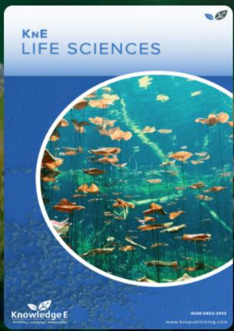
Halaman Cover

KNEOpen  Publications  About  KnE Clues  Contact  Search our Publications

- Aims and Scope
- Journal Information
- Indexing
- Ethics and Policies
- Peer Review Policy
- Article Submission
- Archive
- Register for Content Alerts
- Author Support Services
- Promote Your Research




# KnE Life Sciences

**ISSN:** 2413-0877

The latest conference proceedings on life sciences, medicine and pharmacology.

Register for Content Alerts


## The 6th International Conference on Technology, Education, and Social Science (6th ICTESS): Science and Technology

Identitas Prosiding


## The 6th International Conference on Technology, Education, and Social Science (6th ICTESS): Science and Technology

This collection contains selected articles based on papers delivered at the *6th International Conference on Technology, Education, and Social Science* held in Surakarta, Indonesia, on September 28th, 2024, at Slamet Riyadi University.

The conference aimed to share practical and innovative solutions and best practices in agriculture and food science to achieve the Sustainable Development Goals (SDGs) by 2030. It focused on food safety, smart farming, and advances in oil research, among other topics.

This *KnE Life Sciences* special issue contains 21 peer-reviewed articles exploring new advancements in food and agricultural science, with a central focus on analysing the physico-chemical properties of palm and soybean oil. This special issue evaluates the effectiveness of activated carbon for biogas purification, food safety by identifying microbial contaminants, preventing diabetes by consuming certain foods, advancements in smart-farming techniques, mathematical modelling, and community forest management practices among farmers.

These articles will be of interest to academics, students or professionals researching or working on food, agriculture, and life sciences.


**Conference date:** 28 September 2024
**Location:** Surakarta, Indonesia
**Organizer:** Slamet Riyadi University.
**Editors:** Novizar Nasir, Haslina, Nanik Suhartatik, Ravindra C. Joshi, Rameshprabu Ramaraj, Muhammad Ishfaq Khanj, Nobutaka Ito, Yus Aniza Yusof, Do-Hyeon Kim, Lekhnath Kafle, Akhmad Mustofa, Merkuria Karyantina, Nike Larasati, Fadilah Husnun, and Mutya Paramita Pratita
**Published:** 12 August 2025
**ISSN:** 2413-0877


Daftar Isi makalah

Naskah Makalah:

KnE Life Sciences
The 6th International Conference on Technology, Education, and Social Science: Science and Technology
KnE Publishing

Research Article

# Preliminary Design of Oil Palm FFB Elevator Attached to Truck with Counting Feature to Reduce Workload

**Andreas Wahyu Krisdiarto[1]*, Eko Aris Budi Cahyono[2], Teddy Suparyanto[1], and Irya Wisnubhadra[3]**

[1]Agricultural Engineering Dept., Stiper Agricultural University, Jl. Nangka II Maguwoharjo, Sleman, D.I Yogyakarta, Indonesia
[2]Mechatronic Engineering Technology Dept., Sanata Dharma University, Jl. Mekatronika Sanata Dharma, Maguwoharjo, Depok, Sleman, D.I Yogyakarta, Indonesia
[3]Informatics Dept., Atma Jaya University, Jl. Babarsari 44, Sleman, D.I Yogyakarta, Indonesia

**ORCID**
Andreas Wahyu Krisdiarto: https://orcid.org/0000-0002-5276-9650

Corresponding Author: Andreas Wahyu Krisdiarto; email: andre@instiperjogja.ac.id

**Published:** 12 August 2025

**Publishing services provided by Knowledge E**



Selection and Peer-review under the responsibility of the 6th ICTESS: Science and Technology Conference Committee.



