RECYCLING PROCESS

RECYCLING ACADEMY.

Mini-guide

From small-scale to semi-industrial production of pavers (or tiles)

Everything you need to know about the "plastics - sand" line

Key learning outcomes :

- *A better understanding of the challenges facing the "plastic-sand line*
- *Identify obstacles*
- *Know how to take action*

PLASTIC ODYSSEY

Updated by Jean-Baptiste GRASSIN on 21/12/2023

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The contents of this guide are proposed in **open source**

NB: The information in this guide is a "work in progress" and the information is likely to evolve along with our research. Any feedback is welcome by email to jean-baptiste@plasticodyssey.org. Thank you.

Introduction

Context

With only 9% of the world's 400 million tonnes of plastics produced each year recycled, there's a long way to go. For so-called high-value plastics such as PET bottles, some PE or PP, traditional recycling routes exist, provided they are accessible or the plastics meet fairly strict criteria. For a large proportion of other plastics, however, this is not currently possible, and even for PE or PP, particularly flexible but also sometimes rigid, the lack of market, proximity or collection solutions means that these plastics will never see the traditional recycling channels.

The plastic-sand process

For these plastics with low commercial value, it becomes legitimate to look for alternatives to these traditional channels to find alternatives that avoid plastic pollution, burning or incineration. In this context, the process of transforming plastic waste mixed with sand into building materials such as paving stones, bricks or tiles is a fairly well-known practice in the plastic waste transformation sector, particularly in Africa and in the informal sector, as plastic and sand are available in abundance, the need for building materials is great and in certain markets, these plastic-sand mixed products are competitive alternatives to cement or concrete products.
In the short term, this practice is a way of getting to grips with plastic recycling and testing the market: setting up a plastic collection or supply system, setting up a small team to carry out the processing stages and finding outlets to sell the pavers and make a profit.

There are many ways of doing this, but the most widespread is the so-called artisanal method, described in section 2. This method has both advantages and disadvantages, and it would seem appropriate for many project owners to try to scale up in order to develop or even survive. That's what we're going to look at in this mini-guide.

2. Reminder about the small-scale process

The first and best-known way of transforming plastics into paving stones, particularly widespread in Africa, takes the form of an artisanal, low-tech system.

It requires **very little equipment:**

- a metal kettle (for heating and melting the plastic-sand mixture)
- a mixing stick
- Mechanically-welded molds
- Metal table for molding / drying
- Moulding trowel

In terms of consumables, you'll need :

- a means of heating the processing tank (wood, gas, etc.) ;
- plastics (flexible and rigid)
- sand (dry).

The main stages in the production process

Plastic collection

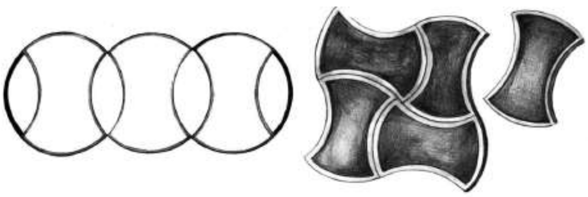
Transformation

Moulding

Final products

Credits - BGS Recyplast - Guinea Republic (process before the scale-up of 2022/2023)

The guide from WasteAid sums up the process and what's at stake, here are a few photos and an extract for the s molds and the tank:



The “recipe” plastic- sand :

WasteAid also gives its analysis for the recipe they tested for the plastic-sand mix, which is pretty reasonable:

"The strength of the paver depends on the mix with the sand. Laboratory tests indicate that the optimum mix is 3 parts sand to 1 part plastic (3:1 sand:plastic), but it is strongly recommended to try different mixes. Start with a 50:50 mix of sand and plastic, then increase the sand ratio to 60:40 and 70:30 to see what works best for you. A 75:25 mix works well for pavers to be used in a residential complex. In general, slabs contain more sand than plastic, as the plastic acts as a bonding agent to hold the sand together."

What plastics can be processed?

It's important to note that the plastic generally used here is a blend of PE (High Density or Low Density) and PP (flexible or rigid).


