trolley that killed one person. Which decision is the most ethical? It is a question that the same was asked by programmers AGV alone when they know of a situation like that.

Regarding the vehicle automatically, should the AGV you kill you if saved over many lives? As that had me explain the whole essay is, the car autonomously be programmed to follow the rules and traffic and reduce the number of accidents, but should it apply to the safety or the safety of the driver looking for situations that are less dangerous? After they analyzed the situation and they did it choosing the best option, now we have another. Because the driver is not able to reach the right time, the vehicles are held accountable for actions such and can strive against. Three Indonesian Laws of Robotics. The rules have introduced by Isaac Asimov, a writer of fiction science stories about. Concretely, it might try to fight the first one because it explains that "A robot

must not hurt humans or, because it can not act, allow humans to come in danger ". With such, because the car not be rated in the case of an accident, should the manufacturer be the person in charge of law? This is the aspect of another prove that the AGV when it is not effective because of the vacancy law.

3. FUTURE OPPORTUNITIES

In the system of manufacturing modern, AGV has become part integral of MHS. According to Azimi [15] because of the high flexibility of AGV , the guidance path can be easily modified to respond to any changes in the FMS where routine changes are done inevitably. To avoid a collision between the each other and finish the task they , AGV needs to be coordinated on the whole map the way it themselves [16]. Multiple layer graphics are used to find the path. Some large papers have been presented literature which is associated with problem AGV. Martínez- Barbera, and Herrero-Perez [17] tested the method just in a guidance area which combines technology modern in the field of electronics and mathematical sciences. A number of researchers have discussed the AGV and the various issues that relate with Literatur them but there are some loopholes in the literature. The most important gap in the literature is the adaptation and implementation of FMS and AGV in developing countries where labor is very cheap and easily available.

- In the literature, the assumption of most large covering the floor flat and assuming the availability of the infrastructure that is provided to support guides the vehicle.
- There are several review papers on multi-load AGV . Multi- load vehicles are expensive but can cause a substantial increase in throughput, depending on the quality of the scheduling system.
- According to Lee and Chen [18], most large studies scheduling engine assumes the number of transporters is not limited to sending material or ignore the time of transport.
- The majority of the research is available in the literature FMS to consider processing the material through a workstation only and assumes the possibility that not disconnected AGV and machine processing. Clearly, most of these assumptions are not realistic for AGV -based systems [19].
- It should be noted that the modeling and traffic in the system of multi-vehicle still open problems, which has been investigated by several groups of research [20].

The performance of the overall system is greatly influenced by track guide system layout because it has impacted directly on the time of travel, the cost of installation, the complexity of device software system control and efficiency of delivery vehicles and scheduling. The researchers in several years past have been given much attention in the path AGVmasalah design. To formulate various problems of design lanes AGV, integer or model of programming integer mixture has been used and many in them solved by a method based on branch and bound. Problems layout lines guide the AGV is the first proposed by Sarker and Gaurav [21] discusses the problems designing system layout lane guidance and algorithm routing for AGV in along the lines of two directions to minimize the distance total distance.

This research fills the research gap regarding the reliability and maintenance of multi-AGV systems. Methodologies have been developed to model the multi- AGV System design, operation, and maintenance strategy. The work period ahead will extend the model to incorporate the relevant other activities of maintenance, such as maintenance predictive. Also, the methodology that is described in the paper can be upgraded to a model that is more substantial and the system AGV is more complex. This can be achieved by dividing the system into small basic operating elements. By investigating the system layout structure elements of the base and the interactions in between them, the simulation of a system that is complex to do. Moreover, the approach that was developed in the paper is also able to easily adjusted with a model of the maintenance of a fleet of vehicles other, such as a bus or truck.

4. CONCLUSION

Automated Guided Vehicle (AGV), a type of vehicle that is driverless and is programmed to perform on a predetermined route to transfer costs. While widely used in modern material handling systems to improve efficiency and improve the system functions of the AGV that support to save time, costs and personnel involved in the industry. Flow path or layout is a fixed guided pathway where vehicles can travel to various points of collection and delivery of cargo. To avoid collision and deadlock problems, traffic management is needed. To avoid physical collisions and obstacles in the path, sensors must be installed AGV. Automatic vehicle maintenance, we must remain while the AGV is being operated, therefore we are very wary of in the event of an accident, as discussed above that an autonomous car will be programmed to look for channel links and increase the amount of assistance, so that it can be used for driver assistance and looking for that difficult. After

analyzing and trying to choose the best option. Thus, the maintenance of this AGV must be normative so that car accident cannot happen again.

REFERENCES

[1] AZIMI, P. (2011) 'Alleviating the collision states and fleet optimization by introducing a new generation of automated guided vehicle systems', *Modelling and Simulation in Engineering*, Hindawi Publishing Corporation, Doi:10.1155/2011/210628.