**Abstract.**
The primary product of oil palm processed into oil is its fresh fruit bunches (FFB), which typically weigh between 6 and 35 kg. After harvesting, these FBBs must be transported to the palm oil mill. One critical step in this process is loading the FBBs onto truck beds, which is currently done manually. This physically demanding task poses a risk of injury and requires considerable labor. Additionally, counting the number of FBBs loaded is necessary for inventory and logistics. This study presents a preliminary design for an FFB elevator system mounted on a truck bed, which also includes an automatic counting feature. The design methodology combines exploration of existing manual loading practices in oil palm plantation with redefinition through the development of a mechanical conveyor system integrated with mechatronic components. The design process involved calculating loading speed and power requirements, selecting appropriate energy sources, and incorporating a counting mechanism. The proposed system consists of an elevator attached to the side of a truck bed, powered by an electric motor with a minimum generator capacity of 3 HP, and achieves a loading speed of 6 FFBs per minute. The counting system is operated by an Arduino microcontroller, equipped with switches and counter sensors. The design serves as the foundation for future model development and functional testing to validate performance and feasibility.

**Keywords:** oil palm, elevator, mechatronics

## 1. Introduction

Indonesia is currently the largest producer of palm oil in the world, in 2023 producing 50.07 million tons of crude palm oil (CPO) and 4.77 million tons of palm kernel oil (PKO). Of this amount, exports of 32.21 million tons, provided Indonesia with income worth US$ 30.32 billion [1]. CPO and PKO are produced from the pressing of Fresh Fruit Bunches (FFB) of Oil Palm, which are bulky, and have a large volume and weight. The volume of fruit transported from one block of plantation ± 20 ha with an average fruit weight of 20 kg can reach 8-13 tons/day. This causes the process of harvesting, loading, and shipping to the factory requires a lot of manpower. Harvest and transportation management and infrastructure greatly determine the quantity and quality of FFB processed by the factory. Several systems have issued mechanisms that have been implemented by palm oil companies, including the net system and bin system supported by grabbers [2,3]. However, these mechanization systems are expensive and require a well-organized plantation system, so they are not efficient for plantations owned by farmers or small companies. Loading of FFB from the Fruit Collection Point (FCP) into the truck bed is currently generally still done manually, namely by being punched, lifted, and then thrown into the truck bed (see Figure 1). The capacity of this loading work is highly dependent on the ability of human labor. Due to the weight of the FFB and the high throwing, this process has the potential to cause injury to the loader and cause fruit damage [4]. In company plantations, and especially farmer plantations that have not implemented digital recording applications, recording the number of FFB collected and loaded is still based on manual calculations by the "krani" (harvest recorder employee), which is also manual, which has the potential for human error. In addition to manual recording, in the system of purchasing farmers' TBS by middlemen, counting and weighing often use uncalibrated scales, so transparency cannot be guaranteed [5] .

**Figure** 1: Manual loading of TBS from FCP into the truck bin.

The process of moving FFB from field to FCP and loading it into trucks manually, in addition to requiring great effort, also has the potential to cause injury to the loader. This has been the focus of several previous studies to find a solution [6,7]. To overcome this problem, several FFB loading tools have been designed to load equipment, for example by [8–10], but these designs only provide a loading function, there is no automatic FFB counting system. In previous designs, the loading system was separate from the truck body, while in this study the system designed was integrated with the dump truck body. The TBS loading system designed in this research is also different from other designs in that this loading system is equipped with an automatic TBS counting system whose data is stored digitally so that it can be used as information for management analysis. This article aims to present the initial design of a FFB loader from FCP to a truck (FFB conveyor) with a counting feature. The purpose of this manuscript is to present the preliminary design of an FFB elevator attached to a truck bed that can also count the FFB being loaded.

## 2. Materials and Methods

### 2.1. Materials

This design research uses secondary data obtained from the practice of loading oil palm FFB on plantations. The parameters used as the basis for design are:

1. Truck bed dimensions
2. Dimensions and rheological properties (weight, volume, shape) of FFB
3. Manual loading work process (mechanism)
4. FFB calculation work process
5. FFB loading work capacity into the truck bed

### 2.2. Methods

The general design method uses the following stages:

1. Development of the idea of the loading and counting mechanism
2. technical calculation of system requirements

3. technical drawing using Solid Works software

Then the parameters of the mechanical equipment determined by the design are:

1. Conveyor mechanisms and materials, including 1) conveyor type, 2) total weight transported, 3) chain speed, 4) chain pitch, 5) interconnecting chains, 6) operating environment, 7) lubrication, and 8) tensile strength and breaking strength of the chain [11]
2. Conveyor rotation and electric motor speed reduction system
3. The amount of power of the driving engine, which is determined based on factors that affect the traction force: a) weight of the material transported, b) weight of the chain and additional supporting elements, c) friction coefficient, d) corrective coefficient for the type of operation, depending on the load and hours of operation per day, e) speed correction coefficient, f) corrective coefficient when the chain is taken by the sprocket and g) safety and pressure coefficient [12]
4. Type and size of electric motor
5. Mechanism and system of TBS calculation, using arduino and switch sensor.
6. Structured research stages are depicted in Figure 2.

