19 BUSINESS OPPORTUNITIES

ECONOMIC BUSINESS MODELS IN EGYPT'S RECYCLING SECTOR FOR STARTUPS AND SMEs

European Commission

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Department of Economic Affairs, Education and Research EAER
State Secretariat for Economic Affairs SECO

german cooperation
DEUTSCHE ZUSAMMENARBEIT

Implemented by:

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

KFW

NSWMP
national solid waste management program
البرنامج الوطني لإدارة المخلفات الصلبة

WMRA
Waste Management Regulatory Authority

Ministry of Environment

Published by:
Ministry of Environment

Ministry of Environment

Waste Management Regulatory Authority

WMRA
Waste Management Regulatory Authority

National Solid Waste Management Programme

NSWMP
national solid waste management program
البرنامج الوطني لإدارة المخلفات الصلبة

With the support of:
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

german cooperation
DEUTSCHE ZUSAMMENARBEIT

Implemented by:
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
KFW

Authors:
Chemonics Egypt
Cleantech Arabia

Designed & Printed by:
Liquid Advertising
info@liquid-adv.com

Contact:
National Solid Waste Management Programme Egypt (NSWMP)
17 Port Said St., Maadi Sarayat,
Maadi, Cairo, Egypt
T +202 238 00 339
www.nswmp.net
www.facebook.com/egyptnswmp
www.twitter.com/Egypt_NSWMP

As at:
April 2018

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

B2B	Business to Business
BOM	Business Opportunity Mapping
CAPEX	Capital Expenses
CAGR	Compound Annual Growth Rate
CAPMAS	Central Agency for Public Mobilization and Statistics
CPI	Consumer Price Index
CRT	Cathodic Ray Tube
CPU	Central Processing Unit
EEAA	Egyptian Environmental Affairs Agency
EGP	Egyptian Pound
E-waste	Electronic waste
FAO	Food and Agriculture Organization
Gcal	Giga calorie
GCR	Greater Cairo Region
GDP	Growth Domestic Products
IFC	International Finance Corporation
IRR	Internal Rate of Return
MENA	Middle East and North Africa
MDF	Medium Density Fibre board
MSW	Municipal Solid Waste
NGOs	Non-Governmental Organizations
OPEX	Operating Expenses
PCB	Printed Circuit Board
PET	Polyethylene terephthalate
RAM	Random Access Memory
RDF	Refused Derived Fuel
SMEs	Small and Medium Enterprises
SRF	Solid Recovered fuel
SWM	Solid Waste Management
TDF	Tire Derived Fuel
UNIDO	United Nation Industrial Development Organization
USD	United States Dollar
WMRA	Waste Management Regulatory Authority

SECTION 1

WASTE PROBLEM AND WASTED OPPORTUNITIES

1.1 MARKET OPPORTUNITIES IN THE WASTE SECTOR

Unlocking businesses in the waste management sector through information, knowledge and market intelligence. The objective of the "19 Business Opportunities: Economic Business Models in Egypt's Recycling Sector for Startups and SMEs" study is to trigger innovation and entrepreneurial activity, through showcasing business opportunities in the waste management sector across Egypt. These business opportunities turn waste through processing, recycling and upcycling into productive uses that have a positive impact on the environment compared to current practices. Hence, they create sustainable market dynamics, in which they are being leveraged to create profits for firms and provide positive economic as well as environmental returns for society. The study aims at filling the information and knowledge gap, which thus far among others have limited investments in the waste management sector. Yet, investors and financial service providers do realize the opportunities in waste management. However, the limited access to information and knowledge locks investment flows. Entrepreneurs often struggle in building their businesses and evolve mainly through trial and error. They face risks, which can be effectively mitigated through information and market knowledge. It is expected that the present economic study will contribute to unlocking investments in the sector as well as increase the success chances of entrepreneurs and business endeavours.

A market driven approach. Worldwide, waste management is among the fastest growing industries. Internationally, the waste industry has evolved through waste characterization, specifications and standards, regulations, education, occupational professionals, and most importantly the markets it could serve through recycling and material recovery. From a market point of view, generated waste is a feedstock or a raw material that is processed to serve client needs through products. Thus, in various waste streams lies a business opportunity, given a supportive market structure. In Egypt, waste management is often viewed in terms of waste streams and regarded as supply driven. Yet, business opportunities flourish better if defined through the market side; the demand. Being demand driven was the pivoting point of the study. Market data was gathered and analysed, amounts of various waste streams and current activities were also identified and analysed.

Further, most up to date technologies as well as gaps in demand and supply were determined. Based on tested methodologies, through field surveys, desk research, expert consultation meetings, as well as Chemonics Egypt and Cleantech Arabia market experts, 70 market opportunities were scanned and shortlisted to feasible 19 business opportunities within Egypt's waste management sector. This is not an exhaustive list of business opportunities, others do exist, however, these are the feasible ones within the current policy frameworks, market dynamics, and are affordable for startups and SMEs.

Therefore, the identified business opportunities that can be initiated on a small scale and rely on innovation in the business model and the skills of the entrepreneurs

and SMEs. Information was developed based on the markets the business opportunities serve, the technologies required, as well as available and accessible waste streams. Using this information, financial analyses of the business opportunities as well as value chain analyses were carried out, with respect to most suitable locations for the business models, access to supply, interaction with the informal sector, and other key information that might guide entrepreneurs, business owners and investors. Market insights including risk and mitigation measures are also presented.

Aiding the practical application of the study's analyses, the financial tool "Waste Management Feasibility Scanner" with its complimentary guidebook was designed to allow entrepreneurs, startups, SMEs, and investors to assess the feasibility of the opportunities in waste management. The tool captures the details of the sector and guides SMEs to key numbers and potential pitfalls. It is a decision-making tool through which the business can evaluate the impact of its decisions on the financials of the company; whether those decisions are directly related to financial aspects (e.g. prices, quantities, ways of financing, etc.) or related to the business model (e.g. diversifying the product mix, outsourcing certain processes, etc.).

A market pull with positive environmental, social and economic impact. Most of the 19 identified opportunities have an IRR between 60-90% and are therefore highly profitable and feasible for startups, SMEs, and investors to pursue. Additionally, from a societal point of view they also provide high returns, in terms of job creation, environmentally friendly practices and know-how exchange. As proven in Egypt and internationally, once a market pull is created on a waste stream, more effective collection activities are triggered. Waste starts to be viewed as a resource and treated as such. This market pull usually diverts waste from reaching landfills, dumpsites, or environmentally detrimental venues towards productive uses. Hence, the business' opportunities' impact on key waste streams is analysed. The amount of waste absorbed in each market is determined, as with increased business activities significant amounts of waste can be diverted from disposal toward a resource in key markets. Furthermore, the potential impact of these market opportunities on job creation, national economy, and trade balance is analysed. The 19 opportunities are listed in the table below.

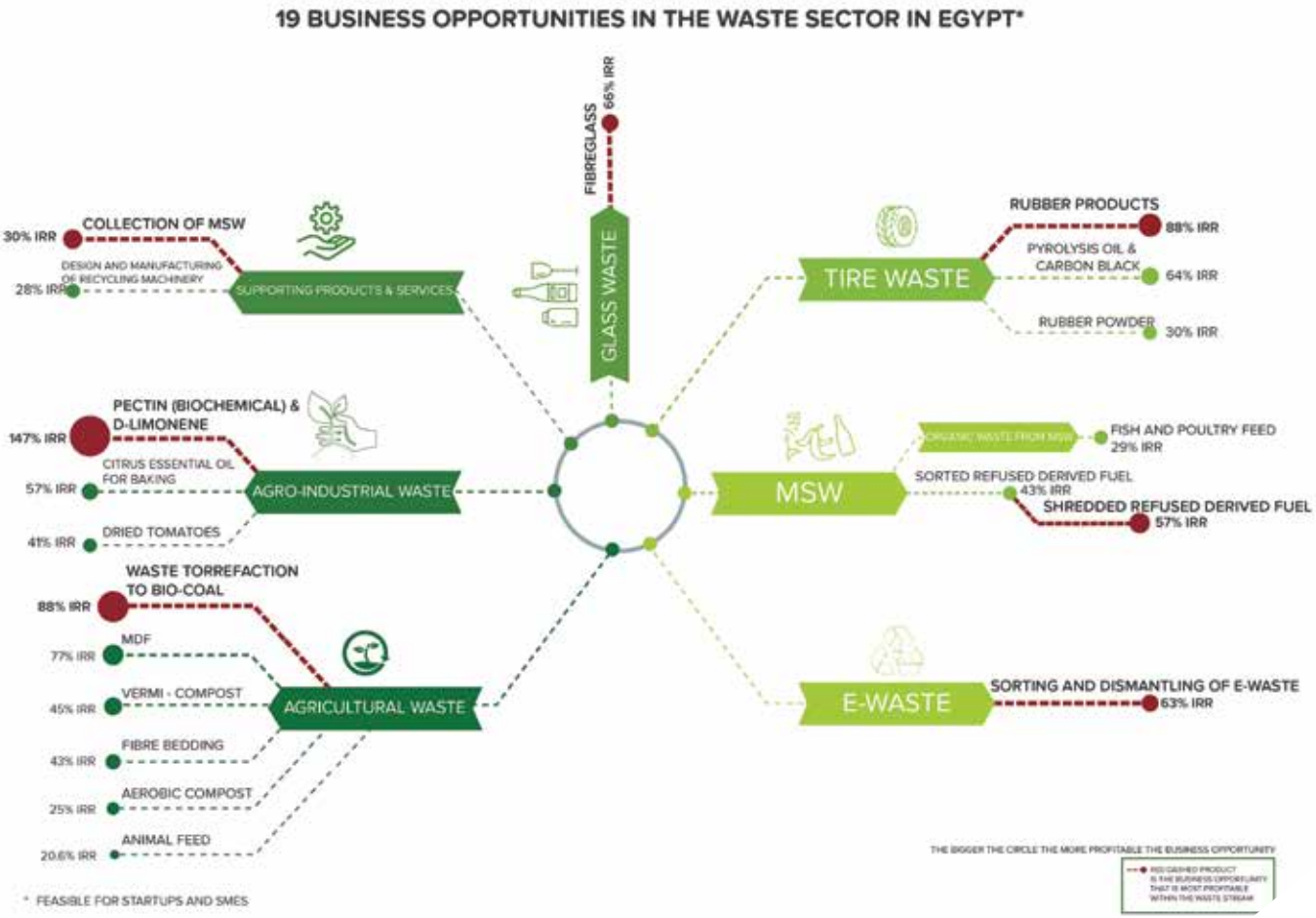
Opportunities studied: 70

Feasible opportunities: 19

Total job creation potential: 850,000 jobs

Potential economic impact: 63Billion EGP/year

Total potential waste absorbed: 13Million tons/year


19 BUSINESS OPPORTUNITIES IN THE WASTE SECTOR IN EGYPT*
FIBREGLASS
66% IRR
GLASS WASTE
30% IRR
COLLECTION OF MSW
DESIGN AND MANUFACTURING OF RECYCLING MACHINERY
28% IRR
SUPPORTING PRODUCTS & SERVICES
TIRE WASTE
RUBBER PRODUCTS
88% IRR
PYROLYSIS OIL & CARBON BLACK
64% IRR
RUBBER POWDER
30% IRR
147% IRR
PECTIN (BIOCHEMICAL) & D-LIMONENE
57% IRR
CITRUS ESSENTIAL OIL FOR BAKING
AGRO-INDUSTRIAL WASTE
41% IRR
DRIED TOMATOES
MSW
ORGANIC WASTE FROM MSW
FISH AND POULTRY FEED
29% IRR
SORTED REFUSED DERIVED FUEL
43% IRR
SHREDDED REFUSED DERIVED FUEL
57% IRR
88% IRR
WASTE TORREFACTION TO BIO-COAL
77% IRR
MDF
45% IRR
VERMI - COMPOST
AGRICULTURAL WASTE
43% IRR
FIBRE BEDDING
25% IRR
AEROBIC COMPOST
20.6% IRR
ANIMAL FEED
E-WASTE
SORTING AND DISMANTLING OF E-WASTE
63% IRR
THE BIGGER THE CIRCLE THE MORE PROFITABLE THE BUSINESS OPPORTUNITY
* FEASIBLE FOR STARTUPS AND SMES

1.2 UNDERSTANDING THE SUPPLY SIDE

Egypt generates a large amount of waste that can be turned into products. With its exponentially fast growing population, promising industrial sector, and abundant agro-reclaimed lands; Egypt generates about 90 million tons of waste annually, of which significant amounts are not handled properly. The waste management system in Egypt – whether municipal or other waste streams – cannot ensure proper disposal and treatment, especially under the rising waste amounts. Yet, various waste streams can be utilized in productive uses, in which waste becomes feedstock for business innovation to transform into products. Recycling metals, fermenting food residue, agricultural waste as animal feed, fertilizers or biofuels, are just a few items on top of a long list of potential business opportunities.

Egypt's waste has a diverse composition with the potential to open opportunities for a variety of businesses. The socio-economic status of citizens as well as the macro-economic conditions of a country are represented in the waste composition. According to 2016 data, the main waste streams are agricultural waste (34%), municipal solid waste (23%), canals and irrigation network cleansing (28%), construction waste (6%), and industrial waste (5%) (Table 1). [1]The waste composition follows the main economic trends in Egypt, depicting an independent agricultural sector, an agglomeration of wealth and services in urban centres, paralleled by booming real estate developments, as well as slowly growing manufacturing enterprises.

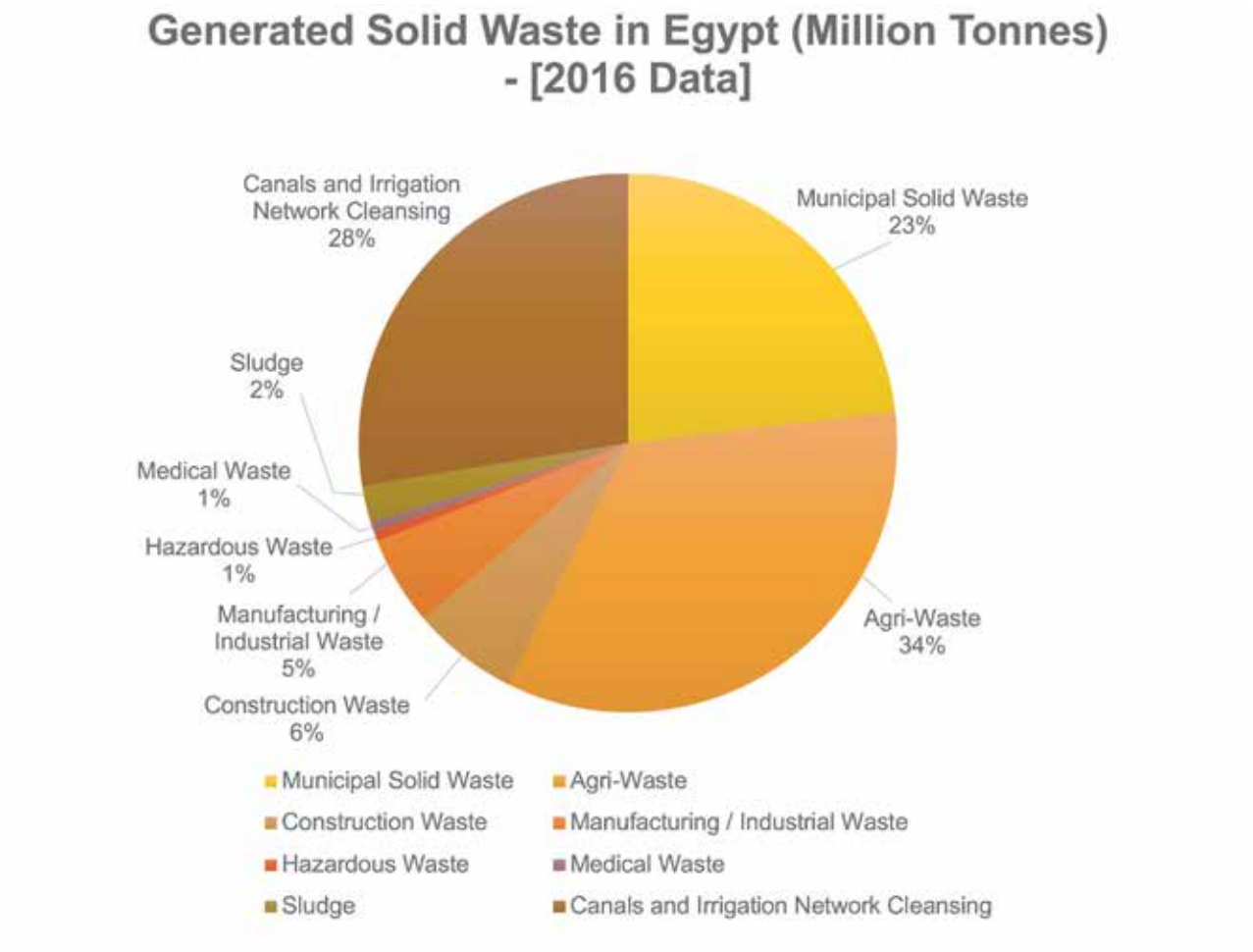


Figure 1: Generated solid waste in Egypt (in million tons) - (EEAA, 2017)

Egypt waste in 2018 could reach 95 million tons. A recent study conducted in 2016 shows that Egypt generated 90 million tons of waste with the break down indicated in Table 1. The increase in Egypt's waste generation is two folds; (1) it is due to the rapid population growth and (2) due to the increase of consumption and hence waste generation rates. When only accounting for the increase in population, the waste generated in 2018 could reach 95 million tons.