(a) HDPE


(b) LDPE


(c) PP

LDPE and flexible PP include: films, bags, water pouches, etc.
HDPE and rigid PP include: crates, jerrycans, caps, chairs, basins, etc.

PVC and PS/EPS should be avoided for toxicity reasons (toxic fumes).
Also, PET (water/soda bottles) melt at higher temperatures and cool fairly quickly, which can lead to quality problems. They don't mix well with PE and PP (polyolefins). The photos from La Fabrik's project in Djibouti (at the start of the project with a small-scale process) illustrate this problem with the PET plastic used here.

Pros and cons

Below is a table comparing the advantages and disadvantages of this approach:

	Pros	Cons
Finance	**Very cheap!** (only a few hundred euros for the basic equipment - not including the land/shed)	
Tech and operational	Very easy to operate and easy to obtain equipment	- Small production capacity (maximum 100 to 200 cobblestones per day per vat) - Time-consuming manual mixing work
Economics	This solution enables you to bring your first products to market very quickly... (On the other hand, it's more difficult and time-consuming to find products of sufficient quality that sell well and in quantity).	With limited production capacity and a high demand for human resources, profitability is affected.
HSE (Health, Safety, Environment)		- Difficult temperature control, frequent burning and emission of fumes in the open air (risk for operators if they are not protected, material losses, heating method often quite polluting for the air).
Quality		Risk of product irregularities, limited quality due to poorly controlled heating temperature

To sum up, the small-scale solution can be an interesting way of prototyping, starting to transform materials and getting to grips with them at lower cost. In many cases, it is unavoidable on a local scale for lack of alternatives, other solutions or financial resources. On the other hand, this technique remains limited in terms of production capacity and therefore market access, but also in terms of quality and safety standards.

In the following section, we study this process on a semi-industrial scale.

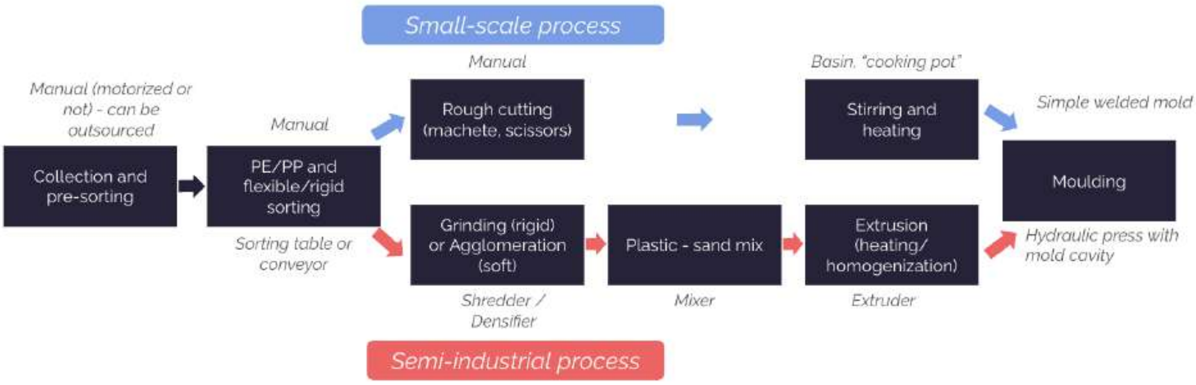
3. Description of the semi-industrial process

The semi-industrial process is an attempt to combine the best of both worlds, between a local production chain with standards and a capacity that are closer to an industrial model.

This type of process will require more equipment and machinery, as well as a more precise and rigorous operating protocol, while remaining relatively easy to use and accessible. Of course, such a system will require a more substantial investment, but well below that of an industrial plant.
To put it simply, in terms of investment, we would have :
- small-scale production: investment of EUR 1,000 to 10,000;
- the semi-industrial sector (Plastic Odyssey): investment of 50,000 to 150,000 EUR
- industrial sector: 500,000 / 1 m EUR to 10 - 20 million EUR investment and more

The main stages in the production process

The document below presents the semi-industrial protocol compared with the artisanal operational protocol.
The main difference is obviously the mechanization of the process, which increases production capacity tenfold and raises quality and HSE standards in general.