## 3. Results and Discussion

This manuscript presents a preliminary study of the design and construction of a palm oil FFB loading system from the FCP to the truck bed equipped with a feature to calculate the number of loaded FFB bunches. The prototype to be produced is intended to reduce the burden on the FFB loader, which is currently still done manually. Palm oil FFB weighs 6-25 kg, if lifted and thrown into the truck bed at a height of + 2 m, it has the potential to cause injury, both incidental and long-term. This process will be replaced with mechanical equipment, namely a conveyor. Like the loader design conceptualized by [8], the system built also uses an electric motor as a conveyor chain drive. The electric motor is driven by a gasoline-fueled electric generator (see Figure 4).

The difference in the design concept in this study [9] and [8] is that the tool designed in this study is coupled to the truck bed and equipped with an automatic counter. The first feature is expected to increase the speed of loading work because the conveyor

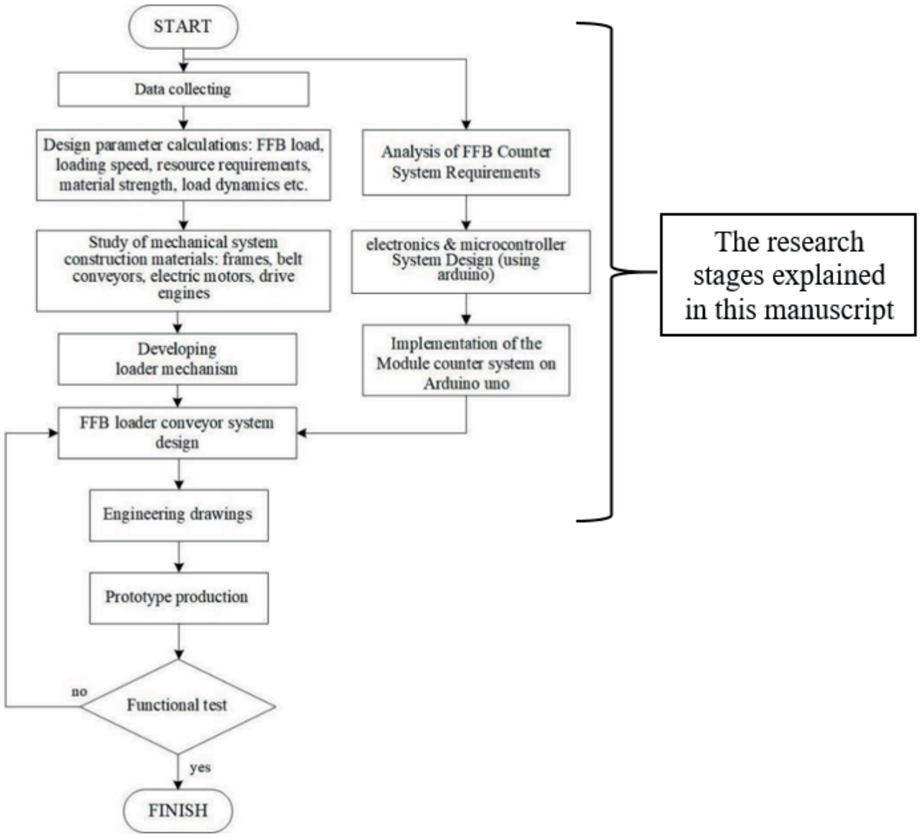



**Figure** 2: Research stages.

does not need to be moved manually. While the second feature is included in the system to reduce the workload of the FFB number recorder, while minimizing human error.

Based on system requirements, considerations of loading mechanisms, and related dimensions, an initial concept for an automatic counter TBS loading system was designed as shown in Figure 3.