Table 1: Amounts of each type of solid waste based on 2016 and extrapolated 2017 and 2018 amounts

Generated Solid waste in Egypt	Annual Waste Produced (million tons) 2016 Data	Annual Growth Factor[2]	2017 Data	2018 Data
Municipal Solid Waste	21	2.50%	21.525	22.06313
Agricultural Waste	31	2.50%	31.775	32.56938
Construction Waste	5.8	2.50%	5.945	6.093625
Manufacturing / Industrial Waste	4.9	2.50%	5.0225	5.148063
Hazardous Waste	0.54	2.50%	0.5535	0.567338
Medical Waste	0.52	2.50%	0.533	0.546325
Sludge	2	2.50%	2.05	2.10125
Canals and Irrigation Networking Cleansing	25	2.50%	25.625	26.26563
Total	90.76		93.029	95.35473

Another method to forecast the amounts of waste relevant to economic activities is to correlate the data to GDP growth. Table 3 shows the GDP growth in the agricultural, manufacturing and construction sectors, respectively. The GDP is intentionally calculated in USD to counter the EGP devaluation data discrepancy that was effective since November 2016 and inflation was taken into account. Based on such assumptions, it is forecasted that the amount of agricultural waste in 2018 is expected to remain the same as in 2016, while the industrial waste amounts will increase by a growth factor of 4.8%, while the construction waste by 5.8%. Nonetheless, for accuracy reasons it is suggested to maintain the waste growth rates based on the steady population growth of 2.5% for all waste categories, as the GDP may reflect potential investments that are still in the pipeline. Hence, GDP growth is not reflected in the actual amounts of waste generated (Table 4)[3].

[1] *EEAA, 2017. Environmental Status Report - 2016. Arab Republic of Egypt. Cairo: Ministry of the Environment.*

[2] *Equal to annual 2.5% growth of population, Source: CAPMAS.*

[3] *Source: tradingeconomics.com.*

Table 2: Annual GDP from agricultural, construction and industrial

Year	GDP from agriculture (million USD)	GDP from construction (million USD)	GDP (USD) from manufacturing
2014	7,857.00	2,272.00	6,818.00
2016	5,681.00	2,840.00	8,863.00
2017	4,521.00	2,659.00	7,978.00

Table 3: Extrapolated amounts of agricultural, construction and industrial waste based on growth in GDP

Generated Solid Waste in Egypt	Annual Waste Produced (million tons) 2016 Data	Annual Growth Factor[4]	2017 Data (million tons)	2018 Data (million tons)
Agricultural Waste	31	-no change	31	31
Construction Waste	5.8	6.00%	6.14	6.51
Manufacturing / Industrial Waste	4.9	4.00%	5.09	5.29

Table 4: Total amount of annual waste generation in Egypt. Projections are based on growth in population for MSW, sludge, medical waste and canal cleansing. For the remaining sectors the growth rate is based on GDP growth per sector.

Generated Solid waste in Egypt	Annual Waste Produced (million tons) 2016 Data	Annual Growth Factor[5]	2017 Data (million tons)	2018 Data (million tons)
Municipal Solid Waste	21	2.50%	21.52	22.06
Hazardous Waste[6]	0.54	4%	0.56	0.58
Medical Waste	0.52	2.50%	0.53	0.54
Sludge	2	2.50%	2.05	2.10
Canals and Irrigation Networking Cleansing	25	2.50%	25.62	26
Agricultural Waste	31	-no change	31	31
Construction Waste	5.8	6.00%	6.14	6.51
Manufacturing / Industrial Waste	4.9	4.00%	5.09	5.29984
Total			92	94.4

[4] *Based on GDP growth.*

[5] *The growth rates used in calculating the increase in production from GDP value had to account for the inflation and flotation of the Egyptian Pound of 2016.*

[6] *The rate of increase of hazardous waste was assumed to be mainly dominated by increase in industrial production. Hazardous waste is generated from other sources as in hospitals for instance, yet it is dominated by industrial sources.*

From a business perspective, the composition of waste is as relevant as its amount. For instance, taking a closer look into the Municipal Solid Waste (MSW) composition, approximately 60% of solid waste is composed of organic residue, another 13% of plastics, 10% of paper/ cardboard, 4% of glass, and 2% metal – see Figure 2. The annually accumulating piles of MSW reached 13.8 tons in 2010. The composition of the MSW waste however varies between rural and urban areas, governorates, as well as the socio-economic conditions of the governorates. Therefore, the waste composition percentages represent a national average. Rural areas are expected to have higher percentages of organic waste than urban areas. Recent data from 2017 shows the diversity of MSW composition between governorates with dominant rural population versus more urbanized ones. The composition of waste in rural areas versus the national average is shown in Figure 2.

Based on in-depth analyses of various recent studies, the following waste compositions and amounts can be used as guidelines for businesses focusing on MSW:

- Per capita generation of waste in rural areas is 0.5 to 0.6 KG/day
- Per capita generation of waste in urban areas is around 1.0 KG/day
- Rural areas generate 70 - 80% organic waste of roughly 2/3 food scraps and 1/3 animal manure
- Rural areas generate approx. 6% plastic waste, 6% diapers, 4% paper and cardboard, 2% glass and 1% metals

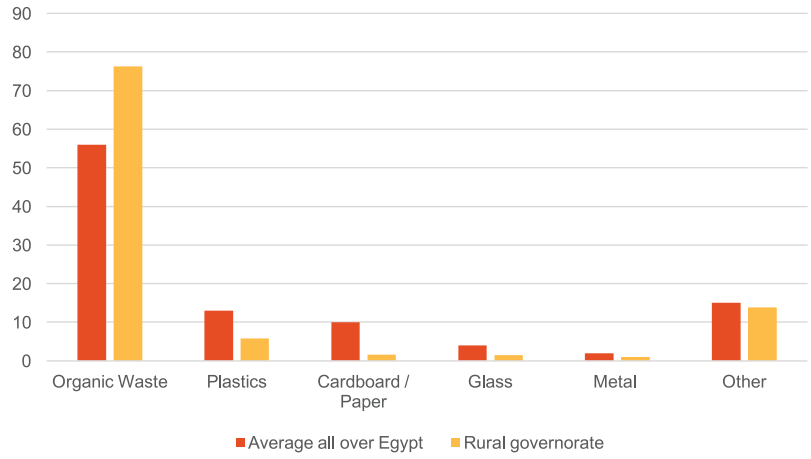


Figure 2: Waste composition in Egypt (average) and in rural areas[7].

Hence, it is crucial for businesses to know the amount of waste generated in the governorates they operate it. Cairo's solid waste output is by far greater than the rest of the 26 governorates combined (Table 5; Figure 3)[8]. This centrality of generation is a representation of the services provided and the consumption patterns in mega-urban centres versus rural governorates. In order to provide timely data, the amount of MSW per governorate projected in Table 6 is based on the population growth rate.

[7] *Source: Municipal Solid Waste Composition in Egypt [2012 Data] cited in Zaki, T. & Khial, A., 2014. Country Report on the Solid Waste Management in Egypt, Cairo: SweepNet and ANGED.*

[8] *"Environmental status report – 2016" Egyptian Environmental Affairs Agency, 2017*

Table 5: Municipal Solid Waste Generation [Tons /Day] in 2012 - cited in (EEAA, 2017).

Governorate	Amount of Waste Generated Daily [Tons]	Governorate	Amount of Waste Generated Daily [Tons]
Cairo	15,000	Fayoum	740
Alexandria	4,300	Beni Suef	820
Giza	4,800	Menya	1440
Qalyubia	3,800	Assiut	720
Dakahlia	4,800	Sohag	1130
Gharbia	3,800	Qena	1335
Munufia	2,650	Aswan	920
Behira	3,700	Luxor	330
Kafr El Sheikh	2,750	Red Sea	465
Al-Sharkia	2,350	Matruh	310
Damietta	950	Northern Sinai	250
Ismailia	620	Southern Sinai	570
Port Said	670	New Valley	135
Suez	410		

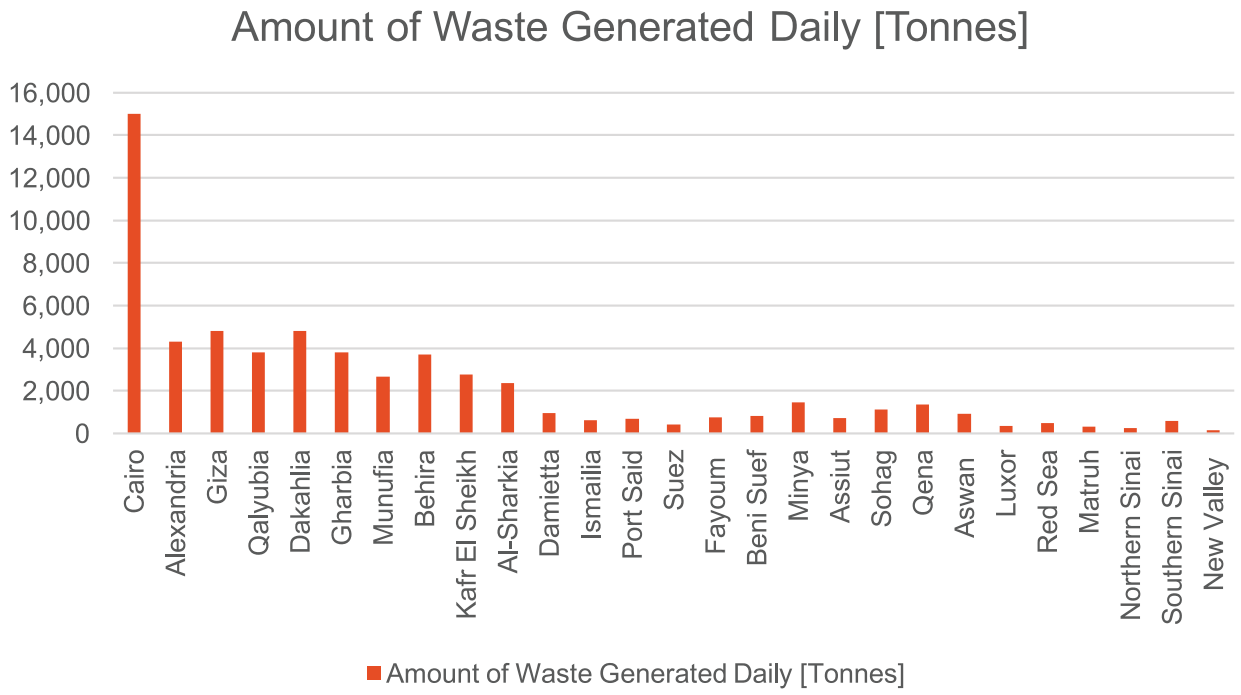


Figure 3: Municipal solid waste generation [tons/day] in 2012 - cited in (EEAA, 2017)[10].

[10] *"Environmental status report – 2016" Egyptian Environmental Affairs Agency, 2017*

Table 6: Estimates of amounts of waste per governorate based on growth of population and data from 2017

Governorate	2016 (Daily Tons) Reference (EEAA, 2017)	2016 (Annual Tons) [Multiplied the Previous Column by 365]	2017 (Annual Tons)	2018 (Annual Tons)
Cairo	15,000	5,475,000	5,611,875	5,752,172
Alexandria	4,300	1,569,500	1,608,738	1,648,956
Giza	4,800	1,752,000	1,795,800	1,840,695
Qalyubia	3,800	1,387,000	1,421,675	1,457,217
Dakahlia	4,800	1,752,000	1,795,800	1,840,695
Gharbia	3,800	1,387,000	1,421,675	1,457,217
Munufia	2,650	967,250	991,431	1,016,217
Behira	3,700	1,350,500	1,384,263	1,418,869
Kafr El Sheikh	2,750	1,003,750	1,028,844	1,054,565
Al-Sharkia	2,350	857,750	879,194	901,174
Damietta	950	346,750	355,419	364,304
Ismailia	620	226,300	231,958	237,756
Port Said	670	244,550	250,664	256,930
Suez	410	149,650	153,391	157,226
Fayoum	740	270,100	276,853	283,774
Beni Suef	820	299,300	306,783	314,452
Menya	1,440	525,600	538,740	552,209
Assiut	720	262,800	269,370	276,104
Sohag	1,130	412,450	422,761	433,330
Qena	1,335	487,275	499,457	511,943
Aswan	920	335,800	344,195	352,800
Luxor	330	120,450	123,461	126,548
Red Sea	465	169,725	173,968	178,317
Matruh	310	113,150	115,979	118,878
Northern Sinai	250	91,250	93,531	95,870
Southern Sinai	570	208,050	213,251	218,583
New Valley	135	49,275	50,507	51,770
Total	59,765	21,814,225	22,359,581	22,918,570

The data displayed in Table 6 regarding the waste amounts and composition should become part of the business decision-making in terms of the preferred location for operations. It is crucial for decision-making to account for the projected amount of waste that can be captured from the waste streams that are relevant to operations and to include the transportation cost of waste. In many cases, businesses start operating in the recycling sector without realizing that their network of suppliers of waste is ultimately limited to the available waste over certain distances. If the amount of waste that can be accessed by the business is overestimated, it could cause the failure of the business.

Though wasted opportunities lie in abundance, making use of it is not a straight forward approach. Another aspect a business must consider is how much of the waste can be collected at what price. There is a vibrant network of waste collectors and traders through which the waste can be purchased at an extra cost that needs to be accounted for. Informal businesses are active in collection and early processing stages of the waste value chain. In the case of MSW, the informal collectors run most of the waste collection activities in parallel to the efforts done by the government. Therefore, most of the segregation and early processing stages, such as washing, shredding and pressing of for instance plastics, cardboard, and/or cans, are performed informally. Thereafter, the waste is transferred in large quantities to successive nodes of specialized traders. This cycle is evident for most waste streams in Egypt.

A representative diagram of early stages of collection and management of MSW based on Cairo's waste management communities in the Moqattam neighbourhood is represented in Figure 4. The cycle can be broken down into two distinctive stages. In the first stage, independent waste collection service providers approach private households and landlords to collect the MSW or outsource the collection to collectors per district. The collector then segregates the waste for recyclables to be sold off to traders and the organic waste which was normally used as feed for swine. However, swine breading became limited after 2009 and hence organic waste is either transferred to dump sites or used as feed for poultry and sheep on a very limited scale. The second phase is partially formalized under a waste collection system. Collectors, often in the form of small waste companies, developed few co-operatives to operate pickup trucks collectively. They were required to acquire a license from Cairo's Cleaning and Beautification Authority in order to continue with the door-to-door collection. The waste is segregated and pre-processed in workshops close or within the neighbourhoods of the collectors, which became common practice.

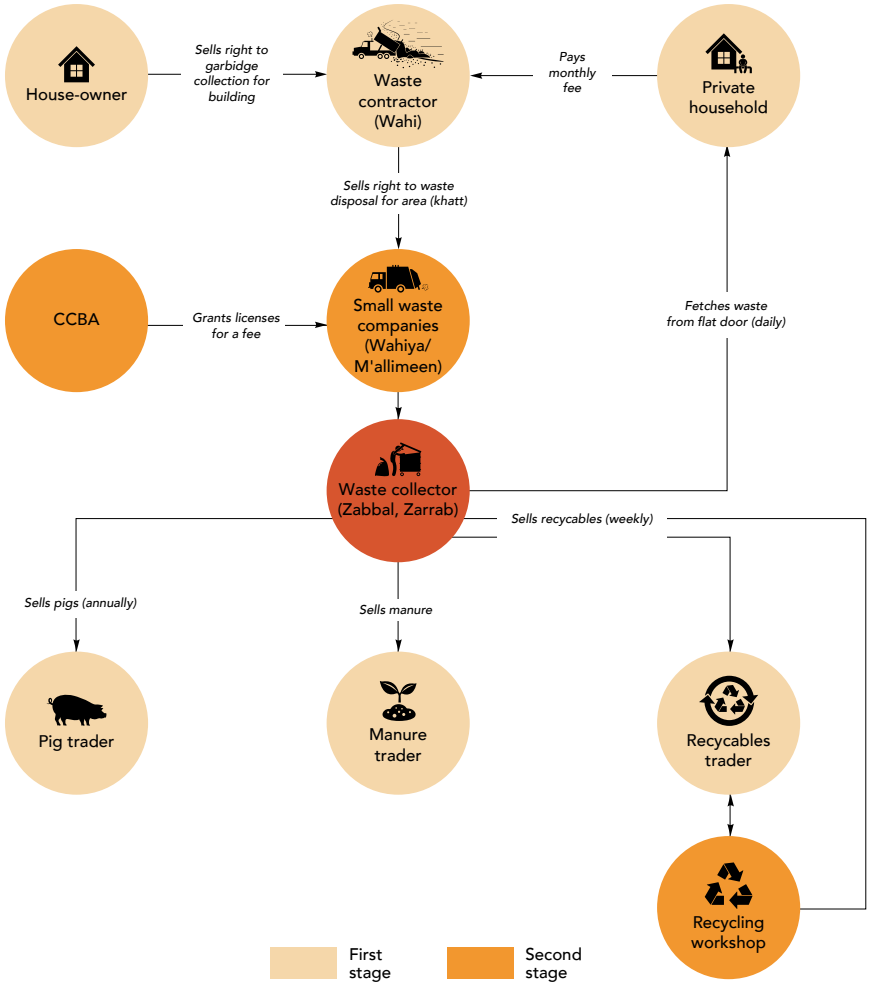


Figure 4: Informality of the Waste Collection Network - Cairo Case - Image Source (Maike Diedro 2011)[11].

More formal activities exist at the industrial level and large commercial facilities. Due to various formalization activities and further involvement of the private sector, access to industrial and MSW is mixed. The mixed waste can be accessed through informal collectors, traders, merchants, private sector firms, NGOs; all taking an active part in the waste management efforts. In the agricultural sector, access to waste is less contested, with mainly informal collectors active in the sector. However, large amounts of the agricultural waste are not collected. In case of proper compensation, farmers could carry out the collection. Analyses of case studies of successful startups and SMEs in waste management in Egypt shows that integration with any existing collection activities is more beneficial for firms than attempting to establish collection networks from scratch. Competing with informal collectors should be avoided. Startups and SMEs should see informal collectors and traders as suppliers rather than a competitor on waste. Furthermore, recycling firms would find limited return on investment by dedicating resources to collection and diverting them away from productive assets.

Businesses in waste management need to understand and adapt to the waste value chain. The rational is based on the incapability of many waste entrepreneurs to compete with the efficiency the informal system, or other existing of collectors and entities at the early stage of the value chain.

[11] *Source: Municipal Solid Waste Composition in Egypt [2012 Data] cited in Zaki, T. & Khial, A., 2014. Country Report on the Solid Waste Management in Egypt, Cairo: SweepNet and ANGED.*

Instead of competing with existing activities, it is more effective to leverage on them. This lowers operational costs and solves what is perceived as a major challenge for firms who are less aware of the dynamics of the waste sector in Egypt. Another challenge arises, if presumed that waste recycling companies outsource the collection and sorting activities and rather buy in bulks from merchants and traders. It is difficult to formally account for the transactions of recycling companies' registers. This less transparent financial record leads to restricted access to financial services. Interacting with the informal sector or semi-formal one is usually cash based and requires immediate payments.