Below, we'll take you through the process in its several key stages:

1) **Collection, supply of plastics and pre-sorting:** as presented in section 2, polyolefin plastics (categories 2, 4 and 5) are recommended (HDPE/PEBD/PP flexible or rigid) as their properties are close enough to be processed separately or in mixtures, with fairly similar melting properties. PET, PS or PVC are avoided for

reasons of properties and hazardousness (PET with different melting constraints, generally more difficult to recycle on semi-industrial scales).

NB: It's important to select the right plastics at the outset to avoid collecting or paying for non-useful material, generating residue to be disposed of later.

This stage can be carried out in-house, or prior to arrival at the center, by accurately selecting the feedstock from suppliers.

2) **Plastics sorting:** plastics are separated into different types, or at least into flexible and rigid types, in order to facilitate the following pre-treatment stage, which differs according to the density of the plastics.

NB: It's important to note that we're assuming here that plastic waste is not mixed with organic matter or excessively soiled. The plastic in this case does not need to undergo a washing/drying stage, as dust or a few inert impurities do not pose a problem in the process, as the plastic is then mixed with sand.

3) **Plastics pre-treatment :**

- <u>shredding</u> for rigid plastics (jerrycans, basins, shampoo bottles, bottle caps, etc.) into 5 to 15 mm chips (using a **shredder**)


- <u>Aggregation</u> of flexible plastics (plastic bags, plastic film, water bags, etc.) into small pellets that can then be processed like rigid plastics in the extruder (via an agglomerator). Aggregation takes place under the effect of cutting by rotation at the bottom of the tank and by heating.


Before (plastic bags) → **After** (agglomerates)

4) **Plastic - sand transformation :**

Once the plastics have been pre-treated, they can be extruded in a mixture with sand to produce a paste which can then be molded.
The mixture of plastics and sand is prepared in advance in a silo to homogenize the material in a ratio of 40% plastics to 60% sand (by mass). The mixture is then fed into the extruder funnel.

We have chosen an extruder designed for this mixture, called a paddle extruder, which, unlike conventional worm extruders, has a wider screw system to allow this sand-containing mixture to pass through.
The mixture is kneaded, heated and gradually pushed along the extruder's cylinder to produce a hot, viscous paste.

5) **Moulding:**

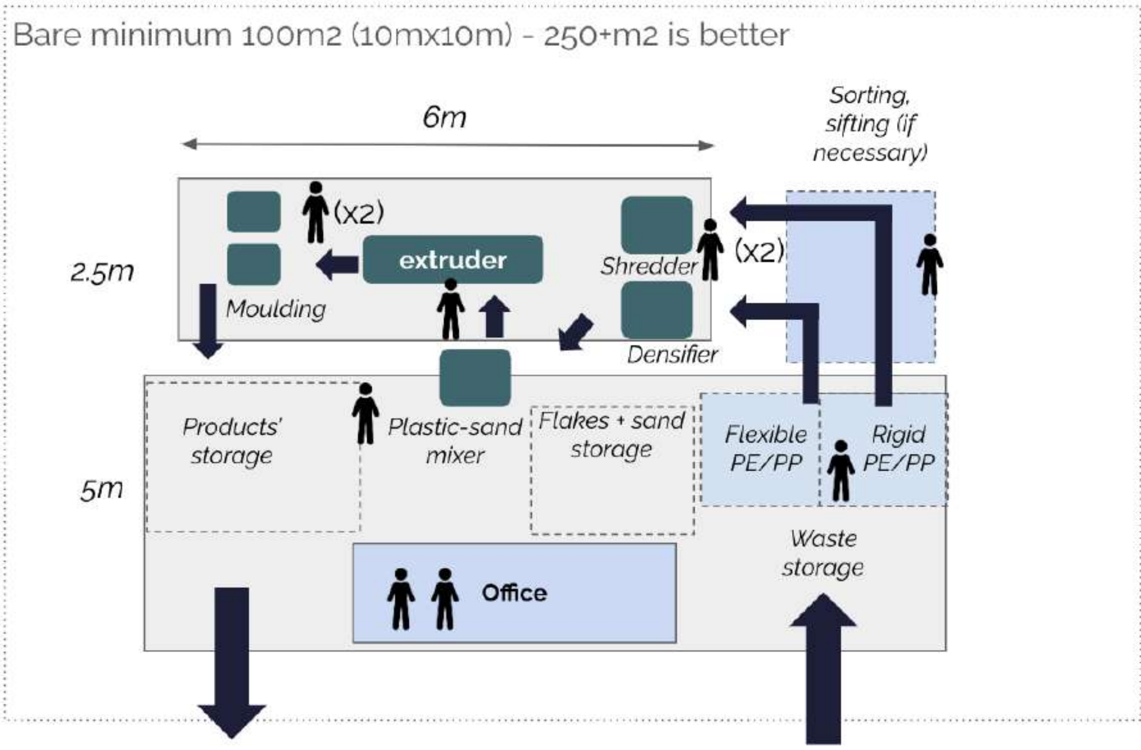
This paste is then collected, weighed and chain-molded in a hydraulic press containing the chosen paver mold. This also includes a cooling system to bring the cobblestone down in temperature and retain its shape.

