

## Motorized Wheelbarrow

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**Abstract:** Wheelbarrow is a small cart with a single wheel at the front, two supporting legs and two handles at the rear, used typically for carrying loads in construction and gardening. The use of wheelbarrow especially in construction field is one of the important elements to ensure the ease of construction work. However, the wheelbarrow functionality on the market today uses manual method which workers have to lift the wheelbarrow handle to move it somewhere else. This method takes a longer time to finish a work and require more energy when lifting the fully loaded wheelbarrow to another place. Worker need tools and equipments that can help the construction work done easily, quickly and effectively. A motorized wheelbarrow was fabricated to help worker in time saving and maximum work load. The 33cc Okazawa lawn mover engine fitted to power the wheelbarrow. Free flat rubber tire was used and positioned at the front like a normal wheelbarrow. The (70×37×50) cm bucket used to carry the load and the handle used to control the motorized wheelbarrow is like any common wheelbarrow handle. Motorized wheelbarrow uses chain drive to move. Two sets of sprocket installed between the motor and the wheel. The first set uses a 428-15T sprocket mated to the motor and paired to 428-38T sprocket, which then mated to the second set of 428-15T sprocket paired to 428-38T sprocket that powers the wheel. The 33cc motor produce between 0.6 kw to 0.9 kw, that translate the power at the wheel around 3.87 kw to 5.80 kw which enough to power the wheelbarrow. As the results, motorized wheelbarrow 70% faster in time saving compare to manual wheelbarrow while motorized wheelbarrow 90% faster in time saving compare to manpower. Its shows that motorized wheelbarrow better in time saving compare to existing wheelbarrow in market.

**Keywords:** Construction Equipment, Motorized Wheelbarrow, Small Hand Propelled Vehicle

## 1. Introduction

Wheelbarrow is a small hand propelled vehicle, usually having one or two wheel that consisting of a tray bolted to two handles and two legs as shown in **Figure 1** [1]. It is designed to push and pull using two handles and controlled by one worker. The wheelbarrow from a design aspect is very simple concept that facilitates the transportation of large amounts of difficult to move materials. It is a device for carrying small loads for the household gardener, a wheelbarrow is often also used in construction and industry for carrying larger loads [2]. It is most commonly used in the construction and gardening industries to move such materials as dirt, gravel, stones, plants and concrete. The worker normally uses manual handling to lift, hold, carry, push and pull to move, assemble and to transit work material from a place to another. The current design of the wheelbarrow can be physically difficult on the user when performing tasks where they must bend forward or pull a load backwards can cause strain to the users back.



**Figure 1: A typical wheelbarrow**

The conventional wheelbarrow usually took a long time to move the load from one place to another place. Nowadays, wheelbarrow in the market have a lot of innovation in term of design and function. Some wheelbarrow has bigger size tires at the front so that it can carry more loads compare to normal size tires. Common materials for wheelbarrow bucket is painted steel. It can handle everything from light loads to heavy piles of bricks without bending or cracking [3]. The main objective of this project is to fabricate a motorized wheelbarrow that can increase time taken and reduce workload. Benefit of using motorized wheelbarrow compare to lift load manually help worker in time saving and increase in work load loading.

## 2. Available Wheelbarrow in Market

Design of common wheelbarrow are consisting of bucket, wheel and handle. Existing wheelbarrow available in market are manually handled by the worker. Some inventor makes an improvement to the wheelbarrow to easier the work for lifting heavy loads. **Figure 2** shows variety of wheelbarrow with different number of wheels. Each of them have same function but can be used to lift different amount of load. **Figure 2** shows different design of handles that be used on the wheelbarrow for ergonomic purpose.

There is various design of wheel of wheelbarrow that has in the market now with different number of wheel, material and the diameter of the wheel. The number of wheel effect the maneuverable and the stability of the wheelbarrow. **Figure 2(a)** is one wheel is more maneuverable and easy to dump compare than the **Figure 2(b)** which is two-wheel wheelbarrow. Two-wheel wheelbarrow however provide much more stability than a single wheel, which helps with especially heavy or unbalanced loads. If compared with one wheel and two wheel, three wheel refer **Figure 2(c)** is most stability and can lifting more load. Next, the size of the wheel depends on the size of wheelbarrow. The bigger the size or the diameter of the wheel, the higher the load that the wheelbarrow can lift. The standard size dimension of wheel of wheelbarrow is (13×3) inch. Lastly, there are a lot of material of the wheel which are rubber, plastic and steel. Rubber wheels can hold up to rough conditions and terrain without breaking or cracking while steel wheels are solid, durable and easy to repair by welding. Plastic wheel is easy to maintain as it requires no pumping and lightweight thus more comfortable to maneuver [4].