Challenges with MSW segregation and it's organic fraction should be well understood. In MSW, the waste fractions that are not recyclable generally accumulate in dumpsites. From 50-60% of the waste in dumpsites is organic waste and thus perhaps the most problematic waste within MSW. Although organic waste has an advantage of being biodegradable, it is very difficult to further segregate and utilize once it reached the dumpsite. It is of a very low calorific value, and thus not suitable for incineration material. Moreover, the liquefaction and moist composition due to the exposure in open dumpsites and collection points makes the fermentation process much slower, especially in case of biogas generation or compost. In addition, segregation focuses on key recyclables of mainly paper and cardboard, plastics, and metals, as refined segregation is less common. Startups and SMEs need to account for this in terms of their interaction with the early stage of the waste value chain.

Another timely problem is the construction and demolition waste. The lack of regulations enforcing construction industries to dispose their waste at dedicated landfills or dumpsites, is adding an unnecessary burden to the governorates crisis management on construction waste. In fact, within the regulations an incentive scheme to use recyclable construction material would promote the sector vastly. Thus far, trucks move from the construction site to the nearest highway or unutilized spaces to dispose the construction waste. Current articles within the integrated waste management law address demolition waste and could change the situation.

An overarching challenge is the perception of waste as a cultural dogma. Many people resist venturing in the waste management sector because of its negative connotation in the society. Society's synonyms for waste are invaluable, unhygienic, and hazardous. Moreover, there is a general perception that the responsibility of waste management lies solely in the responsibility of the government. This lack of awareness in either the perception of waste or its management affects the development of the SWM sector. One of the circumstances of this misconception is the lack of talented labour interested to solve a socio-economic solution and join the waste companies. This also affects the institutions, the policy-makers, and thus the ecosystem at large. A business operating in the waste management sector needs to understand the complexity in the stakeholder structure[12].

[12] *As reported by interviewed companies and sector experts*

A list of stakeholders involved in the waste collection system is presented in Figure 5. In theory, the central government responsibilities are to issue environmental policies, legislations, and regulations. In addition, the central government sees to the development and monitoring of the solid waste management strategy. In addition, among its responsibilities is to invest in capacitating executive institutions to follow up on the implementation of the waste management programs, as well as to provide support to governorates and new housing communities. This is primarily done through the Ministry of Environment[13].

The local government's responsibilities are to implement the solid waste management services, infrastructure provisions, and environmental regulations. This involves mainly the municipalities and hence the Ministry of Local Development. The fiscal and authoritative capacities of the local government do not match the enormity of providing quality waste management services. Hence, the gap filled by informality and the private sector at the collection side is one of the causes of the complex framework. Furthermore, depending on the product coming out of the waste stream, other stakeholders will be involved. For instance, when compost and animal feed are produced from agricultural waste, the Ministry of Agriculture becomes one of the relevant stakeholders. If liquid fuels are produced, the Ministry of Petroleum will play a part, while with increasing activities in manufacturing the relevant stakeholders expand to The Ministry of Trade and Industry with its various affiliates.

<table>
<tr><th colspan="2">Public</th><th colspan="2">Private</th></tr>
<tr><th>Central Gov.</th><th>Local Gov.</th><th>Local</th><th>International</th></tr>
<tr><td rowspan="3">Ministries
Ministry of Environment Ministry of Local Development (to a lesser extent other ministries, such as Health, Trade and Industry, Agriculture, Water Resources and Irrigation).</td><td>Governorates</td><td></td><td>Contracted SWM Operators</td></tr>
<tr><td rowspan="2">Municipalities
(cities and LGUs) Cleaning and Beautification Authorities</td><td>Informal Community</td><td>Donors</td></tr>
<tr><td colspan="2">NGOs</td></tr>
</table>

Figure 5: Main Stakeholders Involved in the Waste Collection System

[13] *El-Gamal, Mostafa, 2012. Municipal Solid Waste Management in Egypt: Legal and Economic Instruments of Environmental Policy (Unpublished, Working Paper). [Online]. Available:*
Mostafa Elgamal, "Municipal Solid Waste Management in Egypt; Focus on Cairo – Legal and Economic Instruments of Environmental Policy", Master of Science Thesis, Hafen City Universitat, Hamburg, 2012.

1.3 LEVERAGING STARTUPS AND SMES

Worldwide entrepreneurship trends are calling for sustainable business models. Synonymous terms for sustainable entrepreneurship are circular economy, green entrepreneurship, and cleantech businesses. Regardless of the terminology, the ideology is to encourage the end-users towards responsible consumption patterns. For example, the trend of circular economy calls for a return policy of hardware products to manufacturers after its lifetime to allow for raw materials reuse in upcoming products. Green trends of entrepreneurship are associated with a high level of environmental awareness, in which 'reduce, reuse and recycle' is the motto behind the commercialized products. Cleantech businesses are the type of businesses in which the socio-economic impact is at the core value of their services and products. Such terms are the driving concepts of startups and SMEs venturing in the waste sector.

Business innovation in waste management can be an effective solution to counteract environmental challenges. Startups and SMEs are generally more agile than large firms are. Innovative technologies and business models can provide startups and SMEs with an edge in waste management. This can be best pronounced in waste streams of limited private sector involvement and potential market demand. Whether the innovation is in the business model of how to access supply in an effective manner, or in the technology transforming waste to a product, the results are the same. A stronger market pull on waste leads to its diversion from being improperly disposed. This can lead to profits for firms but also to effectively managing large amounts of waste. Startups and SMEs can be leveraged in a stronger manner to limit the negative environmental impact of Egypt's waste.

Despite the needed policy intervention and direct support to startups and SMEs, multiple opportunities exist within the current framework. Not all waste can be integrated in productive uses, as for environmental reasons, few waste streams must be disposed in landfills or through incinerators. Other streams could not end in cost competitive products for instance, while others are hindered by policies. However, in the existing framework multiple opportunities have been effectively leveraged by the private sector in waste management. Particularly in recent years, various startups have demonstrated that an effective business model targeting the right opportunity can lead to successful entrepreneurial activities. These activities create fast growing firms with a high return to investors. It has also demonstrated that it can divert large amounts of waste from being disposed in an environmentally detrimental manner to reaching the market in significant quantities. Startups and SMEs will need support in business growth, access to finance, and a supportive policy framework, yet the present study focuses on the existing opportunities under current conditions.

1.4 METHODOLOGY AND DOCUMENT ORGANIZATION

Transforming the behavioural norms of end-users from consuming to producing is the vision inspiring the output of the study. The study attempted to identify business opportunities within the waste sector, in parallel to assessing the entrepreneurial capacity of the waste management firms; and bridging the gap between both pillars. This outcome-oriented methodology hypothesizes that the inclination towards production activities in secondary value chains (e.g. waste recycling) would in the long-term echo resource efficiency on primary value chains, hence leading to a behavioural transformation towards higher sustainability.

The starting point of the study was extensive literature review. The reviewed literature incorporated global status reports on waste utilization, recent reformative efforts documented on a national level, as well as a set of previous projects undergone by the consultant. It also focused on drawing as much knowledge from the diverse set of published work on waste management locally as well as internationally.

Primarily data collection took place through 58 interviews. The survey population is composed of 33 waste companies and/or traders, 15 respondents from the financial side, both bankers and angel investors, as well as 10 representatives of public agencies and NGOs. The sample of firms investigated are representatives of startups and SMEs that emerged recently and operate on less contested waste streams rather than the SMEs in the waste management sector as a whole. The interviewed companies and traders are geographical diversified which is distinctive for the waste sector (Figure 6). The main geographical areas were in Greater Cairo Region (GCR), Upper Egypt Governorates (Menya, Qena, Sohag), Delta (Damietta), and Coastal Cities (Alexandria, Matrouh, Suez). Further, various innovative startups were included in the study as well as informal collectors and traders. The diverse set of stakeholders and firms helped shaping the outcomes of the study effectively. However, many stakeholders refused to meet for an interview, while the majority of those who accepted an interview, were overly conservative and shared only limited information. Based on the feedback of the declined interview requests, the reason behind such resistance is the tendency to avoid attention in the fear of authorities' investigating their operations that might not be entirely legal/formal.

Expert opinions were consulted to extend breadth and depth of information. A pool of experts was frequently consulted to gather further data on estimates of waste amounts, their utilization in specific cases, and data on waste pricing. Focus groups were carried out to assist the selection of business opportunities and assessing their feasibility. Further, prices for machinery was mainly collected from manufactures.

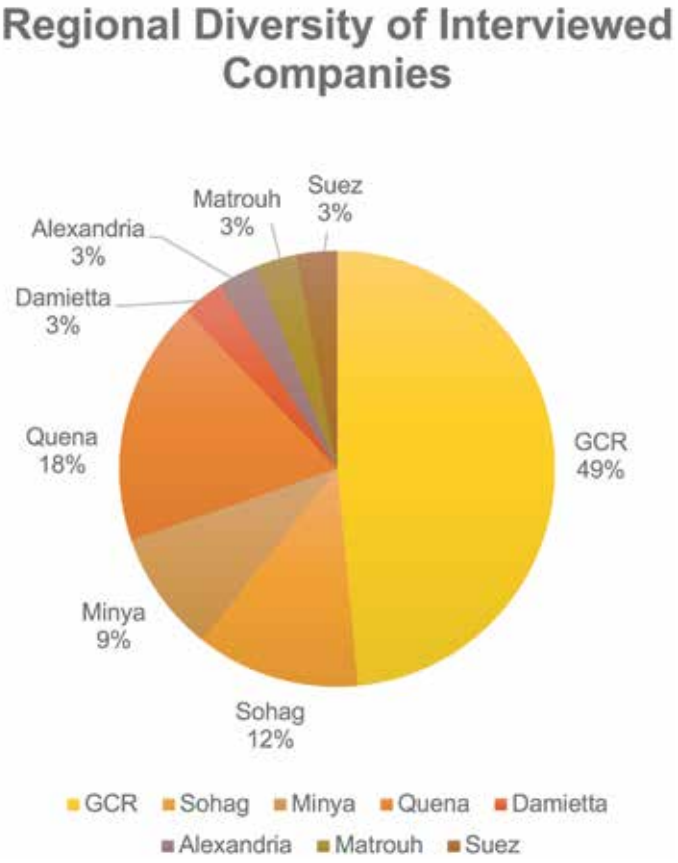


Figure 6: Regional diversity of interviewed companies

The research followed a mixed method of qualitative and quantitative research approaches, using both top-down and bottom up strategies, to capture the dynamic waste management market in Egypt. Analyses of macroeconomic data lead to the assessments of market sizes following a top down approach. In other cases, the bottom up analysis related to collection of data relied upon field research to gather waste stream amounts that were transformed to markets. Market data were often analysed using trade and CAPMAS data.

Reflecting the realities on the ground was crucial. The waste value chain was effectively analysed to determine the accessibility, challenges and opportunities. Various validation methods were carried out.

A market-oriented approach was followed. A market-oriented method was used to determine business opportunities in the sector. The method has been developed by Chemonics Egypt in 2014 and has been effectively implemented with success in various sectors including the waste management sector.

Following the scope, objectives and purpose of the "19 Business Opportunities: Economic Business Models in Egypt's Recycling Sector for Startups and SMEs", the document is divided into 9 main sections:

Section 01: Waste problem and wasted opportunities
Section 02: Insights to the entrepreneurial ecosystem of waste management in Egypt
Section 03: Dentification of waste management opportunities.
Section 04: Materials and industry feedstock market – potential business opportunities.
Section 05: Food market – potential business opportunities.
Section 06: Energy from waste market – potential business opportunities.
Section 07: Agricultural market – potential business opportunities.
Section 08: Supporting products and services – potential business opportunities.
Section 09: Conclusions and Way Forward.

SECTION 2

INSIGHTS TO THE ENTREPRENEURIAL ECOSYSTEM OF WASTE MANAGEMENT IN EGYPT

SECTION 6

ENERGY FROM WASTE MARKET

2.1 INTRODUCTION

Understanding waste management startups is key to capture their capacity and identify the most relevant opportunities. Since the objective of the present study is to trigger startups and SMEs to engage in the waste management sector, it is important to understand their capacity. In addition, comprehending startups and SMEs in the sector helps identifying success factors of the sector and their impact to companies' internal structures.

The 'people behind the company'. Answering questions on how the startups and SMEs interact with the business environment and what kind of challenges they face, is effective in further engaging investors and financial institutions in the waste sector. Therefore, this section starts with introducing 'the people behind the company", based on the founders and their roles with the company, their educational level and the staff's educational diversity and gender distribution. These parameters aid the understanding of the nature of job creation within the sector and the capacity of firms. Hence, the opportunities they can capture.

After introducing the people, the discussion moves towards 'company financials'. This section answers to questions regarding the starting capital of companies versus revenues achieved, the source of capital, cash flow management, the profit margins and the total growth potential. The 'company financials' parameters help in screening the opportunities that are outside the capacity of typical startups and investors.

Thirdly, the 'business model and waste streams' of companies is presented. The legal framework under which the different business models operate is identified, as well as whether the companies interviewed are already operational and what their main activities constitute of. Using this information, it is interesting to investigate their marketing approach and helps developing recommendations which equipment to acquire and how the supply can be most effectively secured.

The fourth component focuses on 'area of operations'. The operations cover the services and products offered, activities done in house or outsourced, and whether quality control measures are performed. Based on this information, gaps in the market were identified.

Thereafter, the entrepreneurs' perception to 'challenges to growth' are discussed. As a foundation to growth, the study reports on whether the companies have a vision and/or strategy on scaling their operations, the type of challenges impeding the growth strategies, as well as what type of mitigation measures they perceive to bypass such challenges and the type of market opportunities the companies acknowledge. Accordingly, mitigation measures for entrepreneurs were developed.

Lastly, an analysis of the waste eco-system map is presented. The eco-system map presents the main market players, the potential roles they could employ to catalyse the sector's growth, as well as the legal and regulatory interventions for sector growth recommended by waste companies. This would help startups and SMEs in determining

the stakeholders relevant to their business. The main objective of analysing startups in the sector is to reflect their business models and indicators on the market analysis and study. The analysis was also used in calculating the expected social impact in terms of job creation. It guided the study on the type of technologies and level of innovation to expect from the sector and provided insights on the potential for local manufacturing. The success factors of startups and SMEs surveyed was also reflected in identifying the focus markets in the sector in terms of market saturation as well as opportunities remaining based on startups and SMEs' capacities. Activities that are potentially based to be outsourced were based on the surveys and analyses of the firms interviewed. Accordingly, successful models in accessing supply were reflected in the identified business opportunities. Finally, the level of initial investment startups and SMEs are capable of leveraging guided the selection of the business opportunities.

2.2 THE PEOPLE BEHIND THE COMPANY

98% of the interviewed companies' founders were university graduates, yet only few have the educational background to innovate within their business. The majority of the interviewed founders were within the age group of 30-35 and thus have already gained previous work experience and know-how from self-learning and/or vocational training. In most cases, the educational background was not relevant for the technical know-how needed in business. Therefore, the business opportunities were foremost focusing on business model innovations based on well-established technologies. Hence, these business opportunities are also accessible to a wider pool of young professionals, in which formal education is not a barrier to the business endeavour.

Founders and co-founders dominate the planning and managerial roles in the company. Figure 7 shows that approximately 40% of the founders are active managers, 5% are financial advisors, 8% lead the technical operations in the company, and only 5% are involved in the sales and marketing activities. With only a minority of founders involved in the technical operations, technical knowledge is mainly accessed through experts and employees. It is expected that the identified business opportunities can be captured by multiple diverse firms and therefore large amounts of waste could be managed by startups and SMEs.

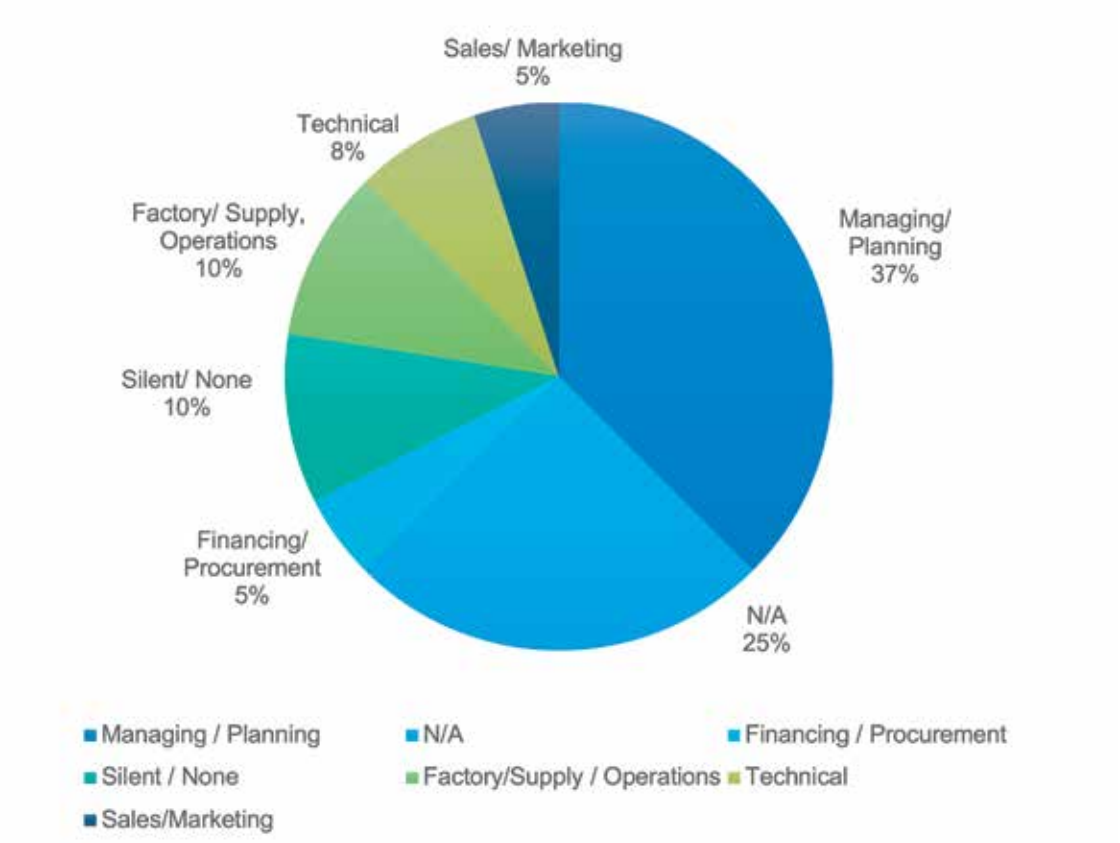


Figure 7: Managerial roles founders of the interviewed companies play

The organizational structure of the companies is one of the main challenges for growth. Most founders of the sample are responsible for the majority, if not all steps, within the business. The lack of delegation and dependency on the leadership position hinders staff and employees to act in a timely manner, which gives less rein to the strategic growth of the company. Micro-management also means less utilization of an employee's talent and the emergence of multiple micro-firms in the sector. Thus, it is unrealistic to predict that the majority of waste will be handled by few firms only that eventually grow to large corporations.