Single pneumatic press above

More efficient hydraulic press (2 pavers at a time) - Double or single hydraulic press

Operating diagram

By way of illustration, here is a diagram of operations in a micro-production plant for plastic-sand pavers:



For a production rate of around 100 kg/h, for example, the following operating system can be envisaged:

- 1 operator for feedstock reception and related logistics,
- (1 operator for sorting and sieving → this step may or may not be necessary depending on feedstock quality and supply)
- 1 (or 2 - depending on capacity) operator(s) for pre-treatment (shredder or agglomerator)
- 1 operator for plastic-sand mix preparation and extruder feeding
- 1 (or 2 - depending on capacity) operator(s) for product molding (this also depends on the press selected and the number of blocks produced simultaneously)
- 1 operator for storage and logistics.

In short, you need a minimum of 5 operators and <u>more reasonably 8 or 9 operators</u> (including a team leader) to keep the machines running.
Note: in the case of multi-shift operations (2 x 8 hours or 3 x 8 hours per day, for example, several shifts are of course required).
A support staff (1 or 2 people) is also needed for sales and administration.
Depending on the area, a guarding system (1 person at night, for example) may also be required.

Operational metrics for pavers (and tiles)

There are many different types and sizes of pavers, depending on their use, not to mention their design. Road pavers (thicker), sidewalk pavers (intermediate thickness) and residential pavers (schoolyard type - thinner).

Here's some information on road pavers (photo opposite):

- A typical road paving stone is at least 6-8cm thick - 20cm x 16cm (compared with around 3cm thick for more residential and soft-mobility paving stones).
- You'll need around 31-32 pavers of this size per m2 - or around 93 kg of material.
- A 6cm-thick paver weighs around 3kg, of which 1.2kg is plastic (40%) and 1.8kg is sand (60%).

<u>Note:</u> we've also tested thinner, hollow pavers (3.5 cm thick - 420 g per piece), but this is a relatively unknown product, and not well mastered when it comes to laying.
We're also thinking of interlocking pavers, but they're more hollow underneath, but their resistance and practical behavior remain to be tested.

"Recipe" for plastics:

For the proportion of flexible versus rigid plastics, properties will be impacted by the proportion of flexible plastics, so ideally and according to our current feedback: **20-33% flexible plastics (LDPE, flexible PP: e.g. plastic bags, water bags, plastic films etc.) and 67-80% rigid plastics (HDPE, rigid PP: basins, jerrycans etc.).**

This will be taken as a reference for all types of paving for the time being (road, sidewalk, residential).

Use of colorants:

A colorant can be incorporated when the plastics and sand are homogenized in the mixer, i.e. before the extrusion phase.

Depending on the desired color, there are different methods for selecting the colorant, but generally speaking, powdered concrete colorant is the most appropriate.

Type	Pigment jaune
Domaine d'application	Bâtiment
Forme de livraison	Microgranulés
Désignation chimique	Oxyde de fer synthétique α - FeOOH
Colour Index	Pigment yellow 42 (77492)
N° CAS:	51274-00-1
N° d'enregistrement REACH	01-2119457554-33
Le produit remplit les conditions de la norme EN 12878 catégorie A (béton non armé).	