The design of the bucket comes with various types of material and size. There are three common type of materials which are plastic, galvanized steel and powder coated steel that are used to create the bucket of a wheelbarrow, and each of them has some unique benefits. A plastic bucket is much lighter than one of the metal options. This is obviously pretty important, depending on the materials user trying to move. Galvanized steel can hold heavy materials like bricks or stones and it will not bend or bow. Powder coated steel has the same qualities as galvanized steel, it just looks a bit nicer. However, it is susceptible to being scratched if you're moving sharp or pointed materials. The standard size of bucket of wheelbarrow is (803×610×10) mm. The load that can be lift by the wheelbarrow depends on the size of the bucket [4].

The best design of the handle of wheelbarrow is the adjustable handle design which can be adjust according to the height of the user. The design of distance between the handle and bucket is also have to be prioritized to push or pull the heavy load at the easy or hard way. **Figure 2(d)** which is the handles are closer than normal wheelbarrows which could make it harder to push or pull heavy loads with such a close grip. The design of single handle such as **Figure 2(e)** is not ideal for pulling around heavy loads and the plastic bucket could prove brittle under continuous strikes with a spade shovel [4].

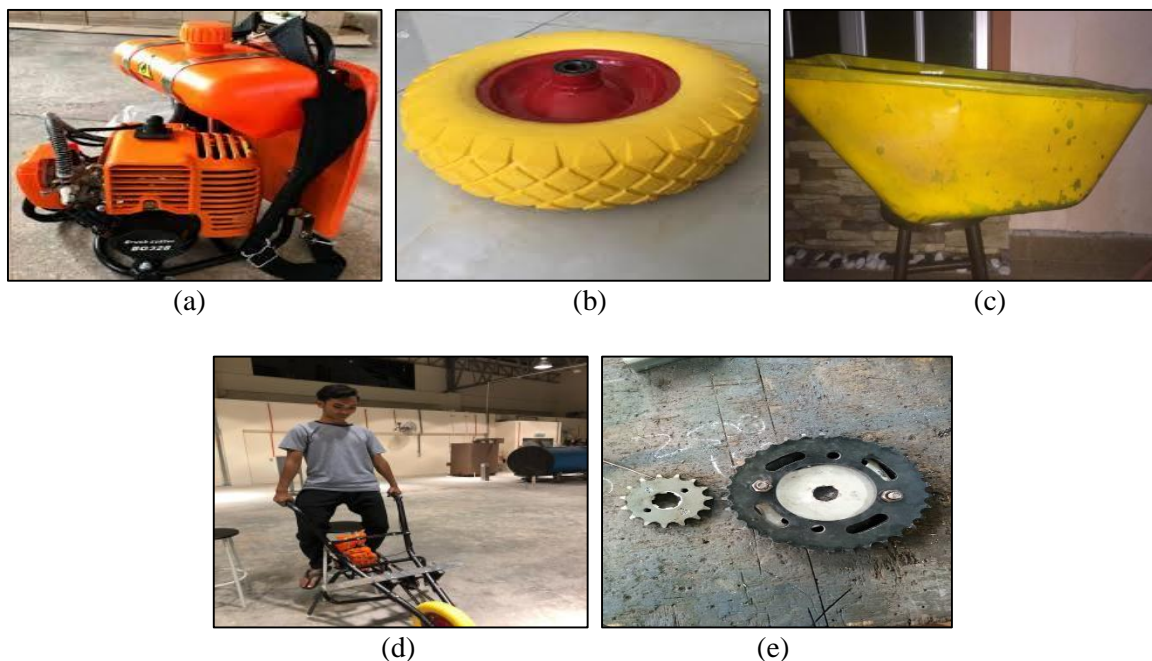


**Figure 2: (a) One wheel (b) Two wheel (c) Three wheel (d) Two handle and (e) Single handle**

### 3. Fabrication of Motorized Wheelbarrow

**Figure 3(a)** shows an Okazawa 33 cc of lawn mower engine is capable to move the wheelbarrow to transfer load from a place to another places that hanging on the wheelbarrow body. A two-stroke or two-cycle engine is a type of internal combustion engine which completes a power cycle with two strokes which is up and down movements of the piston during only one crankshaft revolution. In a two-stroke engine, the end of the combustion stroke and the beginning of the compression stroke happen simultaneously, with the intake and exhaust or scavenging functions occurring at the same time. Two-stroke engines often have a high power-to-weight ratio, power being available in a narrow range of rotational speeds called the power band. Compared to four-stroke