Waste management has a vast impact on job creation - both direct and indirect. Accumulatively, the 33 companies interviewed created 310 direct job opportunities, bringing the average number of jobs per company to 10 see - Figure 8 .Supporting waste management businesses can have a strong impact on employment.

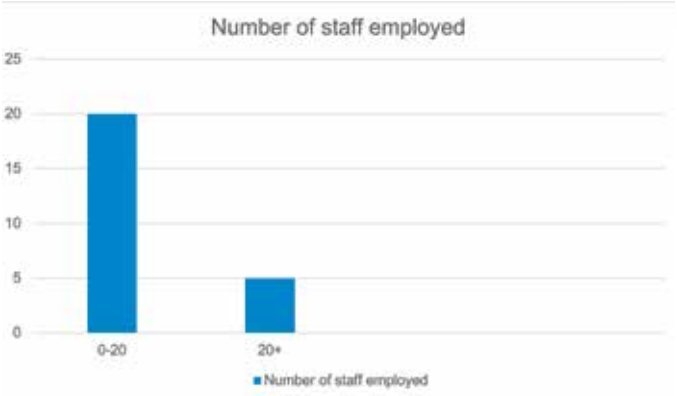


Figure 8: Number of staff employed

Diverse job opportunities are created, with a large fraction of part-time and seasonal jobs. Within the survey sample, only 40% of the staff are full-time employees, 22% part-time, 8% seasonal employees, and 3% volunteers. Interestingly, 25% refrained from answering the question see - Figure 9. The seasonality of workers is mainly present in the agricultural waste businesses, due to the seasonality of crops.

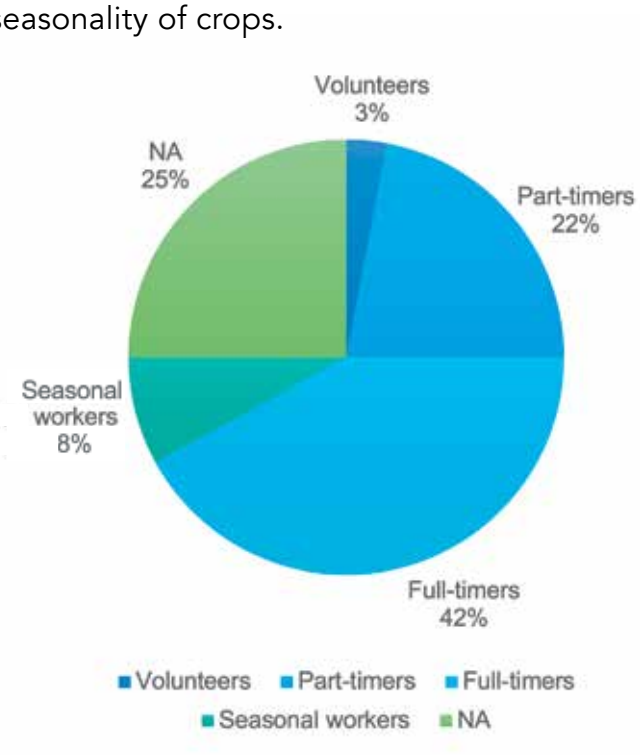


Figure 9: Type of staff employment in the interviewed companies[14]

[14] *N/A means the interviewee was not able or did not want to answer the question. The same meaning for N/A is adopted in all coming figures.*

Employment trends depend on the type of waste management business. The employment trends include skilled and non-skilled employment, full-time and part-time jobs. Such diversity of job profiles represents the positive value the waste sector has on job creation. Almost half of the jobs are held by unskilled / semi-skilled labour see - Figure 10. This means that waste management businesses are effective in creating jobs in various geographies and also create jobs in segments struggling with employment.

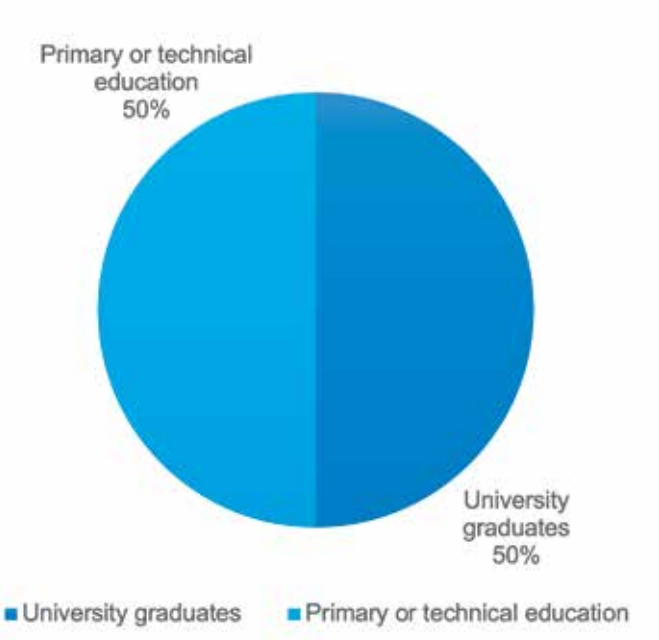


Figure 10: Educational level of staff employed in the interviewed companies

About 30 % of the co-founders are females. This is well above the national average in terms of starting a business[15]. The reason could be due to the small sample size. However, it also echoes similar results in the consortium interaction with startups in waste management, where the percentage of female founders is relatively high compared to other sectors. The reason is difficult to pin down, however it remains a positive indication. The percentage of female employees is also about 33%. It shows again the effectiveness of job creation in the waste management sector.

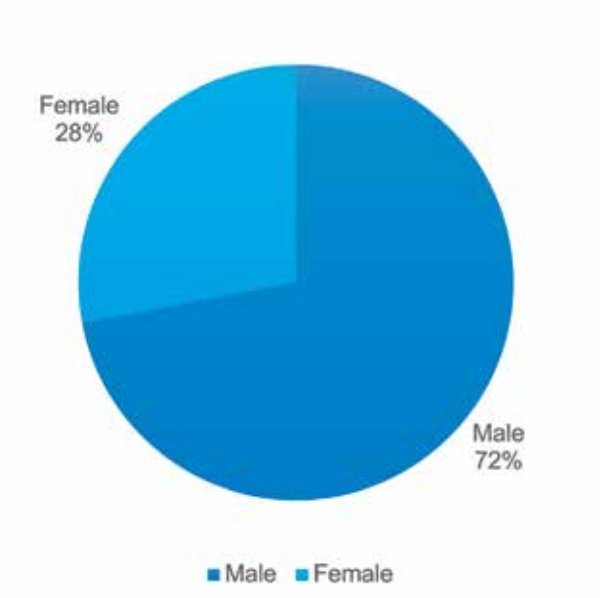


Figure 11: Gender representation of interviewed companies' co-founders

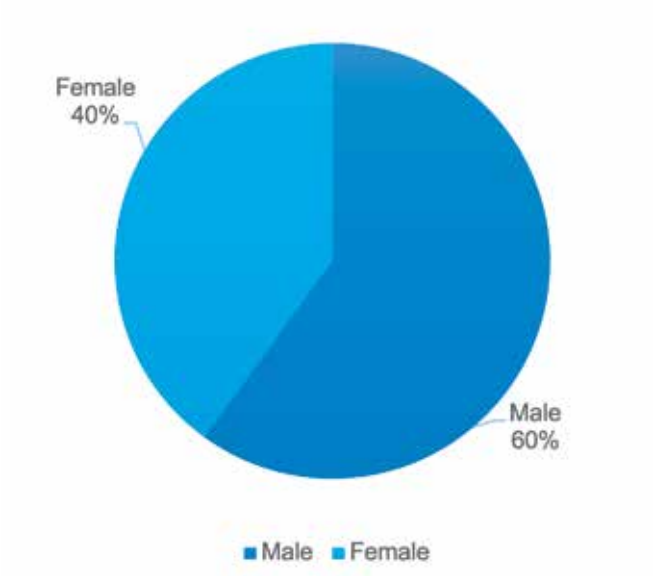


Figure 12: Gender representation of interviewed companies' staff employed

[15] GEM 2016 – Indicates that the ration of female entrepreneurs varies between 25% in early entrepreneurial activities (within three 3.5 years of firm establishment) and 17% of established firms.

2.3 COMPANY FINANCIALS

The presented waste management businesses can be established under a variety of investment volumes. 50% of the companies have started with an investment capital of less than 500 k (Figure 13). Yet, various firms (about 20%) are capable of leveraging initial investments of up to 5 million EGP. In the present study, the majority of business opportunities require an initial investment of less than 10 million EGP, with many business models requiring a capital of below 5 million EGP. These volumes were chosen based on the capacity of startups and SMEs in Egypt.

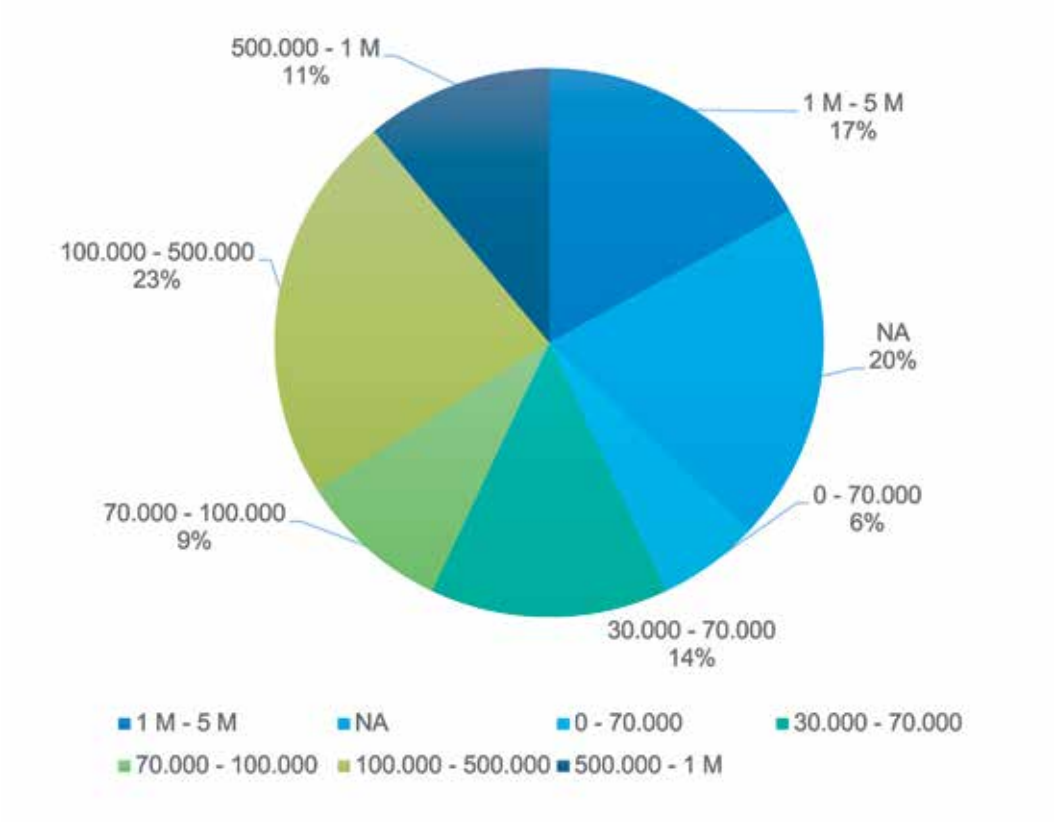


Figure 13: Startup capital (in EGP) the interviewed companies invested to start operations (M stands for millions)

The majority of startups are self-funded. The source of seed investments are predominately personal investments. Companies have acquired more than a total of 38M EGP in initial investments from personal sources, either savings from previous businesses or family assets. Only 20% of the surveyed startups have received grants as a startup investment and only 12% have acquired further investments, which translates to low access to finance. In the opportunities determined in the present work, startups would be capable of leveraging the needed finance to start their business.

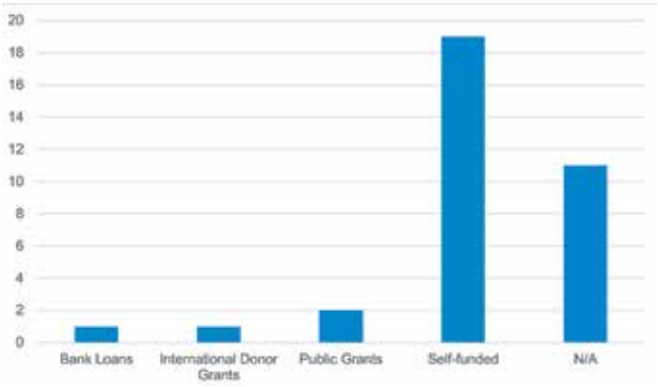


Figure 14: Source of startup capital the interviewed companies used[16]

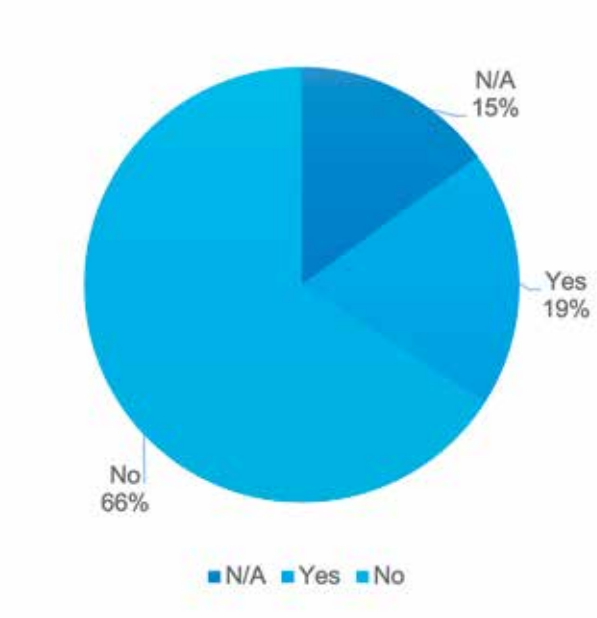


Figure 15: Has the company acquired any grants?

Most waste management firms in the sample are small sized businesses with only limited medium sized companies. Mirroring the Egyptian economy in that sense, the base of the pyramid is wide with a multitude of firms, with a few waste giants exponentially growing. If compared to the initial investment, it seconds the international trend, whereby waste management is one of the fastest growing sectors. This fast pace of growth is reflected in the profit margin of companies.

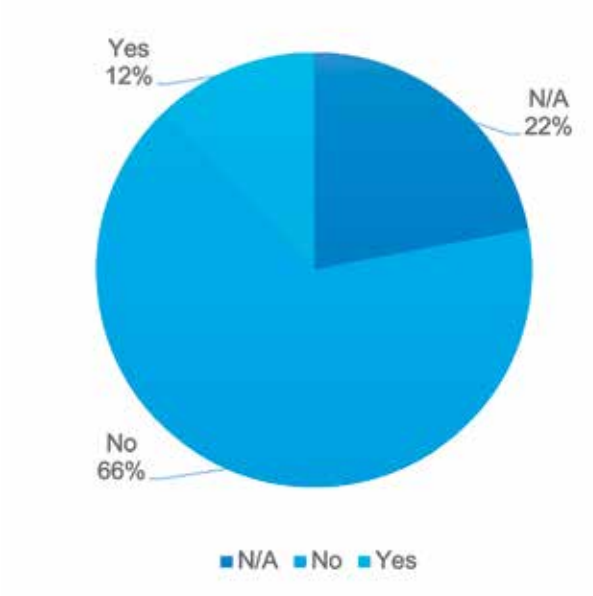


Figure 16: Has the company acquired further investments after the starting capital?

The business opportunities determined in the present study are in markets were multiple micro firms and startups can flourish and small firms grow into medium-sized businesses. Notably, the customers of the waste businesses are offered payment facilitation in terms of a down payment and short-term instalments. Meanwhile suppliers are mainly receiving their payments, upon delivery of raw material (solid waste). The financial facilitation presumably increases the financial burden on the company and make their cash conversion cycles longer. These numbers indicate the intense cash needs as working capital, which has been accounted for in the present pre-feasibility analysis.