The quantity is in the order of **0.5 to 3% by mass** in the mixture.

The cost is around **$70-100 for 25 kg** of colorant.

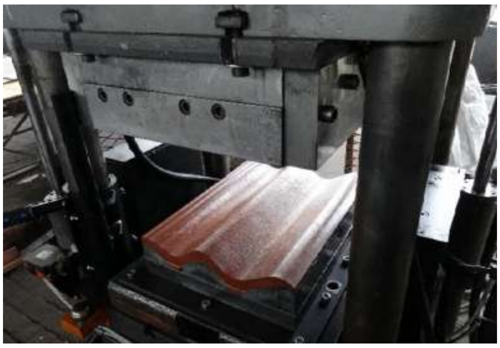
Production:

- It is possible to take machines producing in the semi-industrial window 100-250 kg/h (the limiting factor is rather on the extrusion side).
  For an average of 200 kg/h, for example, and 6cm-thick pavers, this means a capacity of 67 pavers per hour, or just over 2m2 per hour. It also means about one paver per minute (hence the need for a fluid protocol between extruder and press).

- It's important to note that the key to profitability lies in optimizing the material used in the paver. Very thick, heavy pavers are always sold per m2 at prices that don't explode in comparison with thinner pavers. On the other hand, material costs are much higher.

Comparaison - Métriques opérationnelles pour la tuile :

- A roof tile weighs about 4.5 kg a piece.
- Approximately 5.5 tiles are needed for 1 m2 of roofing, i.e. 25 kg of material.
- The manufacturing process is the same as for pavers (same plastic - sand ratios) and the same production chain. Only the mold changes.



Roof tiles in the press with its mold above

Remark:
You can do the same for other products such as bricks, slabs, breeze-blocks, etc.
More ideas in the mini-guide "What to recycle plastic waste into?"

Technical equipment (machines and investment)

Below is an illustration of the machinery and equipment required to transform plastic waste into paving blocks:

(a) Shredder

(b) Densifier

(c) Mixer

(d) Extruder

(e) Hydraulic press with moulds

(f) Cooling system

	Specs	Price estimate (EUR)
Machines		**≈ 58,5k-76,5k EUR**
Shredder	100-150 kg/h - 11kW 150-200 kg/h - **15kW** (take around 1kW per 10kg/h)	≈ 10-15k EUR
Densifier	50-100 kg/h - 20kW	≈ 8-10k EUR
Plastic-sand mixer	125 L - 0.5kW	≈ 0,5k EUR
Plastic-sand extruder	150- 250 kg/h - 30kW	≈ 20-25k EUR (potential to go down to 15k EUR)
Hydraulic press	4kW par presse	≈ 10-15k EUR
Moulds for pavers		≈ **8-9k** EUR
Cooling system	4kW - 7m3/h (circulating)	≈2k EUR
Equipments		**≈ 7k-8k EUR**
Electrical system (wiring, switchboard, etc.)		≈ 4k EUR
Exhaust system for extruder fumes		≈ 1k EUR
Sorting table		≈ 0,5k EUR
Sifting for table		≈ 0,5k EUR
Other equipments (maintenance etc)		≈ 1-2k EUR
Options		**≈ 0-55k EUR**
Washing tank	if feedstock needs to be washed	≈ 5-10k EUR
Drying system	if feedstock needs to be washed	≈ 10-15k EUR
Diesel generator	if power cuts are too frequent and/or too long	≈ 10k EUR
Conveyor	for fluid material transfer (relevant for large capacities)	≈ 5-10k EUR
Small collection vehicle	if in-house collection - 1 tonne compacted per trip	≈ 7-10k EUR

NB: Costs of transport, customs duties and installation are not included here for CAPEX. This is a simple description of machines, equipment and options.