engines, two-stroke engines have a greatly reduced number of moving parts, and so can be more compact and significantly lighter. The free flat-tire (rubber) as shown in **Figure 3(b)** help the motorized wheelbarrow move forward. The tire position is at the front like a normal wheelbarrow. Besides, the dimension of the bucket design shown in **Figure 3(c)** is (70×37×50) cm that used to put the load into the bucket. Handle that used refer **Figure 3(d)** to control the motorized wheelbarrow is like normal wheelbarrow.

A sprocket is a profiled wheel with teeth or cogs that mesh with a chain, track or other perforated or indented material. It is distinguished from a gear in that sprockets are never meshed together directly, and differs from a pulley in that sprockets have teeth and pulleys are smooth. Sprockets and chain can be used to change the speed, torque, or original direction of a motor. A sprocket is a toothed wheel that fits onto a shaft. A chain is used to connect two sprocket. Chains that are used to transmit motion and force from one sprocket to another are called power transmission chains [5]. In order for sprockets and chain to be compatible with each other they must both have the same thickness and pitch. In order for the sprockets and chain to work effectively, all of the sprockets should be on parallel shafts with their corresponding teeth on the same plane. Sprocket that used refer **Figure 3(e)** is 2 × 428-15T and 2 × 428-38T that have two part which is first part is 33 cc of lawn mower engine is connected with 428-15T sprocket with motor chain to 428-38T sprocket and parallel with second part from the 428-15T sprocket with motor chain to 428-38T sprocket that connected with front free flat-tire.



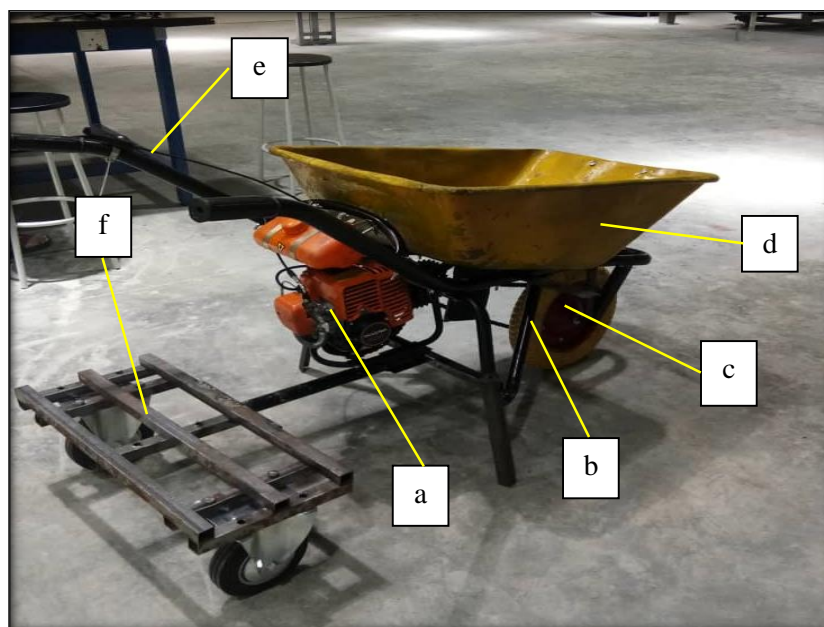
**Figure 3: (a) 33 cc of lawn mower engine (b) Wheel (c) Bucket (d) Handle and (e) Sprocket**

#### 4. Result and Discussion

The worker with 50 kg weight is handle the motorized wheelbarrow. The first experiment is to compare the time taken between three methods of transferring loads which are using manpower, manual wheelbarrow and motorized wheelbarrow. The comparison is made by measure time taken to transfer 30 bricks to 50 m distance to final location. Second experiment is to evaluate the work load between these three methods by measure amount of bricks that can be lifted per trip to final location.