[16] *Based on number of occurrences.*

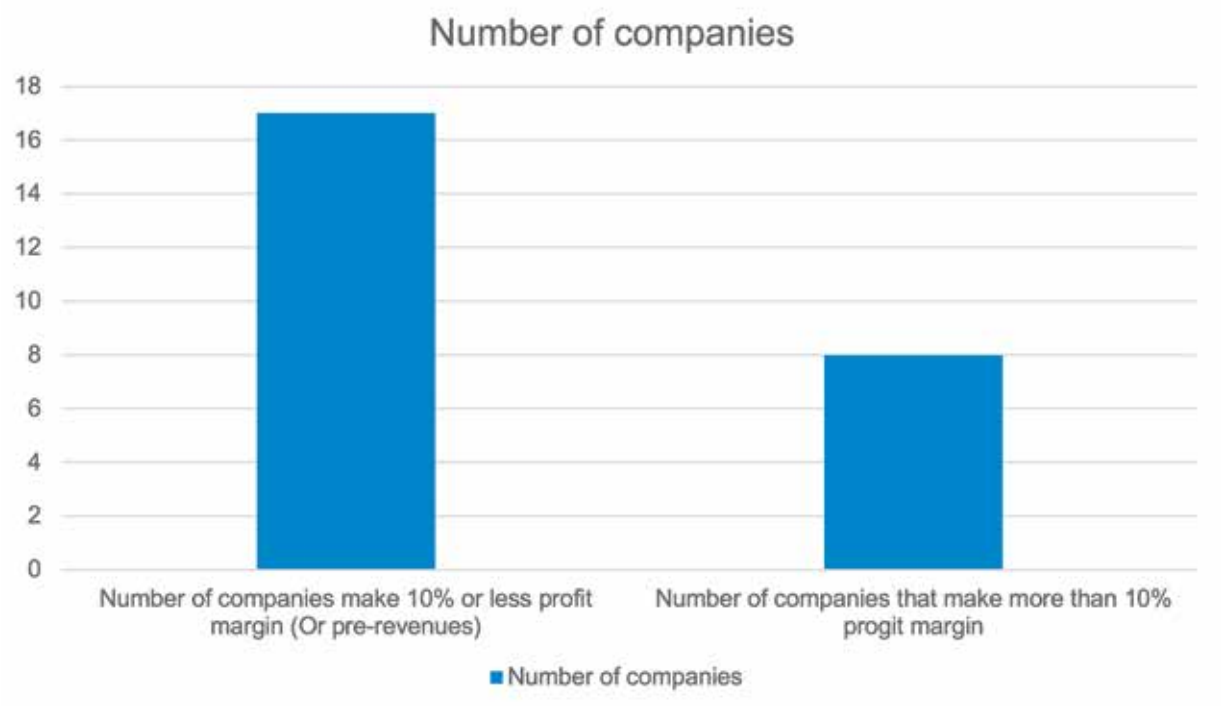


Figure 17: Average yearly revenue

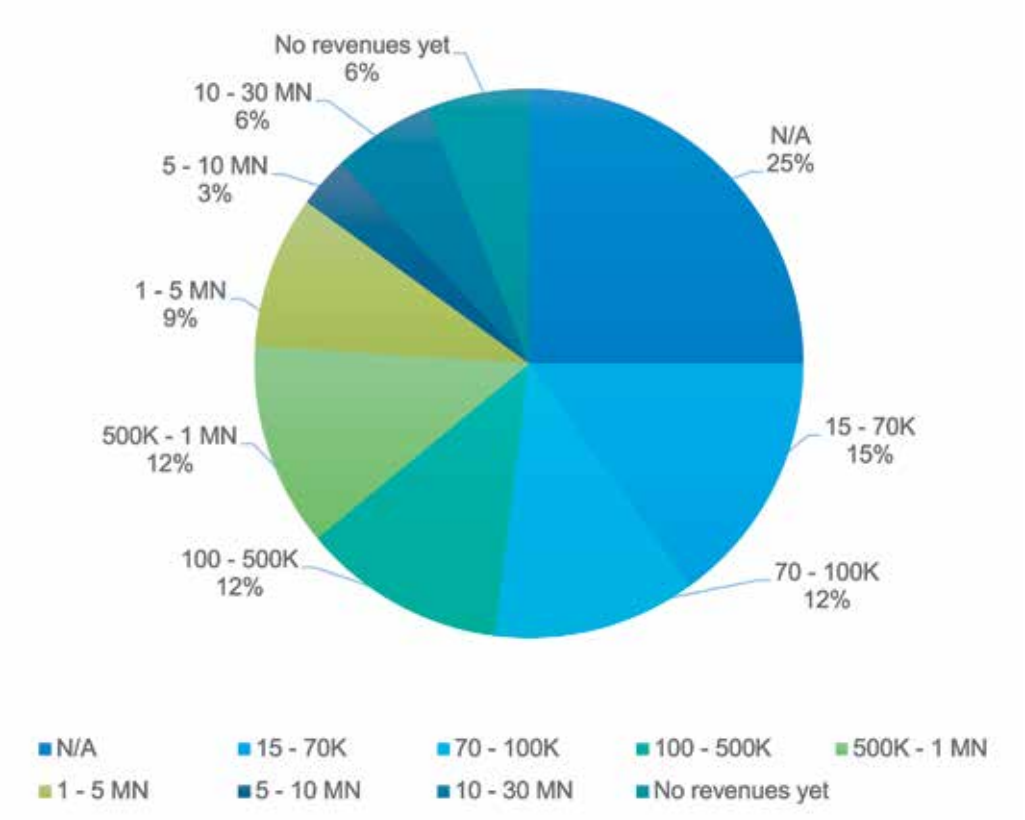


Figure 18: Profit margin - (current or expected)[17]

[17] *Some interviewed companies reported the expected profit margin in the current fiscal year, the reason behind that was either the company expect to have much better profit in the next year, so they wanted to report it for better image or it was in pre-profit stage last year.*

2.4 BUSINESS MODELS AND WASTE STREAMS

Collectively, the firms interviewed capture approx. 0.5 million tons of waste annually. This means that startups and SMEs can truly handle large amounts of waste in the right markets. However, the business models have been identified under the aspect of potential waste volumes that can be handled by startups and SMEs. In general, the role of the private sector in absorbing waste and channelling it to markets is underestimated in Egypt. This is usually due to the involvement of the private sector at the supply side, in collection and pre-processing. However, the studied firms show that if startups and SMEs are active at the market side, eventually the market pull will leverage large amounts of waste. On average, the interviewed firms with an average age of 5 years handle 50,000 tons of waste annually. In the identified opportunities, startups and SMEs can already be profitable with even less amounts of waste.

The firms analysed work in diverse sectors of collection, sorting, and transportation, representing the main activities of the sector, which present 25% of work performed by companies. This shows that the market space is already congested at the early stages in the value chain. More firms are needed in high value added activities. Trading activities, which link collection and sorting to recyclers, are also dominant, with about 14% of firms focusing on it. However, waste to energy activities are more dominant compared to trading with about 20% of firms engaged in waste to energy activities. Fewer opportunities still remain in the early stages of collection and segregation. It is recommended for new players in the market to collaborate with existing collection and sorting providers.

More firms are needed at the production level. Therefore, the business opportunities have a focus on the production activities in the value chain that are closest to the market. Yet, there is diversity in markets and sectors served, which can be further strengthened and leveraged. The sectors served include agriculture, industry, and consumer products. Markets addressed include energy, fertilizers, animal feed, material and industry feedstock.

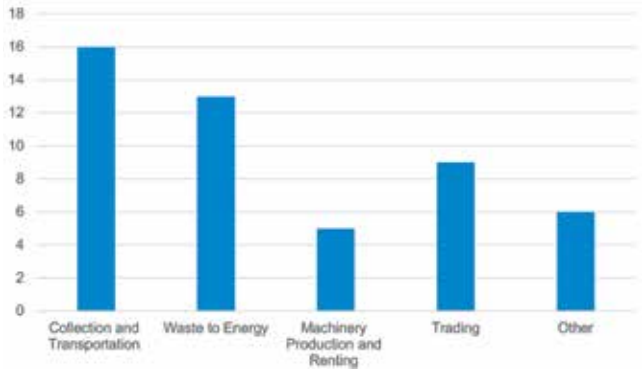


Figure 19: Service/product offered by interviewed companies

The technology utilized alternate between locally manufactured, imported, or rented machinery. Locally manufactured equipment where utilized by about 50% of the firms, whereas 33% relied on imported equipment, and about 25% resorted to renting equipment. However, most of the interviewed companies mix between the three sources or at least have been using more than one source throughout the company's lifetime. In many cases, the locally manufactured equipment is custom-made in order to deal with certain types of waste or to fine-tune the product. Imported equipment are resorted due to the absence of local alternatives or to achieve higher efficiency and quality. The imported equipment are typically high quality/high capacity shredders, specific spare parts and full production lines. Yet, there are local manufacturing machineries used by waste

management startups and SMEs. Hence, the entry barrier and initial investment are reduced compared to having to rely on imported machinery. This was taken into consideration in the business opportunity mapping, in which the status of available equipment was assessed and local manufacturing prioritized if it served the appropriate quality.

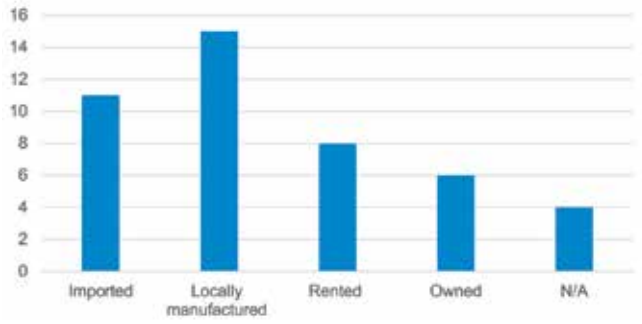


Figure 20: Source of equipment interviewed companies use

Approximately 80% of the startups and SMEs interviewed, source their waste from informal collectors. Sourcing from informal collectors poses cash flow challenges. Formalization of collectors in waste management is a challenge worldwide. It is a complex problem that needs well-crafted policies. In general, the key approach to successful formalization is to realize that it will reflect positively on the whole recycling sector as a whole, to recognize the active role the informal sector plays, and to follow a gradual approach.

A key success aspect of startups and SMEs in high value-added recycling activities is outsourcing collection, transportation as well as sorting if possible. Outsourcing of early stage processing activities can be a more profitable business decision than the startup or SME carrying it out. Out of 33 startups working in recycling, 33% outsource collection and/or sorting, 24% outsource transportation, and 12% outsource some type of processing (Figure 21).

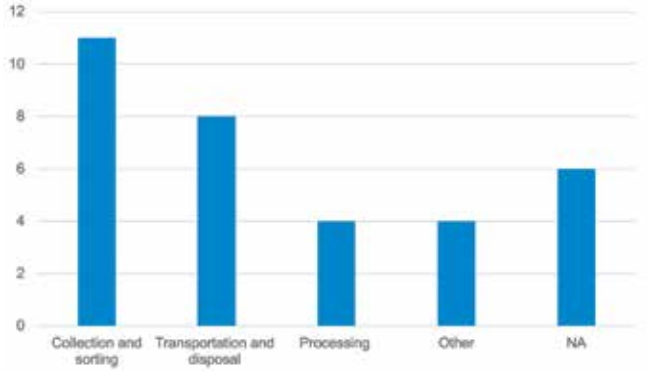


Figure 21: Activities the interviewed companies outsource currently outsource

The waste businesses apply quality control measures to some extent. Effective quality control is crucial, especially since companies' source of waste differs from location and thus varies in quality (Figure 22). In many of the targeted markets presented in this study, quality control is essential for business success and thus challenges with maintaining quality standards are key in most activities. Further analyses show that the firms that do apply quality control measures are the ones that are working in higher value-added recycling.

Almost 75% of the waste businesses follow a B2B business strategy. Most of the time, the business performs as the supplier for another business in another industry. There is no direct interaction with the end consumer. This shows the critical interaction between the solid waste sector and the industry in general. The sector is able to offer a variety of raw material(s) and energy sources in many industries. This is strongly reflected in the business opportunities identified. Opportunities, which produce consumer products are rare and difficult to manage for startups and SMEs, as they require strong marketing channels and entail higher risk. In most cases, the business opportunities are in supplying the industrial facilities and agricultural sector with inputs to their production process.

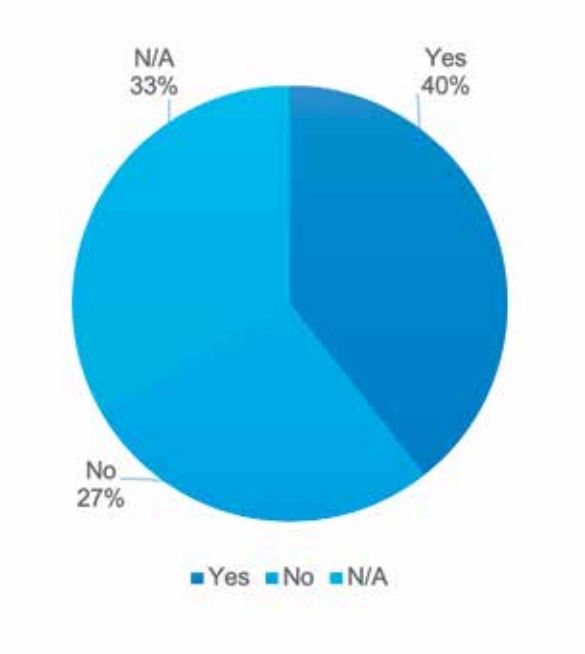


Figure 22: Companies applying any quality control measures[18]

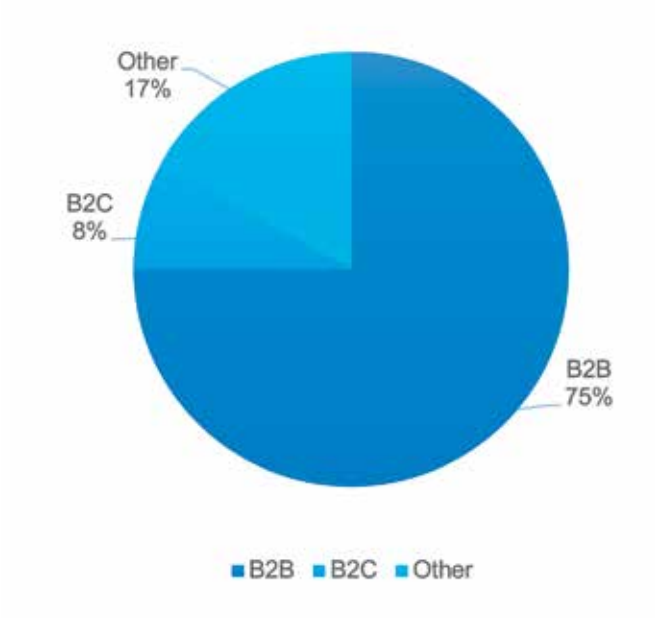


Figure 23: Percentage of interviewed companies that adopt a B2B model

[18] *N/A: Answers were not available as the interviewed company declined responding to the question.*

2.5 CHALLENGES TO GROWTH

Entering the market is relatively easy than sustaining a market share let alone grow it. In identifying business opportunities in the waste sector, one must reflect on the possibilities for growth in each market. There are certain markets that allow rapid growth for business opportunities pursued by startups and SMEs. In other markets, the further the firm grows the more the supply side and increasing overheads constraint the growth potential of the business. Hence, it is easier for firms to enter the market than for existing ones to grow. Not all firms have growth aspirations and the market itself sometimes can grow through interacting micro-firms. Understanding the barriers to growth in later stages will allow to decide which of the identified markets offer growth chances through expansion versus which ones will grow through multiple micro firms. Yet, many barriers to growth could be overcome by policy interventions of different public entities to further unlock the markets.

In the present study, challenges to growth are understood in the light of external and internal hindrances encountered by the companies. The external challenges are the macro-economic conditions, such as (1) lack of regulations or implementability of policies, (2) the economic conditions of for instance the floatation, which might in fact encourage companies to tap into international markets, and/or (3) the institutional conditions, such as regional effectiveness of municipalities and directorates in the waste management system (Figure 26). The internal challenges are related to logistical and managerial aspects. The main remain is the detachment of firms from the entrepreneurial ecosystem, where they lack the necessary financial and technical support. This detachment is also reflected in the respondents' perception of the mitigation measures needed (Figure 27).