Electricity and water needs

Electricity needs

Depending on the size of the system, the useful machine power is around 40-60 kW for a production capacity of between 100 and 250 kg/h.
For 200 kg/h, we have around 55 kW of useful power (or real power), i.e. 275 kWh per tonne of recycled plastic (5h x 55 kW).
At a kWh price of EUR 0.25, for example, this means EUR 69 in electricity costs per tonne recycled.

Note: It's important to note here that we're assuming a system powered solely by the national grid. Depending on outages or other problems linked to access to the grid, it may be necessary or even essential to have recourse to a backup system, generally using a generator (in which case the price per kWh will be different, depending on the price of fuel) or via another energy source such as biogas or solar power (in this case with repercussions on CAPEX and investments to be made accordingly).

Water needs:

Depending on the feedstock and its origin, plastics may or may not need to be washed. Most of the time, we prefer a feedstock that is not soiled by organic matter or too much oil, etc. In this case, the presence of dust or small particles of dirt is not a problem for the process. In this case, the presence of dust and small particles of dirt is not a problem for the process, given the subsequent mixing of the plastic with the sand. With the right choice of feedstock, there's no need for any additional, costly washing-drying phase.

The need for water is therefore essentially concentrated in its use in the cooling system, in a closed circuit. Evaporation is inevitable, however, and the tank will have to be filled regularly, either directly or by delivery.
The associated water cost is not very significant, but it's worth bearing in mind when it comes to logistics and choice of site.

Maintenance advice: machine and equipment upkeep

Type of equipment	Daily	Weekly	Monthly	Yearly
Warehouse / container	Cleaning the work area at the end of each day	Check that doors close properly, grease if necessary	Check for signs of corrosion (roof, walls)	Exterior paint touch-up

General electrical panel	Check that LED indicator is working properly	Meter readings and verification of correct operation	Tighten all screws on circuit breakers, meters, terminal blocks, etc.	
Densifier	Remove plastic film wrapped around the rotor	Checking the power cable	Sharpening blades and counter-blades	Change blade set if necessary
		Check adjustment with a shim and that the blades are securely fastened.	Check condition of bearings and lubricate if necessary	
Shredder	Remove plastics trapped in the screened grid	Sharpening blades and counter-blades	Check condition of bearings and lubricate if necessary	Change blade set if necessary
		Check adjustment with a shim and that the blades are securely fastened.		
		Checking the power cable		
Plastic - sand mixer	Checking the power cable	Cleaning the mixer drum		
Cooling circuit	Check fittings for leaks	Check water cleanliness, replace if necessary and check pump operation	Check pump filter, clean if necessary	Tank emptying and cleaning
Extruder		Cleaning the extrusion zone when the extruder is cold and switched off	Checking the power cable	Checking oil level and cleanliness
			Grease	
		Extrusion screw drain	Checking belt condition	
Paver mould	Mould cleaning and lubrication	General check of mould condition, inside and out	Check for signs of corrosion	

4. Why and how to scale up?

Pros and cons of the semi-industrial process

	Pros	Cons
Finance	- Much more affordable than industrial infrastructure - Possibility of having machines built in the region or even in-house (to be verified according to project area and capacity)	Requires significantly greater investment than a small-scale process
Tech and operational	Relatively easy to operate and maintain, even if a more rigorous protocol must be followed	- Significantly increased capacity (minimum 500 to 1000 pavers per day) - Time-consuming manual mixing work
Economics	This solution enables us to access a larger, more professional market, especially B2B, and achieve economies of scale with a more reliable and controlled process.	We need to keep up a steady production rate to amortize our equipment.
HSE (Health, Safety, Environment)	This solution allows us to move into a new dimension in terms of production standards, which are now of a quasi-industrial order. The heating temperature is controlled, so there are no health risks.	The new standards demand rigor that must be maintained over time. This requires training (not necessarily more qualitative staffing, as the protocol is not really more complicated).
Quality	Production is homogeneous, with enhanced quality.	Need to set up a quality monitoring system to comply with standards

Obstacles and solutions

Technical and operational level

As described in the previous section, the first step in scaling up to semi-industrial production is to mechanize the operational process.

→ For waste pre-treatment, the shredder and **densifier** will be the two key components, rigid and flexible respectively.