##### 4.1 Working Principle of Motorized Wheelbarrow

**Figure 4** shows the motorized wheelbarrow that has been fabricated. **Figure 4(a)** shows a 33cc engine lawn mower has small size that easy to carry. The 33 cc engine lawn mower can afford and enough power to move the wheelbarrow. The engine hangs on wheelbarrow body by using bolt and nut. **Figure 4(b)** is a rubber free-flat tire with dimension (13x3) inch. Rubber material of free-flat tires low in weight and not easy to broke even high loads are applied. **Figure 4(c)** shows the 2 × 428-15T and 2 × 428-38T sprocket. The lawn mower engine is connected with 428-15T sprocket and motor chain to 428-38T sprocket and parallel with second part from the 428-15T sprocket with motor chain to 428-38T sprocket that connected with front free flat-tire as shown in **Figure 5**. A bucket steel with dimension (70×36×50) cm as shown in **Figure 4(d)** are used as a load bucket. Steel material is not easy to broke or cracking when heavy loads are applied to it. Steel handle is used for this motorized wheelbarrow as shown in **Figure 4(e)**. The handle is convenient and suitable to hold by the workers. The platform refers **Figure 4(f)** is annealed stainless steel with dimension (3×2.5×600) cm and connected with other part with dimension (5×2.5×250) cm, the both part are welded together. The platform needs to used caster wheel to move the platform. The important thing about the platform is the platform must be connected with wheelbarrow to move together, so it required to add another annealed stainless steel to connected with wheelbarrow.



**Figure 4:** (a) 33cc lawn mower engine (b) Wheel (c) Sprockets (d) Bucket (e) Handle and (f) Platform of motorized wheelbarrow

$$\text{Sprocket ratio for power transmission} = T1 \div T2$$

Where:

T1 = Driving sprocket

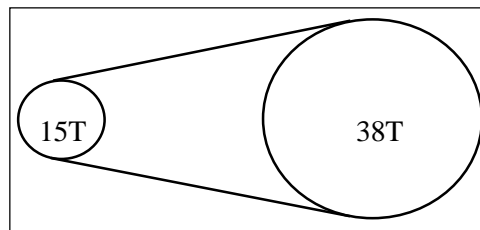
T2 = Driven sprocket

Thus,

$$\text{The sprocket ratio for the motored wheelbarrow} = 15 \div 38$$

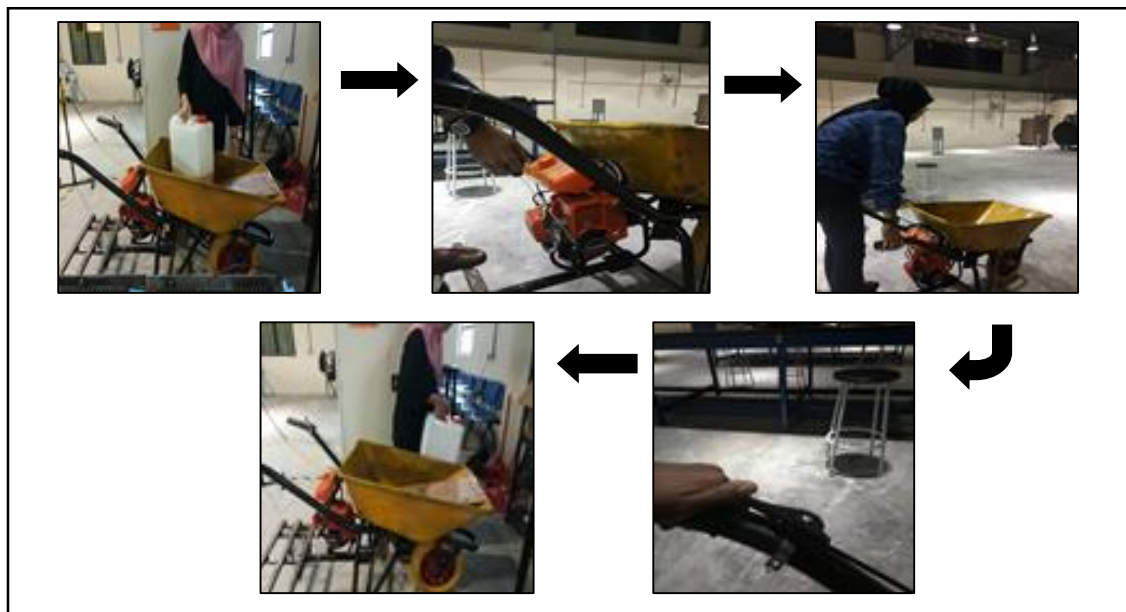
$$\text{The sprocket ratio for the motored wheelbarrow} = 0.394$$