## 4. Calculation of loader system design with conveyor

Chain Conveyor design data to move palm oil FFB from the palm oil storage area to the truck as shown in Figure 4 above is a Length of 3000 mm (3 meters), Width 400 mm (0.4 meters), sprocket diameter of 200 mm (0.2 meters) and Chain conveyor slope 45°. The chain used is the Extra Strength Conveyor Chain from Renold [12] with a pitch of 3 inches (76.2 mm) with a weight per meter of 2.88 kg/meter. The chain conveyor is designed using 2 drive chains. The number of forks is designed into as many as 2 pieces which are installed with a distance between the forks of 0.5 turns of the chain conveyor so that on the chain conveyor there is only 1 FFB in each transport and this

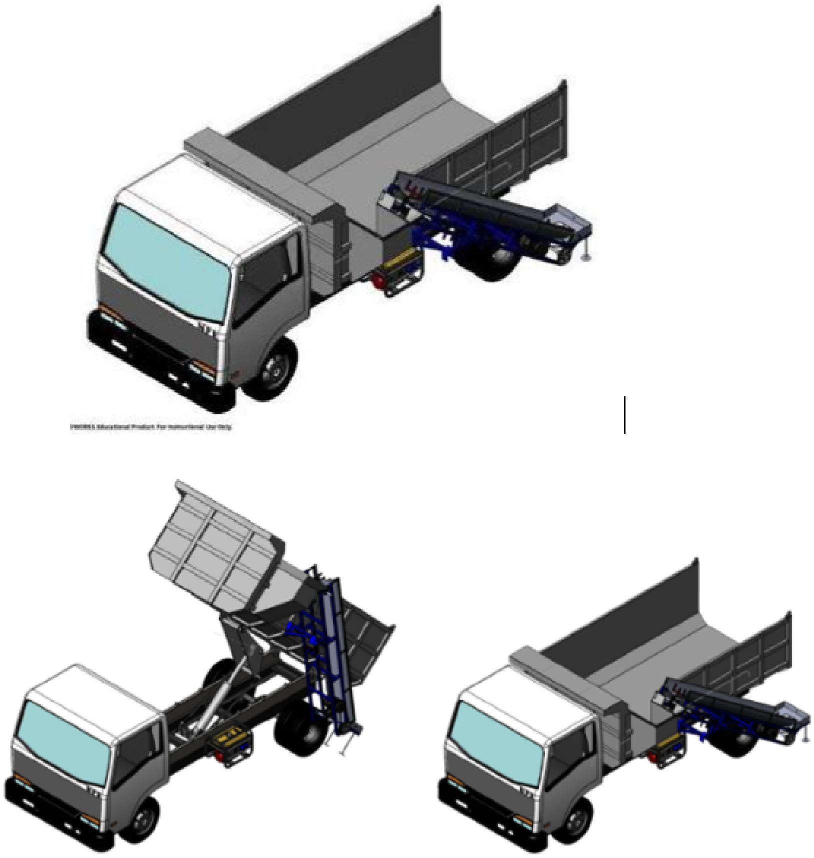


**Figure** 3: 3D view of the concept of the TBS loading conveyor system attached to the dump truck.

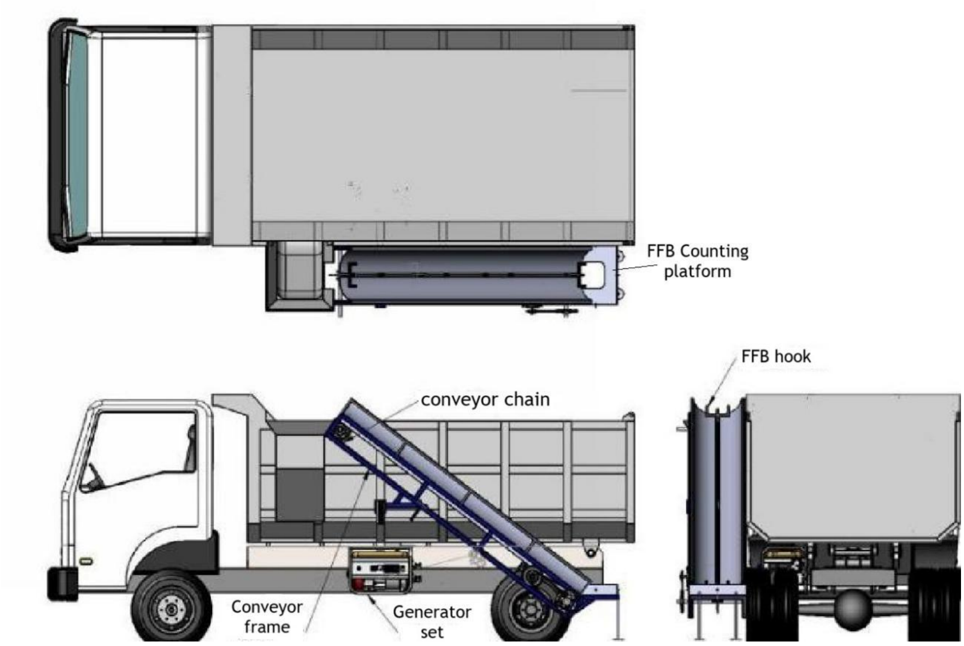



**Figure** 4: Top, side and rear views of the concept of the TBS loading conveyor system attached to the side of the dump truck body.

is used as the basis for calculating the speed, load, and power of the drive motor. In this Chain Conveyor design, the speed of moving FFB from the ground to the truck which is done manually as shown in Figure 1, is used as the basis for calculating the chain conveyor speed. The speed of manually moving FFB is 6 Fresh Fruit Bunches per minute. The speed of moving FFB using a chain conveyor is designed to be the same as the speed of manually moving FFB, which is 6 Fresh Fruit Bunches per minute. The average weight of one FFB is 20 kg, so the chain conveyor capacity can be calculated as 6 FFB x 20 kg x 60 = 7,200 kg/hour or 7.2 Tons/hour.

The length of the Chain Conveyor is 3000 mm (3 meters) so the speed of the chain conveyor can be calculated as 3 meters x 6 FFB / minute / 60 = 0.3 meters/second = 1080 m / hour. To send 1 FFB from the ground, the chain conveyor takes 3 / 0.3 = 9 seconds. This 9 seconds is the time that can be used by the operator to manually move FFB from the storage area to the chain conveyor and to carry out the calculation and weighing process of FFB automatically.