→ For the key transformation stage (heating phase), equipping yourself with a machine that can control temperature (such as an **extruder**) is decisive, as the process then emits very little fumes that can be absorbed by a host.

→ Finally, for molding, a **press** (pneumatic or hydraulic) with a **mould** not only standardizes and accelerates production, but also improves product quality.

→ A **cooling tower** is often a must-have to speed up the mold cooling process and enable rapid production rates to be maintained. Another trick to speed up cooling is to make thinner or hollow products (insofar as they are of interest to the market).

There are two main options to get these machines:

- **build them on site with a local builder** or supplier based on Plastic Odyssey open source plans (if available) or on products already available from the builder if they exist,
- **order them from a supplier** or directly from Plastic Odyssey.

At the economics level

Have sufficient access to ad hoc plastic waste and an outlet for the products!

In order to move up a gear, there needs to be at least some traction in terms of plastic feedstocks or outlets, and the two must eventually coincide.

In the construction market, demand for materials is often significant. This means that a number of builders who issue calls for tenders select candidates capable of producing the quantities requested in a given timeframe. It is therefore very common for these contracts to be inaccessible to small craft structures, as production capacity is too low.
Example: a 5,000m2 lot for the local council to be delivered within 3 months, i.e. around 180,000 paving stones, i.e. more than 2,000 paving stones per day, i.e. around 3 tons of plastic per day for 3 kg road paving stones with 50% sand (schematically).

Of course, the question of outlets has to be addressed on a case-by-case basis, but it's important to bear in mind that volume is a critical parameter in the development and sustainability of the model. A certain production threshold must be reached for the project to be profitable.

In terms of plastic waste sources and supply, it's important to be able to anticipate whether or not it will be possible to continue to supply the same volume with the same supply chain, or whether it will be necessary to find new suppliers, or even to internalize all or part of the collection process, in order to be efficient. In addition to the volumes collected, it's important to consider the quality of this source in relation to its price (already sufficiently sorted, washed, etc.).

At the financial level

At the end of the day, in order to be able to make this move to scale, it becomes necessary to find financial resources.

Several options and scenarios are possible for this:

- proceed step-by-step, first acquiring/manufacturing pre-treatment machinery (grinder then agglomerator) and then processing machinery (extruder, press and mold), convincing customers and investors along the way.
- after the prototype or proof-of-concept (POC), move on to a fund-raising stage to finance the entire project (machines, land, installation and studies, working capital to get started). Don't forget that the budget required is not limited to the machines themselves, but also to all the other ancillary costs involved in setting up and launching the project. Funds can be raised via calls for projects, private investors or donors, customers, etc.

To do this, you can work on your own or learn from other Plastic Odyssey community project leaders on WhatsApp, or get direct support from Plastic Odyssey's Project Acceleration Program (contact jean-baptiste@plasticodyssey.org for more information).

5. Case studies

BGS Recyplast in Guinea

Having started from scratch, Mariam is an entrepreneur who has developed her recycling business step by step. By winning entrepreneurship awards for her idea of collecting and transforming plastic waste into paving stones, she was able to buy some basic equipment and grow her team to a small-scale artisanal production. After more than 3 years, she has been able to gain some significant production mandates, but production conditions and capacity are becoming too limited. Here are a few photos of artisanal production:





In 2022, with the help of Plastic Odyssey, the microfactory project was set up (the first unit of its kind).

The microfactory is equipped with a complete die with a production capacity of 100 kg/h for residential paving blocks.

Here's the micro-factory below:

Residential paving blocks 140x140x35 mm - 2 different interlocking pieces

Here's the project web page for more details: https://bgsrecyplast.com/
More information in the article.

“La Fabrik” in Djibouti

La Fabrik is a project developed in Obock (Djibouti) at the initiative of the IOM (International Organization for Migration) in an attempt to solve the problem of waste (isolated area) and create jobs locally.

The project began with an artisanal process, with the acquisition of a Chinese shredder for the pre-treatment of plastics. Initially, the project used only PET bottles as a feedstock, creating major defects on the paving stones (unfounded, leading to the risk of cracks and surface defects).