Considering the common power output of a 33 cc mower motor is 0.6 kw to 0.9 kw, the power output to the wheel would be around 3.87 kw to 5.80 kw which would be enough to power the wheelbarrow.



**Figure 5: 428-15T and 428-38T sprocket**

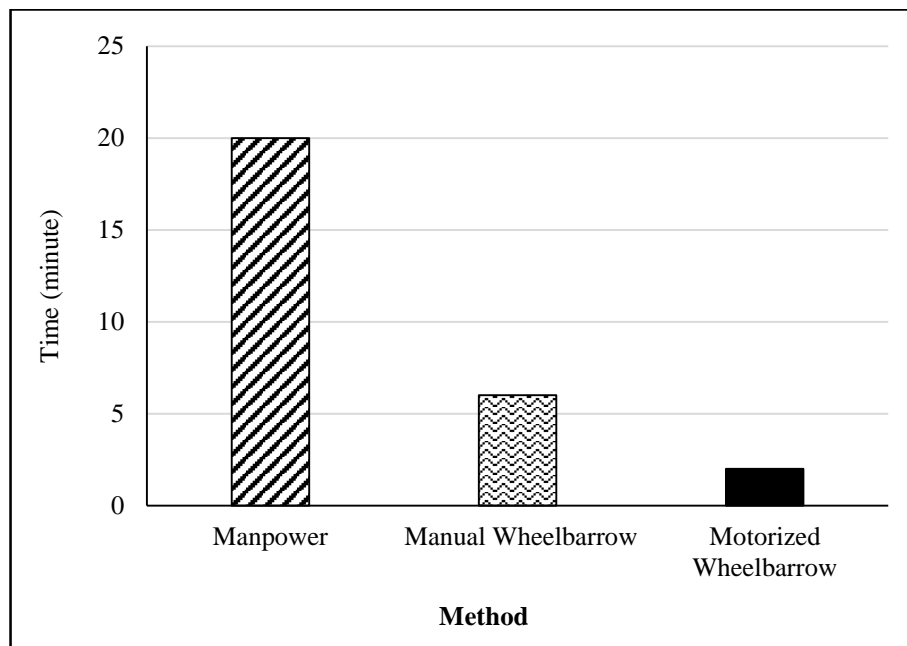
**Figure 6** shows the motorized wheelbarrow used by a worker. The worker lifts a load using motorized wheelbarrow by put the load into the bucket. After the bucket full with loads, a worker need to stand on the platform and start the 33cc of lawn mower engine. The engine is connected to the sprocket will move the sprocket along with the motor chain and causing the wheel to move forward. Then the wheelbarrow will move forward automatically. The function of throttle that placed at handle is to control the speed while driving the motorized wheelbarrow. After arriving at transfer place, press the throttle until the motorized wheelbarrow stop working. After arriving at the transfer place, the next step is to turn off the 33 cc of lawn mower engine and ready to transfer the load.