Chain Conveyor Load Tension and Driving Power can be calculated using the following formula [13]:

T = Fs + Fi + Fk ...eq 1

$Fs = (Qt \times L) + (Pch \times L) \times f =$ ......eq2

$Fi = \frac{Pch \times L}{2} fl =$ ......eq3

$Fk = (Qt + Pch) \times L1 \times sin(\alpha) \times f2$ ......eq4

N = T x v / 75 ...eq 5

where:

T = Total chain force or total work chain tension – (kgf)

Fs = Upper chain tension – (kgf)

Fi = Under chain tension – (kgf)

Fk = Lift chain tension – (kgf)

Q = Conveyor total load (capacity) - (t/h)

Qt = Conveyed material weight – (kg/m)

L = Total conveyor direct length (including inclined/declined) - (m)

Pch = Total chain weight (see manufacturers tables according to chain types)

N = Driving power (kW)

v = Chain conveyor speed – (m/s)

f = Upper chain friction factor – 0.25 ~ 0.35

f1 = Down chain friction factor – 0.10 ~ 0.15

f2 = Lift chain friction factor – 0.25 ~ 0.35

Qt = 7.200 kg/hr / 1.080 m/hr = 6,67 kg/m

Fs = (6,67 x 3) + (2 x 2,88 x 3) x 0,25 = 24,33 kgf

Fi = 2,88 x 3 / 2 x 0,15 = 0,648 kgf

Fk = (6,67 + 2,88) x 3 x sin 45 x 0,35 = 7,09 kgf

T = 24,33 + 0,648 + 7,09 = 32,068 kgf

N = 32,068 X 0,3 / 75 = 0,13072 KW = 130 Watt

The drive power of the chain conveyor required is 0.13 kw and rounded to 250 watts. The chain conveyor drive uses a 1 phase 4 pole induction ac motor with a rotational speed of 1400 Rpm. To adjust the speed of the chain conveyor to the rotational speed of the drive, a transmission is needed. The sprocket rotation required to drive the chain conveyor is 0.3 meters/second and the sprocket diameter is 200 mm (0.2 meters) is:

nsprocket = v x 60 /(phi x d) = 0,3 x 60 / (3,14 x 0,2) = 28,6 Rpm

The required transmission ratio is = motor/sprocket = 1400 / 28.6 = 48.9 and rounded to 45 to meet the minimum speed required by the chain conveyor.