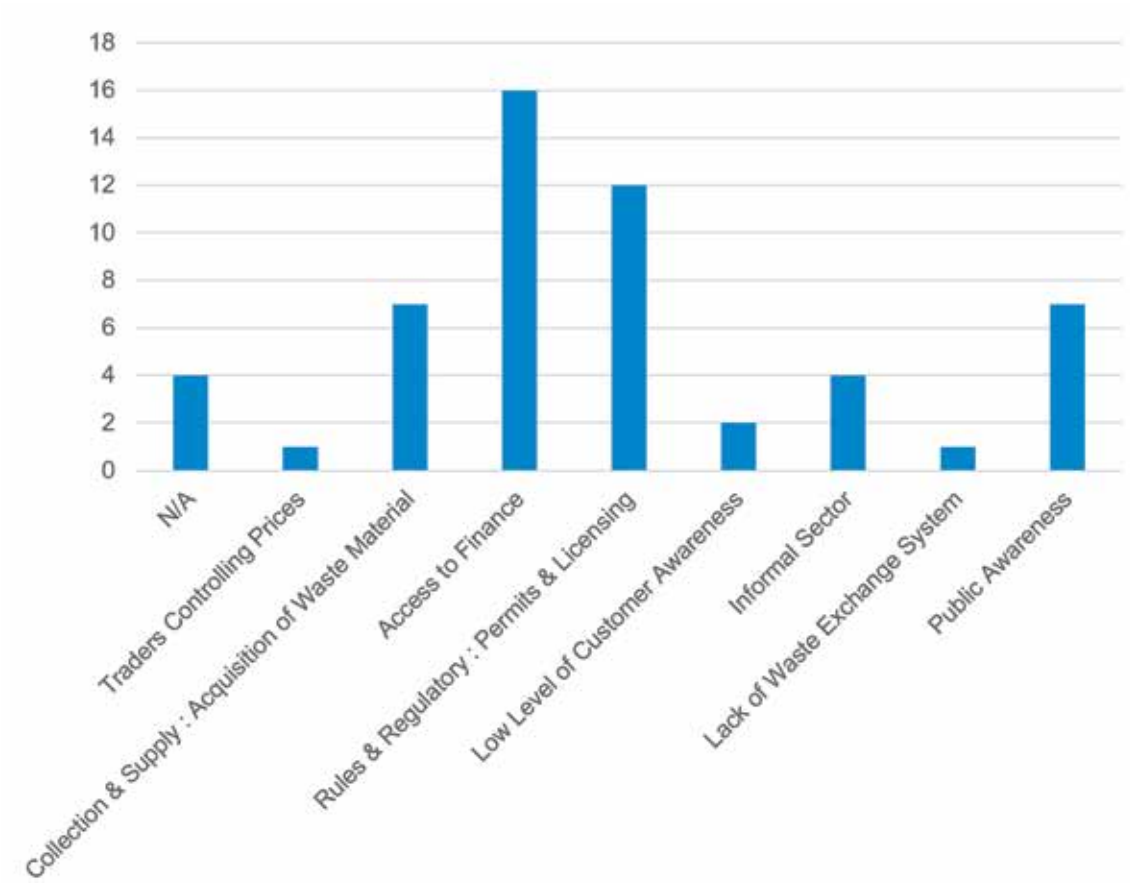


Figure 24: External barriers faced by the interviewed companies

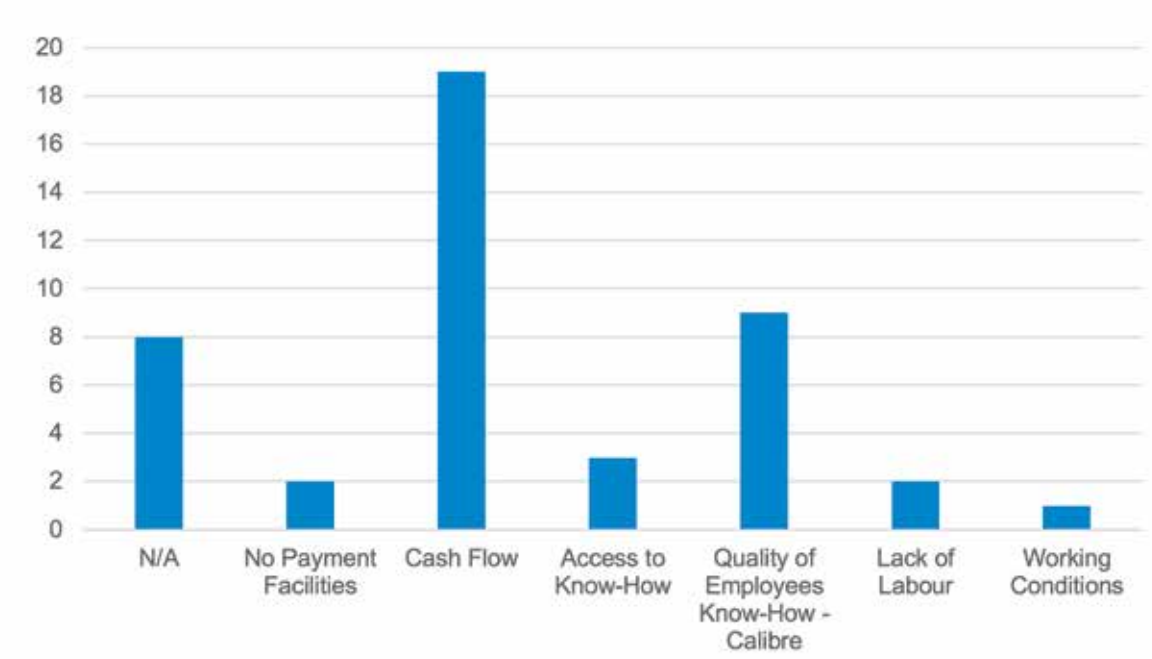


Figure 25: Internal barriers faced by interviewed companies

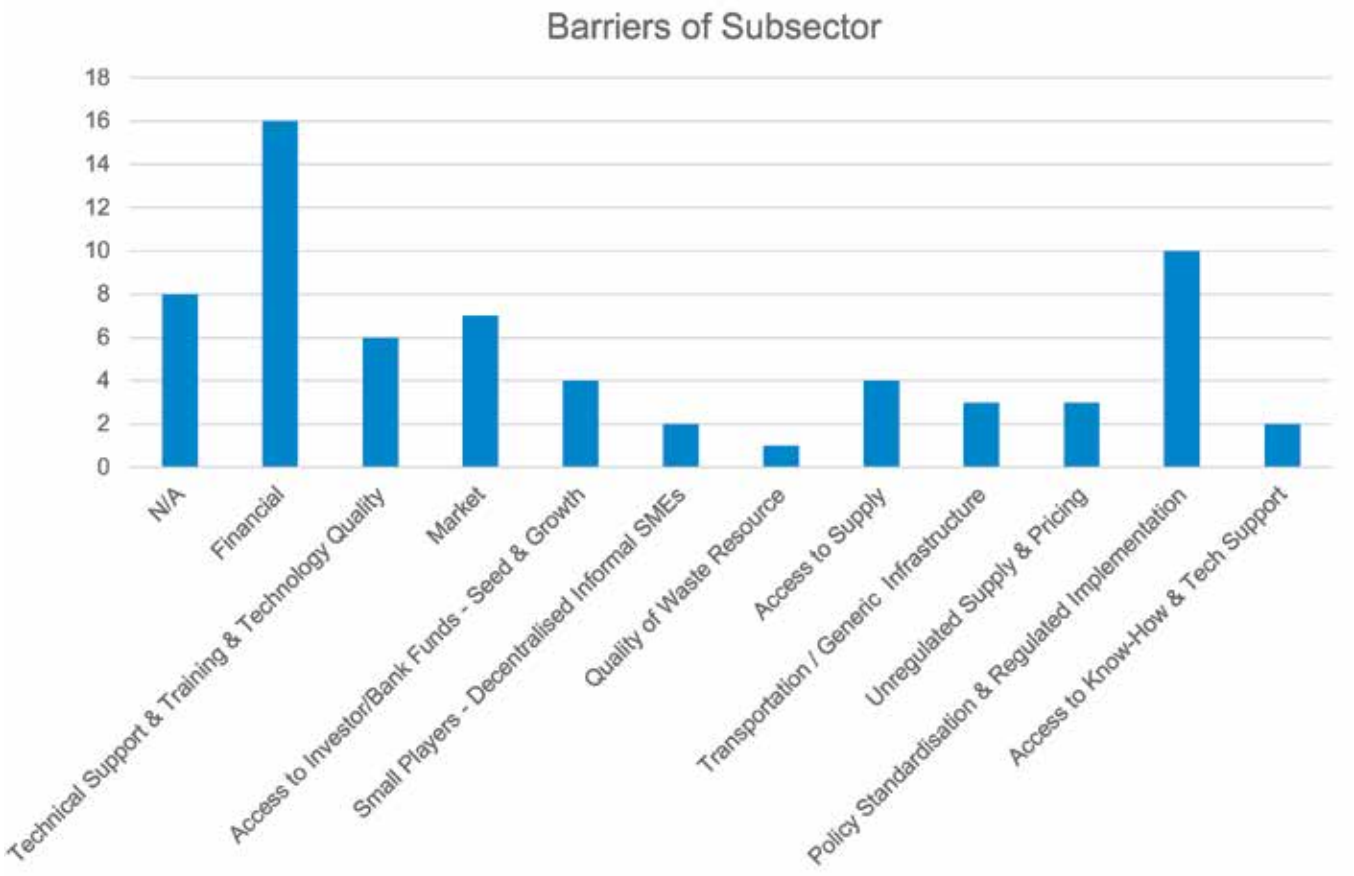


Figure 26: Barriers of solid waste sector growth as reported by the interviewed companies

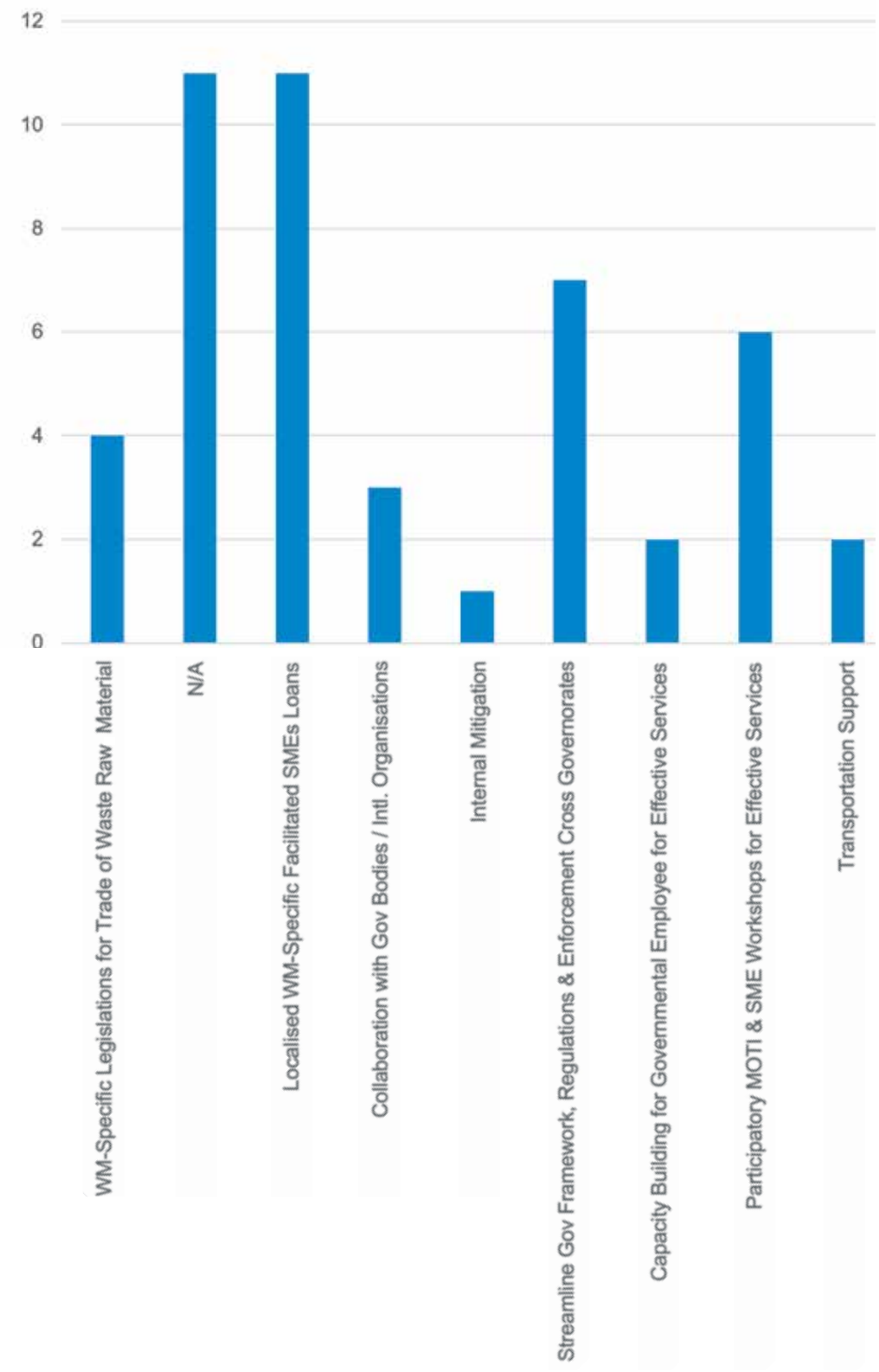


Figure 27: Mitigation measures of the sector barriers as reported by interviewed companies

Many companies are quite conservative in how they plan for sustaining growth in the companies. The lack of expertise of the founders is reflected in the companies' lack of strategic planning. Actually, 40% do not have a plan on how to grow their business.

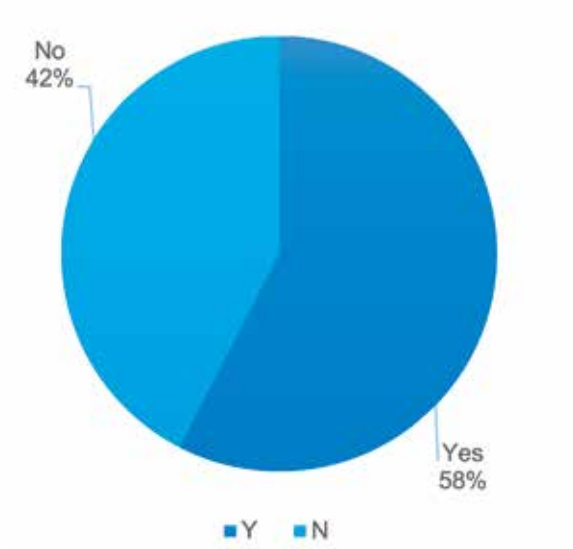


Figure 28: Companies planning for and/or implementing a growth strategy

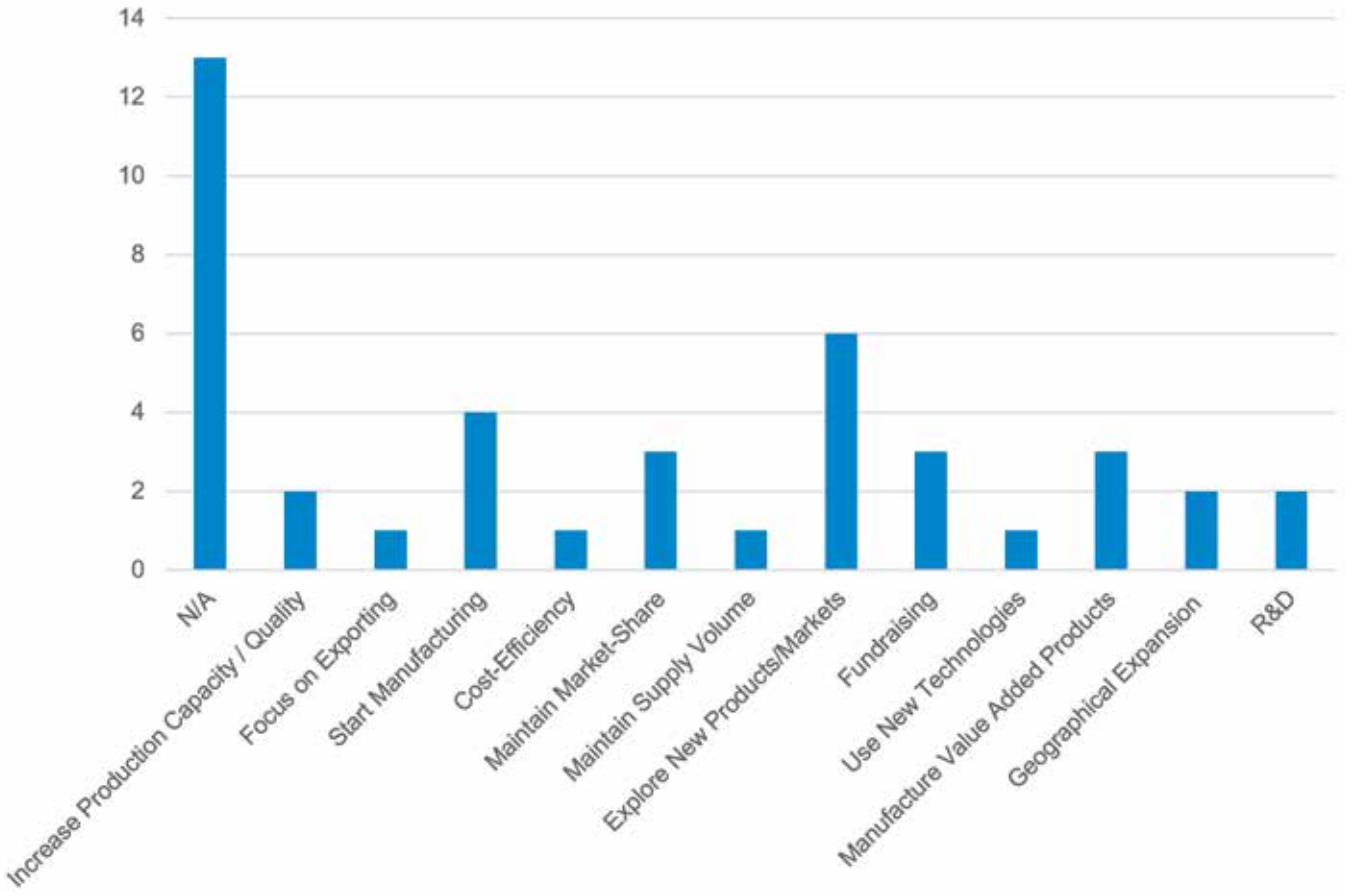


Figure 29: Business growth strategies the interviewed companies have adopted

2.6 MARKET PLAYERS AND ECOSYSTEM SUPPORT

The waste management entrepreneurial ecosystem can be broken down into four different categories of stakeholders. These categories are (1) governmental authorities, (2) informal waste collection, (3) private sector's waste generating entities, and (4) waste management and recycling companies, the core of the present study.

• **Municipalities:** The municipalities are the first layer of active players in the solid waste management system. They are in charge of the waste collection and transportation to landfills or dumpsites within the districts. However, the municipalities are most active in urban areas. Many rural regions do not have a functioning waste collection and transportation system in place.

• **Public authorities:** On a policy level, several ministries and authorities influence the waste management regulations. The main public authorities are the Ministry of Environment (MoE), the Waste Management Regulatory Authority (WMRA) and the Egyptian Environmental Affairs Agency (EEAA), the Ministry of Local Development (MoLD), the Ministry of Trade and Industry (MoTI), and the Industrial Development Authority (IDA). After the issuance of the Feed-in-Tariff for waste-to-energy as an attempt to encourage positive waste disposal, the Ministry of Electricity became a recent influential player. Together with the MoE, the waste-to-energy program is currently in the final negotiations phase.

• **Informal sector:** The informal waste collectors include waste contractors, pickers, traders, and merchants.

• **Waste generating entities/private sector:** Startups perceive that governmental entities, municipalities, and middle-merchants are significantly threatening the sector. The waste management companies fall within a huge spectrum of scale and capacity. The small scale, such as startups and SMEs, perceive the giant scale companies as a significant competition. With the municipalities' significant capacity in controlling the waste collection system and leveraging informal workers, it becomes increasingly difficult for newcomers to break through and lobby for waste gain in the established intricate informal network. The middle merchants however support the informal waste collection network, in which they are given the chance to influence and at times inflate the price of waste as well as increase the traded volume.