**Figure 6: Working principle of motorized wheelbarrow**

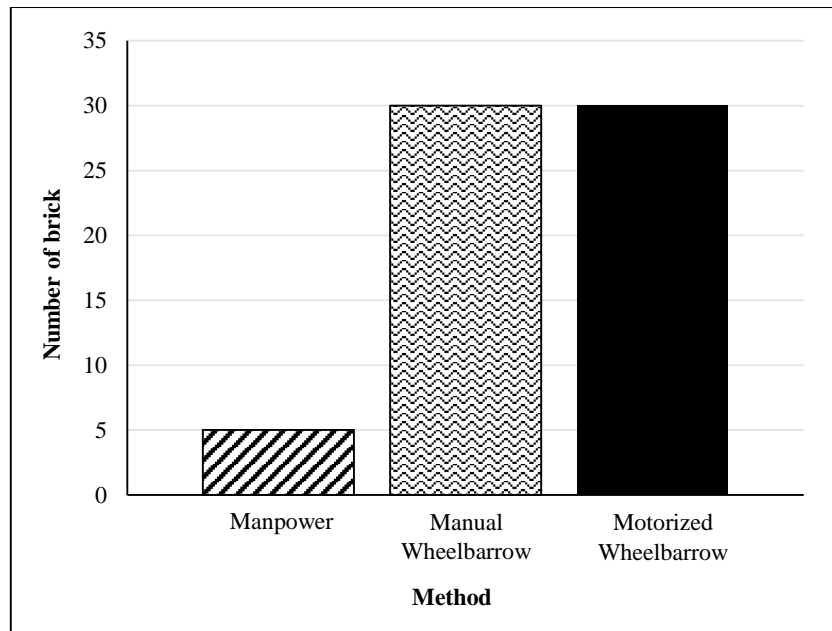
#### 4.2 Analysis on Motorized Wheelbarrow Functionality

The analysis towards a motorized wheelbarrow is made to approve the objective of time saving when used this product. **Figure 7** shows the result of time taken to lift 30 bricks using manpower, manual wheelbarrow and motorized wheelbarrow. From the graph, it shows that motorized wheelbarrow takes shorter time taken to lift 30 bricks along 50 m compare to manual wheelbarrow and using manpower. A motorized wheelbarrow takes 2 minutes to lift 30 bricks along 50 m at construction site, while manpower takes 20 minutes and manual wheelbarrow takes 6 minutes. The ratio time for these three method (manpower, manual wheelbarrow and motorized wheelbarrow) is 10:3:1. Its shows that by using a motorized wheelbarrow can fasten the process of transferring load from one place to another place. Manpower shows 70% slower in time taken compare to motorized wheelbarrow per 20 minutes. Manual wheelbarrow shows 20% slower in time taken compare to motorized wheelbarrow.



**Figure 7: Time taken to lift 30 bricks**

**Figure 8** shows the result of work load to lift 30 bricks using manpower, manual wheelbarrow and motorized wheelbarrow. From the graph, it shows that motorized wheelbarrow and manual wheelbarrow can lifted all 30 bricks along 50 m compare to using manpower. A motorized wheelbarrow and manual wheelbarrow only takes one trip to lift 30 bricks along 50 m, while manpower takes 6 trips to complete transferring 30 bricks. The ratio work load for these three method (manpower, manual wheelbarrow and motorized wheelbarrow) is 1:6:6. Its shows that by using a motorized wheelbarrow is can afford to lift all the bricks with one trip same with using manual wheelbarrow because the bucket that used is standard size of wheelbarrow. Manpower shows 7.7% less in work load compare to motorized wheelbarrow and manual wheelbarrow per trip. Manual wheelbarrow shows 46.15% same in work load with motorized wheelbarrow.



**Figure 8: Number of brick per trip**

## 5. Conclusion and Recommendation

A motorized wheelbarrow comes with improvement in terms types of handle and motorized wheelbarrow compare to an existing product in market. Handle of motorized wheelbarrow can be control by the workers with moved it to left or right. Motorized wheelbarrow used engine to move from one place to another place without used worker's energy. Motorized wheelbarrow is more convenient to be used by workers which is 20% time saving for works can be done faster compare to manual wheelbarrow and manpower. A motorized wheelbarrow can lift load maximum up to 50 kg in motorized wheelbarrow can be further innovated in the future to provide convenience to workers especially in construction field. Recommendation that can be suggestions are number of tires used at the wheelbarrow. Wheelbarrow that used 3 tires can help lift more amount of loads because it has equally stability among the tires. The engine can be upgrade to higher Cubic Centimeter (cc) so that it can increase the power and torque produce by the engine [6].

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