## 5. Design of Automatic Counting System

The FFB counting system on the loading tool developed in this study uses a touch sensor. Although more advanced technology-based counters such as artificial intelligence and infrared sensors have been developed, this research design uses a simpler touch sensor because it is adjusted to the characteristics of the work area on oil palm plantations. An image-based counting system with artificial intelligence such as that developed by [14] has the disadvantage of frequent errors, both when taking pictures, or during processing. The touch sensor uses a simpler system so that it has high durability and consistency. Touch sensors as a counting tool have also been used to count the number of people in a place or area [15]. The object counting system developed by [16] uses infrared, egg objects will be counted if they pass through the sensor. This study did not use infrared because of the differences in the characteristics of the objects and the loading tools developed. The diagonal conveyor system and vibrations will interfere with the working system of the infrared sensor. In addition, TBS also has different shapes and sizes.

The calculation system of this research design uses an Arduino Uno microcontroller with a touch sensor. In addition to being a sensor controller, Arduino is used as a storage media controller (SDRAM) to store digital data on the number of FFBs that have been loaded into the truck, and an LED screen display of the calculation results in real-time. The touch sensor will be installed on the form plate on the initial conveyor base on the loading system (see Figure 4. Side view of the loading system). The FFB placed on the form plate will press the touch sensor, which then forwards the ignition current to the Arduino, and the calculation system works. The calculation results during the process will be stored in SDRAM on the Arduino board. The stored data can be copied to a computer in CSV format so that it can be easily and quickly used as a basis for calculating harvester salaries or analyzing the productivity of the harvested plantation.

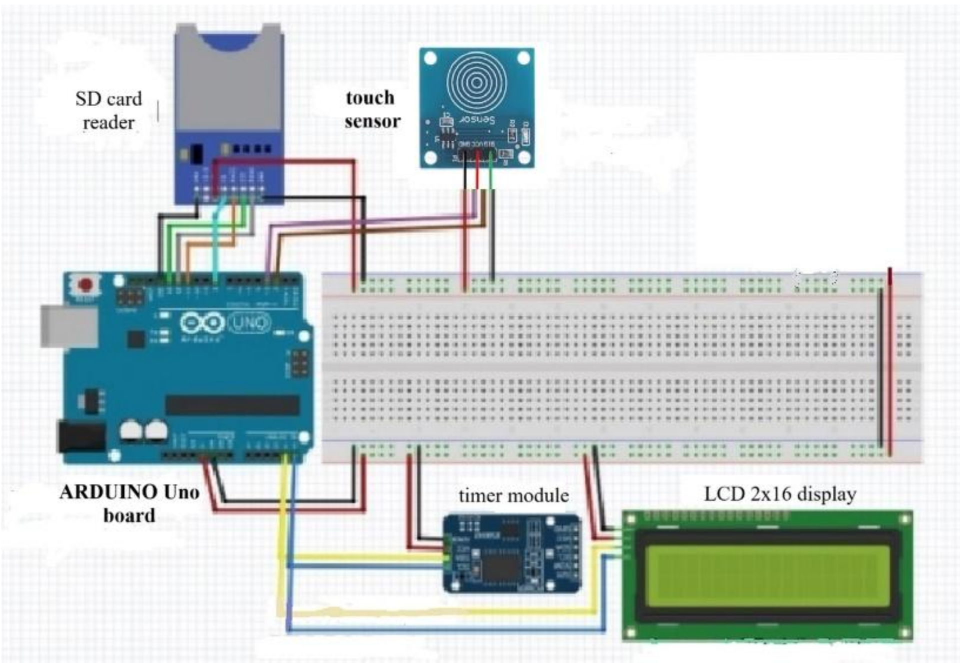



**Figure** 5: Schematic design of an Arduino microcontroller with a touch sensor.

## 6. Conclusion

1. The mechanical equipment for loading oil palm FFB has been successfully designed, equipped with a FFB counter

2. The design results are realized in 3-dimensional engineering drawings, which can be the basis for prototype fabrication.

3. The design needs to be animated to study its interaction with other systems, such as the location of FFB in the FCP, loading of FFB into the loading system by the operator, and arrangement of FFB in the truck bed.


## Acknowledgment

The authors would like to thank:

The Indonesian Palm Oil Plantation Fund Management Agency (BPDPKS) for providing funding support for this research with contract number: PRJ-158/DPKS/2024.