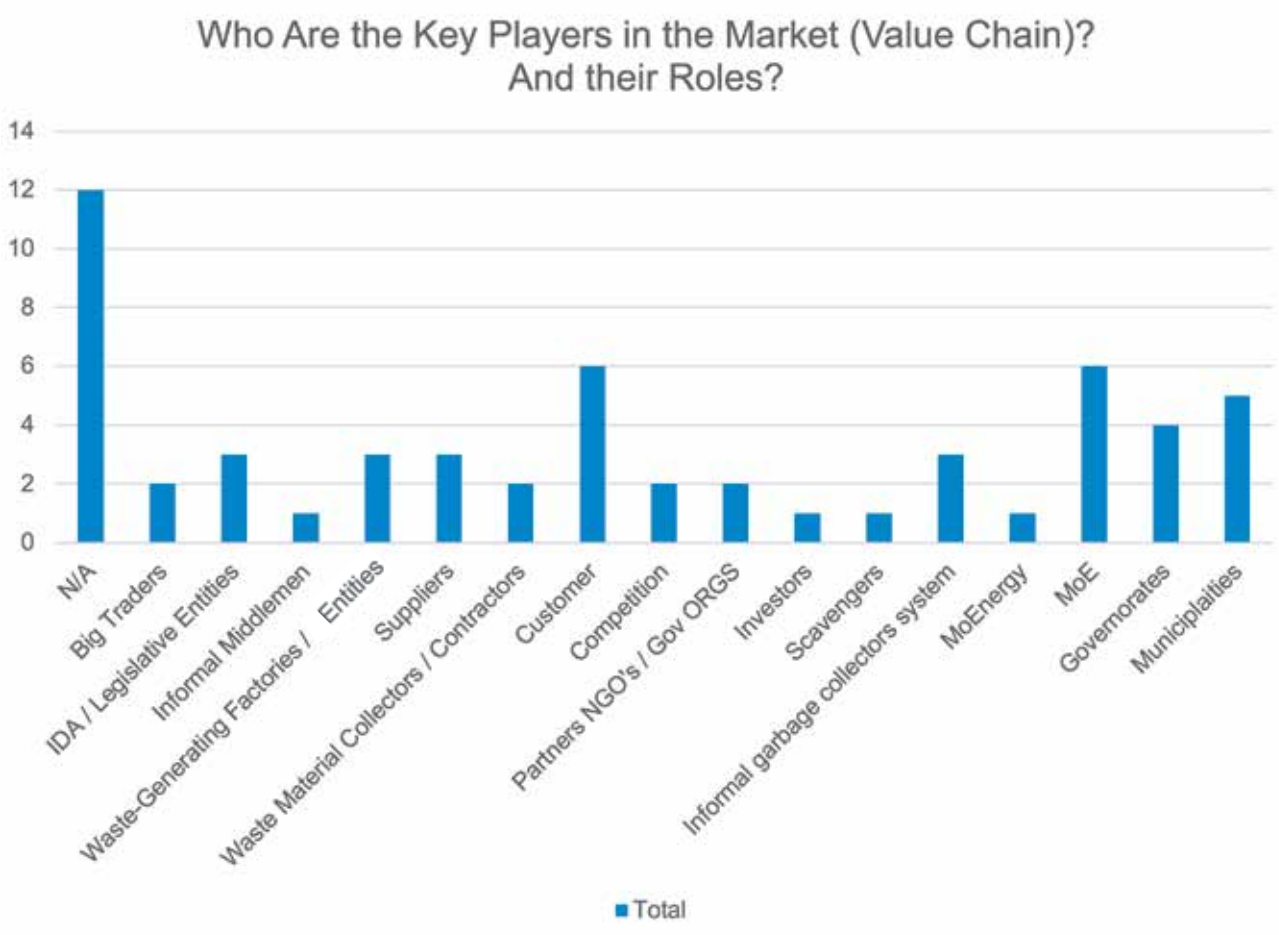


Figure 30: Key players along the solid waste value chain

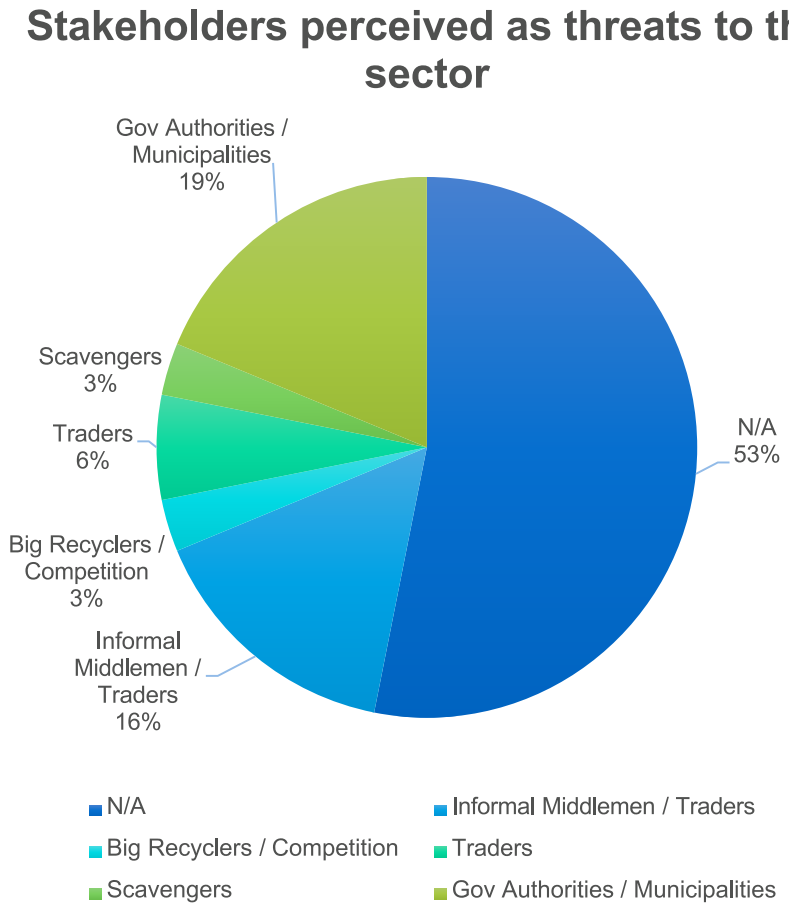


Figure 31: Stakeholders who could represent a potential threat to the sector as perceived by the interviewed companies

Although the interviewed companies perceive the municipalities as the main threatening stakeholder, they understand that they could also have a very influential role in the operations of the waste sector. The municipalities could lead the paradigm shift of the sector and thus the waste businesses by enforcing additional waste regulation measures, exerting efforts to formalize the sector, incentivizing value-added waste collection methods, as well as encouraging waste segregation at the source.

Waste businesses require financial institutions and angel investors to be more interactive. The inability of waste businesses to access loans or payment facilitations through banks and non-banking entities is to a great extent hindering their capacity to grow and expand in the value chain addition. The value addition could be in the form of a more efficient manufacturing process, acquiring a large space for collection and sorting, digitalizing the waste collection platform, or simply improving their business quality to serve international markets. A few cases do exist in which waste businesses have benefited from some sort of support, especially concerning finance, networking, technical support, and workshops. Nevertheless, the fact remains that the entrepreneurial ecosystem needs to reach out and serve waste management entrepreneurs more.

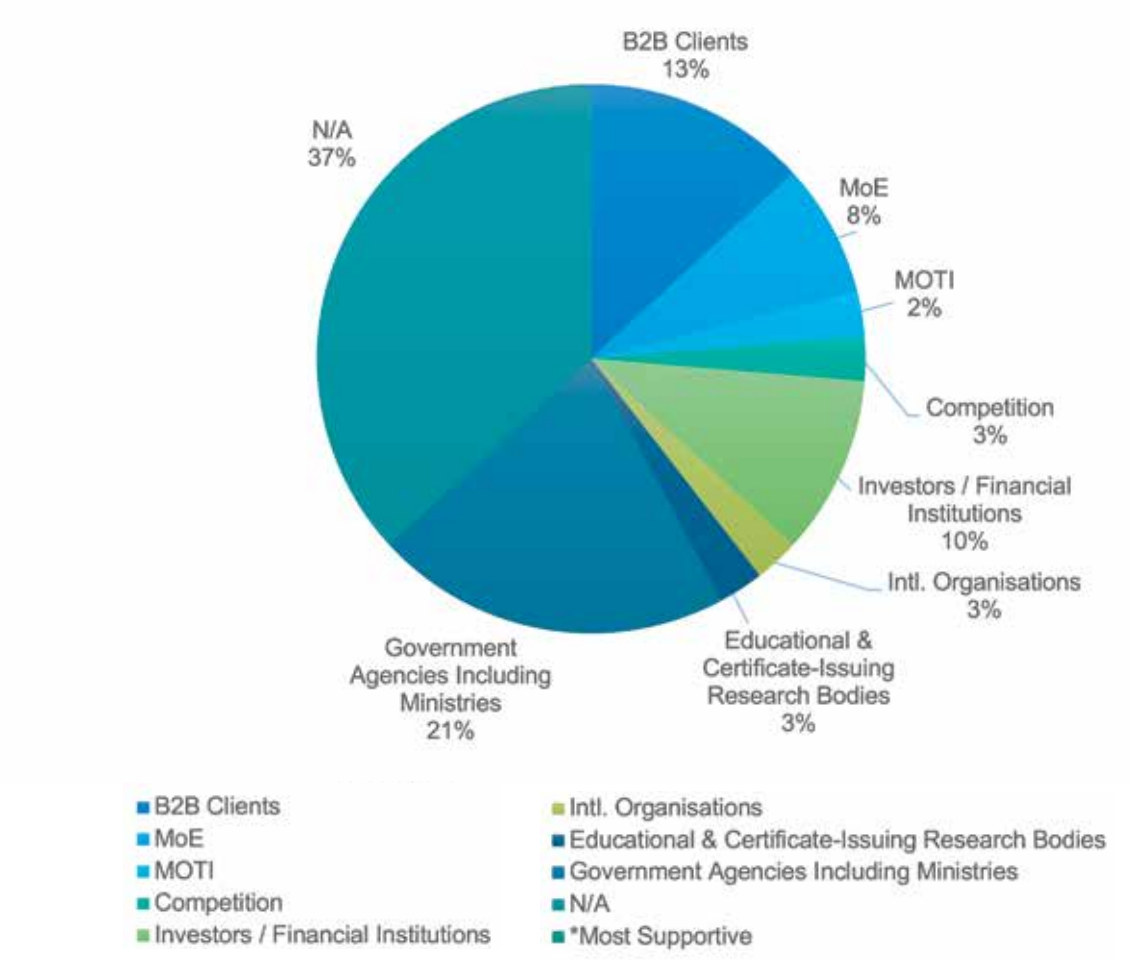


Figure 32: Stakeholders who could represent a support to the sector as perceived by the interviewed companies

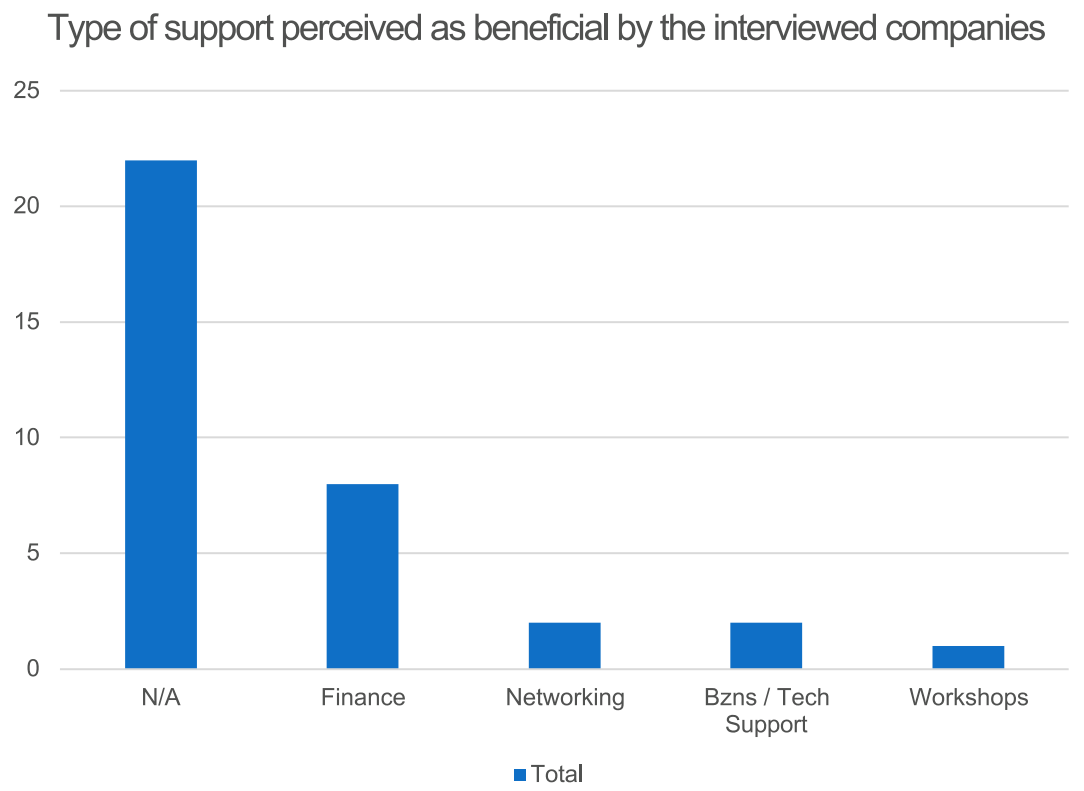


Figure 33: Type of beneficial support


Week 01
M T W T F
Week 02
M T W T F M

SECTION 3

IDENTIFICATION OF WASTE MANAGEMENT OPPORTUNITIES

3.1 BUSINESS OPPORTUNITY MAPPING (BOM)

The main objective of the BOM is to specify opportunities in a certain sector setting. These opportunities offer startups and SMEs a higher chance of success and also ensure implicit improvement of the social and environmental conditions through, for instance, preservation of natural resources and job creation for youth and women. Furthermore, the BOM provides basic knowledge on the business opportunities to serve as a starting point for startups, SMEs and investors. The startups and SMEs that have been supported in the pre-mapping of the business opportunities in 2014, have shown a higher business success rate compared to firms in the same sector that did not have access to the pre-mapping. Until today, 50% of the idea-stage businesses that were supported are successfully operating, with more than 30% continuously growing. Further, they have showcased the predetermined social impact. The identification of such opportunities through a neutral party encouraged angel investors to invest in sectors they might have not been familiar with before.

In order to map the shortlist, an extensive list of business opportunities has been identified and assessed based on multiple criteria. For each business opportunity, a fact sheet was created that assembles all the necessary background information regarding the opportunity. The mapping approach was developed by Chemonics Egypt and Cleantech Arabia while working with UNIDO in 2014 on the project "Entrepreneurship Support in Waste Management Action Plan in Southern Upper Egypt" (13).

The details of the approach and steps of the business opportunity mapping can be summarized as follows:

Step 1: Development of an extensive list of business opportunities based on demand and supply:
70 opportunities identified
Step 2: Development of a short-list of the most viable business opportunities based on multi-indicators reflecting profitability and market conditions:
25 short-listed opportunities
Step 3: Pre-feasibility analysis for short-listed opportunities along with market sizing and financial analysis:
19 feasible opportunities

Step 1 - Extensive list of business opportunities: A list of 62 business opportunities was generated by the consultancy team then additional 8 opportunities were added by the expert panel. The list was generated based on analysing data on supply/demand and market dynamics in Egypt based on the consultant database of knowledge generated from previous projects. In addition, published reports contributed to the list[19]. Further, interviewed local stakeholders were asked to nominate business opportunities that were also added to the business opportunity extensive list. The list contains diverse business opportunities serving various sectors such as the energy intensive, agriculture, and food industries. The opportunities are generated based on mapping of the supply and demand as well as viable technologies.

Step 2 - Short-listing of business opportunities: In the second step, the business opportunities of the extensive list are qualitatively compared against a set of

[19] *UNIDO, Business Opportunity Mapping in Luxor and Qena Governorate, 2016. UNIDO, Waste Management Entrepreneurship Action Plan in Southern Upper Egypt, 2014.*

diverse indicators, which reflect chances of business success, ensures positive environmental and social impact, as well as guarantees the suitability of the startups and SMEs. The indicators used for assessment are discussed below.

Forward linkages: Linkages to clients in existing economic activities, value chains, and clusters - local; regional; national; and international.

Backward linkages: Linkages to suppliers in existing economic activities, value chains, and clusters – local; regional; national; and international.

Availability of supply: It describes the abundance or ease of access to the waste utilized in the business opportunity. Green indicates easy access or abundance and red indicates the opposite.

Seasonality: It describes the seasonality of the waste required in the business opportunity. Green indicates the abundance of the waste all year long and red indicates the opposite.

Existence of demand: It describes the intensity of demand on the outcome of the business opportunity. Green indicates high demand and red indicates the opposite.

Supply chain simplicity: It describes the accessibility of obtaining/supplying the waste utilized in the business opportunity. Green indicates easy reach (less steps and obstacles) to waste and red indicates the opposite.

Growth potential: It describes the likelihood of growth for a small enterprise in the present market or environment. Green indicates high potential to grow and red indicates the opposite.

Market saturation: It describes the capacity of the market to accept new projects in an area. Green indicates good chances to enter the market and red indicates the opposite.

Value added: It describes the value addition the opportunity would provide. Green indicates high value addition and red indicates the opposite.

Capital intensity: It describes the initial investment needed to start a project. Green indicates that small capital is required and red indicates the opposite.

Stability of cash flow: It describes the stability of the cash flow for the business opportunity. Green indicates stability and red indicates the opposite.

Operating cost: It describes the operating cost needed to operate a project. Green indicates that small operating cost is required and red indicates the opposite.

Simplicity of technology: It describes the level of sophistication involved in the technology used in the business opportunity under assessment. Green indicates simple technology and red indicates the opposite.

Access to finance: It describes the accessibility to finance for the business opportunity under assessment. Green indicates the ease of access to finance and red indicates the opposite.

Need for infrastructure: It describes the need for well-established infrastructure required for the business opportunity. Green indicates a well-established infrastructure is not needed and red indicates the opposite.

Clarity and simplicity of regulations: It describes the ability to understand and comply with available laws, bylaws, regulations and function. Green indicates clear, simple and straightforward regulations and red indicates the opposite (or absence of regulations).

Existing of legal framework: It describes the existence or absence of legal framework enforcement along the value chain. Green indicates the existence of a solid and strong legal framework while red indicates the opposite.

Access to knowledge: It describes the ease of attaining the knowledge required to understand, build, operate, and innovate in the technology involved in the business opportunity under assessment. Green indicates that knowledge is available or easy to access and red indicates the opposite.

Existing competition: It describes the state of competition in the market about to be entered. Green indicates easy competition and red indicates the opposite.

Labour intensity: It describes the intensity of employment required in the implementation of the project idea in the business opportunity with respect to the capital invested. Green indicates low labour required and red indicates the opposite.

Job favours unemployed: It describes the ability to create jobs for those who are unemployed and struggling rather than professionals who have the luxury to change employers. Green indicates the priority of job creation to unemployed and red indicates the opposite.

Environmental impact: It describes the environmental impact the opportunity would provide. Green indicated a high positive environmental impact and red the opposite.

Favourability to women: It describes the ability to create jobs for women. Green indicates the favourability to female job creation and red indicates the opposite.