Subsequently, the project acquired machinery for the rest of the processing chain: extrusion and press/mold, focusing on residential pavers first. An agglomerator was also added to process soft plastics, and the shredder was adjusted to fulfill its mission more effectively.
A baler was added to the plant to handle PET bottles on a separate line with a buyer in Djibouti-ville (the capital), while the paving stone line now focuses on PE and PP, the plastics recommended for this line.

More info in the article.

Other case studies

Here are some interesting case studies and resources:

Feedback from a project in Senegal:

- Number of cobblestones produced per month: 5250 or 250m2 (21 cobblestones per m2 and around 200 cobblestones produced per day).
- Price per m2 of 6cm-thick pavers: 7,500 FCFA (transport not included)
- Price per m2 of 8cm-thick pavers: 9,000 FCFA (transport not included)

The company supplies its plastics from industrial sites (for free - just paying for the transportation) and from the population (125 FCFA / kg).

Case study in Mali (documented by the NGO Waste NL)

Impacts of the plastic - sand process

Ultimately, the plastic-sand process producing paving blocks, tiles and bricks has potential and is of certain interest in enabling the recovery of waste of low economic value and the creation of local jobs. On the other hand, it is discussed for its "downcycling" character and its real impacts on the environment. Are plastic - sand pavers recyclable again and how to proceed? How long do these products last? Are microplastics released from these products into the environment? These are important questions to address and on which Plastic Odyssey is working in order to control the impacts of this existing sector. This document will therefore be updated with the analysis results and the solutions found.

Scale up from a semi-industrial to an industrial process?

Another question that arises is: if the sector on a semi-industrial scale works better than on an artisanal scale, why not then move on to an even larger (industrial) scale?
It is true that it is a sector in which one of the driving forces is volume and the phenomenon of economies of scale remains valid. This option therefore remains theoretically valid.
Some questions remain. Notably, on an industrial scale, more and more plastics are needed and therefore the question of plastic supply becomes more and more critical (especially in non-urban areas). Ever more plastics also means ever more consumption and therefore no reduction in plastic production... This question can be applied to recycling in general but so can the question of the transition and the availability of alternatives to plastic.
In terms of profitability, we must then see how this solution compares to the alternatives but if a semi-industrial sector is profitable then the industrial solution will also be profitable provided that the supply of raw materials and the market and outlets are sufficient. and stable to absorb more volumes.
On such a scale, however, the model will be less agile and market disruption or the instability of (sometimes fragile) value chains could be fatal.
Finally, the centralization of the infrastructure means collecting plastics over a wider radius and therefore increases transport and collection costs (which can partly counterbalance the economy of scale compared to the semi-industrial sector) .

Conclusion

To conclude, this sector remains quite recent and not well documented in depth and deserves to be more analyzed to understand its ins and outs, particularly on a semi-industrial scale. However, references are given below and updates will be made gradually. We also welcome your testimonials and feedback to share them with our community.

It's now up to you to take this knowledge and apply it to the environment around you.

Resources

- Mise en place d'une unité de transformation de sacs plastiques en pavés (Togo, 2009/2010)
- Projet de création d'une entreprise de fabrication et de commercialisation de pavés à base de déchets plastiques dans la ville de Parakou (Bénin, 2020)
- Etude de faisabilité technique et financière de la mise en place d'un centre pilote de valorisation des déchets ménagers du Bassin du Versant du Gourou à Abidjan (Côte d'Ivoire, 2017)
- Élaboration et caractérisation d'une structure composite (sable et déchets plastiques recyclés) : Amélioration de la résistance par des charges en argiles.
- Cementless building materials made from recycled plastic and sand/glass: a review and road map for the future (2022)
- FORMULATION AND CHARACTERISATION OF A TILE BASED ON PLASTIC WASTE AND ALLUVIAL SAND SANAGA-CAMEROON (2023)
- Manufacturing of Floor Tiles by using Polypropylene as a Plastic Waste Material with Manufactured Sand (2020)
- Process for Making Self-Locking Pavements from Madagascar River Sand and Plastic Waste (2023)
- Reuse of Waste Plastics in Developing Countries: Properties of Waste Plastic-Sand Composites (2022)