## References


[1] Sardjono M. Kinerja Industri Minyak Sawit Tahun 2023 & Prospek Tahun 2024 [Internet]. Gabungan Pengusaha Kelapa Sawit Indonesia (GAPKI). 2024 [cited 2024 Nov 24]. Available from: https://gapki.id/news/2024/02/27/kinerja-industri-minyak-sawit-tahun-2023-prospek-tahun-2024/

[2] Asmono D. Driving Innovation To Maximize Oil Palm Productivity. Paper presented at: Forum Sawit Indonesia; 2023 Nov 22; Yogyakarta, Indonesia.

[3] Purnomo R. Digitization and Research for Improving Palm Oil Productivity. Paper presentation presented at: Forum Sawit Indonesia; 2023 Nov 22; Yogyakarta, Indonesia.

[4] Krisdiarto AW, Sutiarso L. Pengaruh tingkat kerusakan jalan perkebunan dan posisi tandan buah segar di bak truk terhadap kinerja angkutan kelapa sawit (Effect of Estate Road Damage and Fresh Fruit Bunch Position in Truck Bin on Oil Palm Transportation Performance). J Agritech. 2016 Oct;36(02):219.

[5] Krisdiarto AW, Gading YF. Penyusunan Model Matematika Berat TBS Kelapa Sawit Terhadap Bacaan Timbangan Pada Angkong Sebagai Dasar Rancangan Angkong Digital. In: Prosiding Seminar Nasional PE, editor. Perteta. Yogyakarta: Institut Pertanian STIPER Yogyakarta; 2018. pp. 246–9.

[6] Alisha N. Halim Rd, Syukri M, Aswin B, Hidayati F. Determinan Keluhan Muskuloskeletal Pada Pekerja Bongkar Muat Tandan Buah Segar (TBS) Kelapa Sawit. JIK J ILMU Kesehat. 2021 Oct;5(2):366.

[7] Sagala IA. Penilaian Risiko Beban Kerja dengan Metode QEC dan RULA pada Pemanen Kelapa Sawit di Kecamatan Kualuh Selatan. 2022;

[8] Desrial MK, Muhammad K. Design and Simulation of Oil Palm FFB Loading Machine. IOP Conf Ser Earth Environ Sci. 2022 Jun;1038(1):012059.

[9] Fachri Z, Muslem M. Konveyor portable pemuat tandan buah segar (TBS) kelapa sawit ke kendaraan pengangkut. J-Innov. 2020;9(1):24–7.

[10] Inovasi Truck Langsir Perkebunan Kelapa Sawit [Internet]. 2018. Available from: https://www.youtube.com/watch?v=IV9cvKvhyQs&ab_channel=AbdiIrdyasandi

[11] Tsubaki: Chain [Internet]. [cited 2024 Nov 27]. Available from: https://tsubaki.id/catalogs/chain/

[12] Palm Oil - Renold Plc [Internet]. [cited 2024 Nov 27]. Available from: https://www.renoldindonesia.com/sectors/palm-oil/

[13] Chain conveyors practical calculations - An Approved Cont inuing Educat ion Provider PD H on lin e - Studocu [Internet]. [cited 2024 Nov 27]. Available from: https://www.studocu.com/in/document/indian-institute-of-engineering-science-and-technology-shibpur/engineering-mechanics/chain-conveyors-practical-calculations/50522545

[14] Shiddiq M. Counting of oil palm fresh fruit bunches using computer vision. J Oil Palm Res [Internet]. 2022 May 31 [cited 2024 Nov 27]; Available from: http://jopr.mpob.gov.my/counting-of-oil-palm-fresh-fruit-bunches-using-computer-vision/

[15] Nakazawa K, Mizuhara K, Hirabayashi T. Development of person counting system using distributed touch sensor. In: Proceedings of the 1992 International Conference on Industrial Electronics, Control, Instrumentation, and Automation. San Diego, CA, USA: IEEE Xplore; 1992. https://doi.org/10.1109/IECON.1992.254373.

[16] Mohamad SN, Mat Tahir NH, Azimi FH, Abdul Rahman N, Anuar NS, Wan Fauzi WM. Implementation of Arduino-Based Counting System for Kuih Ros Production Yield. J Technol Humanit. 2022 Aug;3(2):6–12.