[2] ABDELMAGUID, T.F., NASSEF, A.O., KAMAL, B.A. and HASSAN, M.F. (2004) 'A hybrid GA/heuristic approach to the simultaneous scheduling of machines and automated guided vehicles', *International Journal of Production Research*, Vol. 42, No. 2, pp.267–281

[3] CHAUHAN, A.K., 2013. "Role of Automated Vehicles in Flexible Manufacturing System". *VSRD International Journal Vol. 3 No. 4*, 121 – 126

[4] DAI, J. B. and LEE, N.K.S, 2012. "Economic Feasibility Analysis of Flexible Material Handling Systems": A Case Study in The Apparel Industry, *International Journal of Production Economics*, No 136, pp 28-36

[5] FRANKE J, LÜTTEKE F, 2012. "Versatile Autonomous Transportation Vehicle for Highly Flexible Use in Industrial Applications. CIRP Annals – Manufacturing Technology 61:407–410

[6] GROOVER, M.P., 2008. "*Automation, Production Systems, and Computer-Integrated Manufacturing", 3rd Edition.* Prentice Hall, New Jersey.

[7] HEE-*WOON* CHEONGA, and HWALLY LEEB, 2018. "Concept Design Of AGV (Automated Guided Vehicle)" Based On Image Detection And Positioning" Sciencedirect Procedia Computer Science 139 (2018) 104–107

[8] IVANOV D, DOLGUI A, SOKOLOV B, et al. "A dynamic model and an algorithm forshort-term supply chain scheduling in the smart factory industry 4. 0". Int JProd Res 2016;2:386–402.

[9] ILIĆ, O.R. (1994) 'Analysis of the number of automated guided vehicles required in flexible manufacturing systems', *International Journal of Advanced Manufacturing Technology*, Vol. 9, No. 6, pp.382–389.

[10] LEE, C.Y. and CHEN, Z.L. (2001) 'Machine scheduling with transportation considerations', *Journal of Scheduling*, Vol. 4, No. 1, pp.3–24.

[11] LEE J, BAGHERI B, KAO H-A., 2015 "A cyber-physical systems architecture for industry 4.0-based manufacturing systems''. Manuf Lett 2015;3:18–23.

[12] LEVIN, SAM, and NICKY WOOLF. "Tesla Driver Killed While Using Autopilot Was Watching Harry Potter, Witness Says." The Guardian, 1 July 2016. Available at: https://www.theguardian.com/technology/2016/jul/01/tesla-driver-killed-autopilotself-driving-car-harry-otter.

[13] MANTEL, R.J. and LANDEWEERD, H.R.A. (1995) 'Design and operational control of an AGV system', *International Journal of Production Economics*, Vol. 41, Nos. 1–3, pp.257–266.

[14] NTSB.GOV. *Driver Errors, Overreliance on Automation, Lack of Safeguards, Led to Fatal Tesla Crash*. 9 December 2017. Available at: https://www.ntsb.gov/news/pressreleases/Pages/PR20170912.aspx.

[15] MARTÍNEZ-BARBERÁ, H. and HERRERO-PÉREZ, D. (2010) 'Autonomous navigation of an automated guided vehicle in industrial environments', *Robotics and Computer-Integrated Manufacturing*, Vol. 26, No. 4, pp.296–311.

[16] PATRIC BEINSCHOB, MARK MEYER, CHRISTOPH REINKE, VALERIO DIGANI, CRISTIAN SECCHI, LORENZO SABATTINI., 2016. "Semi-automated map creation for fast deployment of AGV fleets in modern logistics". Robotics and Autonomous Systems. journal homepage: www.elsevier.com/locate/robot.

[17] PARKER, L.E. (2009) 'Path planning and motion coordination in multiple mobile robot teams', *Encyclopedia of Complexity and System Science*, Springer, Heidelberg.

[18] RUNDONG YAN, S.J. DUNNETT, L.M. JACKSON, 2018. "Novel Methodology For Optimising The Design, Operation And Maintenance Of A Multi-AGV System" Reliability Engineering And System Safety 178 (2018) 130–139

[19] RAMESH R, JYOTHIRMAI S, LAVANYA K. INTELLIGENT, 2013. "Automation of design andmanufacturing in machine tools using an open architecture motion",. controller.J Manuf Syst 2013;32(1):248–59.

[20] RAJ, T., SHANKAR, R. and SUHAIB, M. (2007) 'A review of some issues and identification of some barriers in the implementation of FMS', *International Journal of Flexible ManufacturingSystem*, Vol. 19, No. 1, pp.1–40.

[21] JARVIS THOMSON, JUDITH. "The Trolley Problem". *The Yale Law Journal*. 9 October 2008.