The assessment takes place through a diverse set of experts including:

- Market experts
- Technology experts
- Investors in waste management
- Startups and SMEs

Step 1 and 2 led to a short listing of 25 opportunities.

Step 3 - Pre-feasibility analysis, business model development and market assessment: The 25 opportunities were financially analysed and led to the 19 feasible opportunities, which are presented in the following sections. In order to develop the **"Waste Management Feasibility Scanner"** and the underlying pre-feasibility studies of each business opportunity, the assumptions in Table 7 were used. The rational of each assumption is elaborated below.

Inflation

The inflation is based on current inflation rates announced by the Central Bank of Egypt, which is currently in the 17-18% range. A conservative 15% average was assumed for the next 5 years, which is reflected on both selling price of products and costs of inputs.

Cost of capital:
The cost of capital is based on the cost of equity, which was determined using global industry benchmarks for the waste sector and factoring in Egypt's risk-free rate of 15% and risk premium rate of 8%. Cost of debt was ignored, as the projects are assumed to be 100% equity financed.

Terminal growth
The terminal growth is based on the overall economy's expectation to grow beyond the 5-year projection's horizon and a conservative 2% was used.

Tax rate
Based on the maximum possible rate in the current tax legislation.

Macroeconomic Assumptions	
CPI Inflation annual avg.	15.0%
Capital Structure	
Equity	100%
Cost of Capital	20%
Terminal Growth of Company	2%
Tax Rate	22.50%

Table 7: Macroeconomics assumption of "Waste Management Feasibility Scanner"

Along with the pre-feasibility analysis, the business model operations are identified and discussed. The market served by the opportunity is also presented.
For each opportunity, the following is described:

- Product and technology
- Access to supply
- Market size and features
- Financial features
- Challenges and mitigation measures
- Economic, social and environmental Impact

3.2 OVERVIEW OF 19 IDENTIFIED BUSINESS OPPORTUNITIES

In the following section, the 19 business opportunities listed in the table below are assessed and an in-depth analysis presented.

Identified 19 market opportunities feasible for startups and SMEs	
Mixed agricultural waste to vermi-compost	Aerobic compost from agricultural waste
Organic waste to poultry and fisheries feed	Sorting and dismantling of E-waste
Mixed agricultural waste to bio-char	Carbon black from waste tires
Second grade tomato to dried tomato	Agricultural waste to animal feed
MDF from mixed agricultural waste	Waste tires to rubber products
Agricultural waste to fibre bedding	Collection of MSW
Design and manufacturing of recycling machines	Rubber powder from waste tires
MSW to sorted RDF	Fibreglass from glass waste
MSW to shredded RDF (preliminary shredding)	Citrus peel to pectin
Citrus peel to citrus oil should be aligned to the left in the same color as the other opportunities	

The 19 business opportunities serve various markets and sectors. Hence, they contribute to increasing the competitiveness of the Egyptian industrial and agricultural sector, as well as provide consumers with cost competitive products. In addition, addressing diverse markets creates opportunities for various types of businesses and increases the resilience of the sector. They capture the range of waste streams and their geographical variation. In both urban and rural settings, opportunities can be found.

Figure 34 visualizes the different sectors the business opportunities serve. Almost half of the business opportunities serve the industrial sector in terms of supply of feedstock for manufacturing facilities. Approx. a quarter of the opportunities serve the agricultural sector and consumer products sector. Only 5% of the opportunities identified fully focus on export (1 opportunity). Furthermore, the opportunities cover the whole country, in both urban and rural settings. This provides opportunities for businesses and economic growth across the country's governorates. In fact, few opportunities can flourish across the whole country. Further details on geographical distribution of the business opportunities are mapped in the study report. Thus, the business opportunity map identifies the most suitable locations for the identified business opportunities across Egypt.

Figure 35 shows the diversity in markets the business opportunities serve. These range between markets for animal breeding and fisheries, fertilizers, energy source, material and industry feedstock to services and equipment.

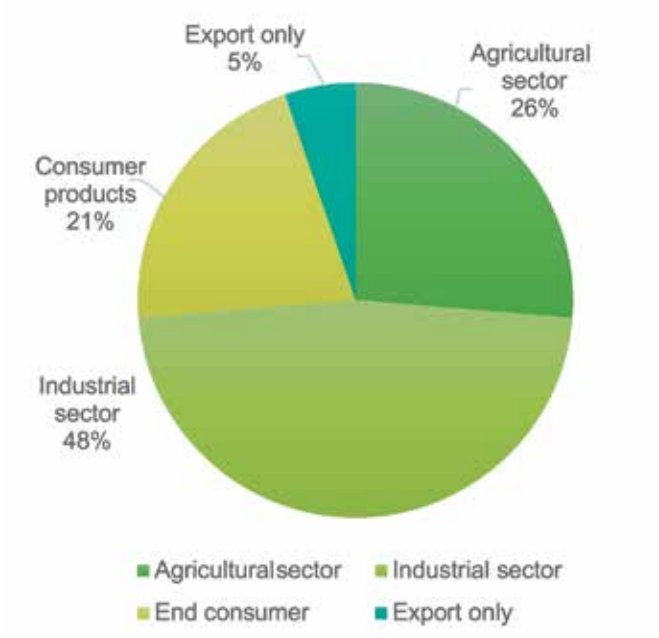


Figure 34: Percentages of top opportunities serving various sectors

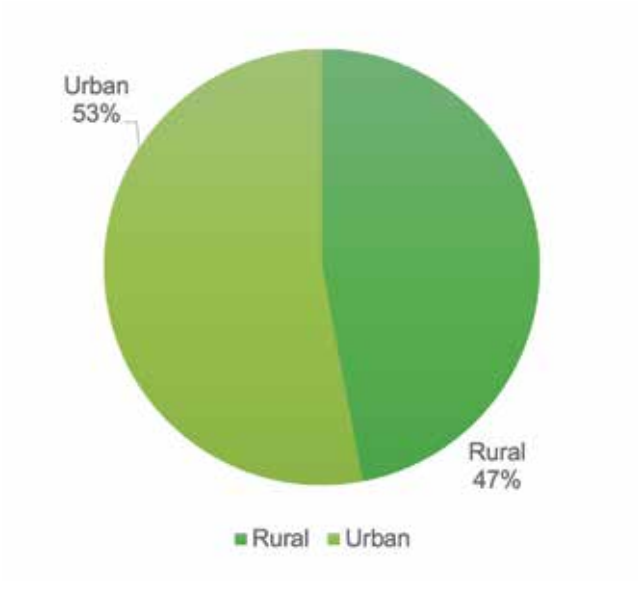


Figure 36: Distribution of opportunities - Rural vs. Urban

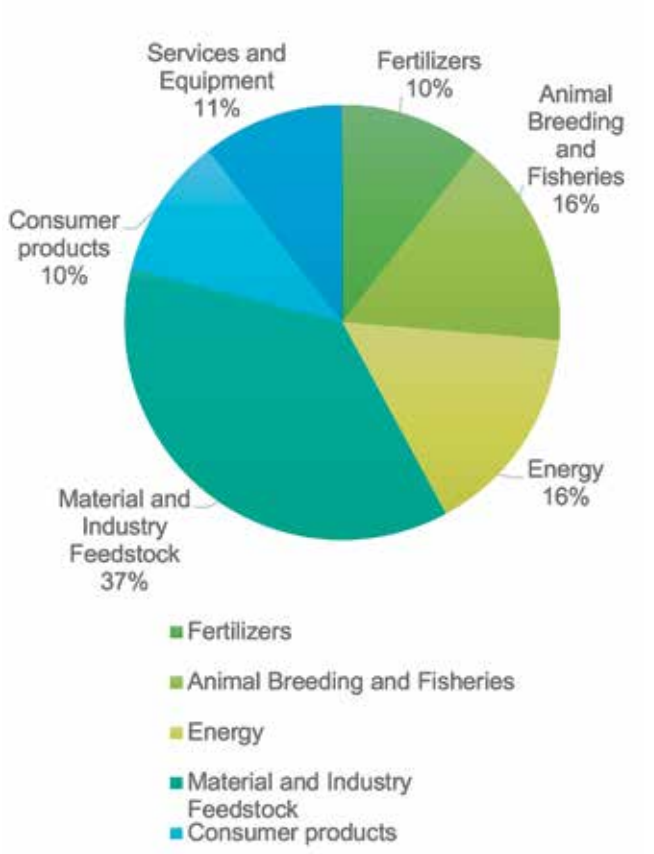


Figure 35: Percentages of opportunities serving certain markets

Opportunities are almost equally distributed between rural and urban areas as shown in Figure 36. This is in line with the national agenda of diversifying economic activities. Few opportunities can operate in both rural and urban settings. However, the classification focused on which is the more likely context of operations.

The business opportunities are mapped across Egypt showing that each region provides various opportunities in waste management as shown in Figure 37.

Opportunities that could be implemented nation wide

Vermicompost | Aerobic compoost | Collection of MSW | Fiber bedding | Design of recycling | machines Poultry and fisheries feed | Animal Feed

Figure 37: The map of Egypt with relevant business opportunities in each region

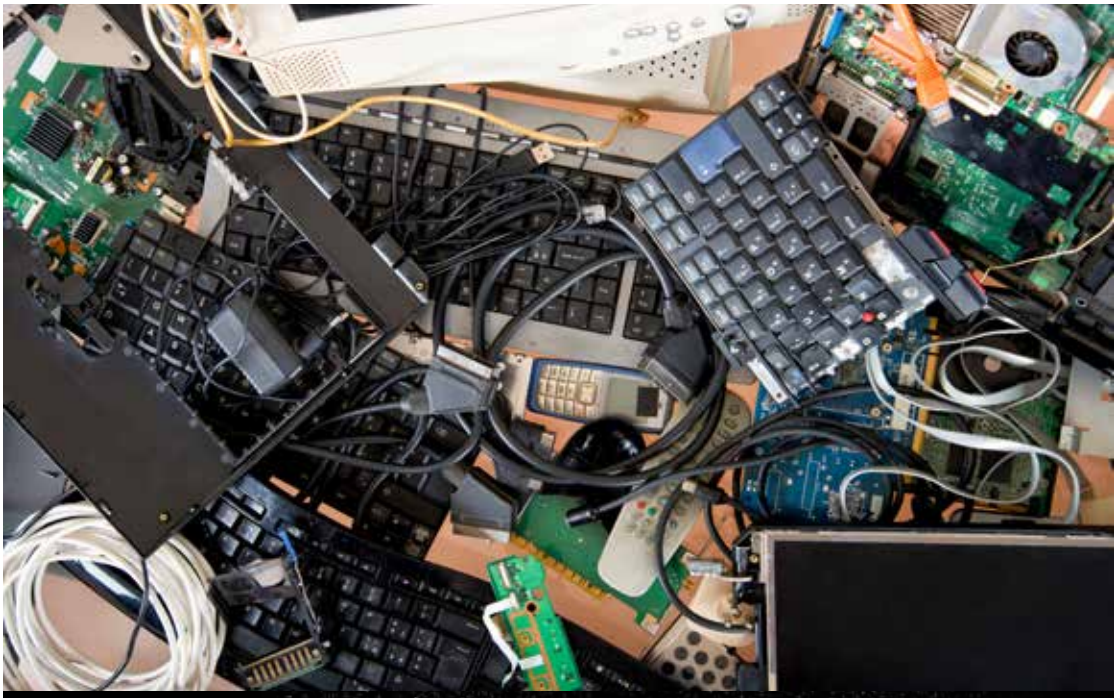
Some opportunities are geography specific, which means they can flourish in certain regions only, whereas other opportunities can be found across the country. The geographical uniqueness is determined by the availability of supply and/or proximity of markets. However, most governorates have multiple opportunities. The least amount of opportunities can be found in the Red Sea, North Sinai, and South Sinai governorates, which is mostly due to the limited waste amount and diversity generated in these regions. The number of opportunities in each governorate is shown in Figure 38.

Figure 38: Regional distribution of business opportunities per governorate

The 19 opportunities serve four key markets. Hence, the opportunities are classified as per the market they serve. Each market and the opportunities within are discussed in the following sections.

The markets and opportunities are as follows:

- Material and industry feedstock (6 opportunities);
- Food and beverage markets (3 opportunities);
- Energy market (3 opportunities);
- Agricultural market (5 opportunities);
- Supporting products and services (2 opportunities).



SECTION 4

MATERIALS AND INDUSTRY FEEDSTOCK MARKET

4.1 OVERVIEW OF THE MARKET

Feeding the Egyptian industry. The material and industry feedstock market includes the production of various high value-added material (feedstock), which is used by manufacturing industries to develop final products. This market covers diverse sectors and opportunities. The business opportunities in this market is to produce material and feedstock for the manufacturing industries in the process of producing end products. For instance, the startup or SME in this market could produce wooden panels for furniture factories or produce rubber powder as an additive in the production of rubber products, such as playground tiles and automotive mats. Therefore, the startup or SME is a manufacturing entity, supplying material and/or feedstock for the production process to various industrial sectors. The products developed from waste provide a technically equivalent alternative to virgin material and feedstock with clearly defined specifications. The prices are usually pinned down by international markets for the material or the feedstock. Hence, very limited efforts are needed to convince the client with the product or to negotiate prices once the technical specifications are met.

Cost competitiveness of recycled material and increased demand. Due to the increasing demand on raw material, transforming waste into feedstock for industry instead of relying on mining, production and extraction of virgin material is becoming increasingly lucrative internationally. In Egypt, most of the material utilized by the industry is imported, since Egypt's natural resources do not cover the diversity of industrial activities in the country. The growth of the market locally is hence tied to the growth of Egypt's industrial sector. Especially after the floatation of the EGP, working in the market of material and feedstock has become increasingly lucrative. Recycled material is usually cost competitive compared to its virgin alternative worldwide[20-21]. In Egypt, where the recycled material or feedstock is replacing imported alternatives, the market for recycled material becomes even more competitive.

While the cost of imported material for the Egyptian manufacturing industry effectively tripled since 2015, due to change in the foreign exchange rate, the price of waste increased by an average of 30% across the board[22]. This means that the locally produced recycled material gained a competitive edge against imported alternatives in the process of floatation of the Egyptian pound. Furthermore, recycled material are also more cost competitive than locally produced version material. The cost competitiveness of recycled material against virgin material is not unique to Egypt, but the case in most countries.

Capturing the higher value-added opportunities. Recycling activities for material and industry feedstock are highly active in Egypt. For instance, most Aluminum and steel are collected, treated and reintegrated into the production process. Various types of plastics are also recycled and reach the market as products. However, in many cases the recycling

[20] *Source: US EPA*
[21] *Source: Stanford university*
[22] *Various market surveys and research conducted by the consortium*

processes in Egypt does not capture the highest value-added potential of the material. In plastics for instance, most of the recycled material goes into a product of a lower quality than the original one. Further, often only the processing of the waste takes place in Egypt, but not to the stage of reaching the final product. For instance, PET, which is one of the highest grades of plastics, primarily used in drinking bottles, is rarely recycled to reach food-grade plastic again, but rather exported to be fed to international manufacturing facilities. Startups and SMEs should therefore avoid markets depending on waste streams that are already recycled, such as Aluminium and Copper. For instance, early processing stages (pre-processing) and treatment of plastics (segregation, washing, production of flakes) are saturated markets with various players. Opportunities can be found in building upon collection and pre-processing activities commonly carried out by the informal sector to produce higher value products, such as the production of fibreglass from waste glass. Hence, the most lucrative opportunities in the material and industrial feedstock markets are discussed in the following sections.

4.2 KEY WASTE STREAMS AND OPPORTUNITIES

Key opportunities. The process through which the promising business opportunities are determined was briefly outlined in Section 3. The identified opportunities use waste glass, agricultural waste (corn stalk, bagasse and tree pruning), electronic waste, and waste tires. No opportunities utilizing material such as plastics and traditional metals (aluminium, copper, steel and tin), have been identified. This is mainly due the existence of large number of recycling firms, which operate in those streams. There is market saturation in plastics, aluminium, steel, tin and copper recycling which makes it difficult for new entries. This does not mean that there are no opportunities in these waste streams. It means that these are congested market spaces, which are more difficult to penetrate. There are opportunities in recycling of these traditional streams however they are likely to materialize in large scale recycling facilities which require investments beyond the resources of startups and SMEs; the primarily target of the present study. The large-scale opportunities in plastic and traditional metals recycling are best captured by existing collectors in extending the activities to recycling. The vast majority of waste management businesses are involved in the early stages of the value chain. This include activities such as collection and sorting as well as simple pre-processing (mostly shredding and pressing of waste streams such as plastics, paper and cardboard, as well as cans). The opportunities identified in this study are mostly towards the market side of the waste value chain, away from collection and pre-processing. Opportunities in the early stages of the value chain of traditional waste can exist in certain geographical areas where pre-processing is neglected. Microbusinesses can utilize proximity to supply and capture opportunities in pre-processing, particularly in the southern parts of Upper Egypt. For instance, paper and cardboard collectors in rural areas with high population density can invest in pressing waste before selling it to the next stage of the value chain.

In the following sections, the top business opportunities determined in the markets of material and industry feedstock are briefly discussed. Six business opportunities were identified; each of them represents opportunity to explore new class of businesses

1. Fibreglass from waste glass
2. MDF from mixed agricultural waste
3. Sorting and dismantling of E-waste
4. Carbon black and pyrolysis oil from waste tires
5. Rubber powder from waste tires
6. Rubber products from waste tires

Waste streams: Hence the key waste streams on which the opportunities can flourish are:

- Glass waste (800,000 tons annually all which can be absorbed in identified markets)
- Waste tires (560,000 tons annually all of which can be absorbed in identified markets)
- Agricultural waste, particularly corn stalk, bagasse, and tree pruning (9.4 million tons annually – 170,000 tons of which can be absorbed in identified markets)
- E-waste (may capture 80,000 tons annually of about 350,000)

As seen above, the business opportunities in this market can either draw waste from agricultural waste or a mix of municipal and industrial waste. Therefore, industrial and municipal waste streams can be mixed as feedstock for some opportunities, such as e-waste, waste tires, and waste glass. However, in the raw material markets, mixing various waste streams can be problematic since the composition and quality, in terms of contaminants may vary drastically and hence adds risk to operations.

Features of the value chain. As in most value chains in waste management, the earlier stages, close to the generation of waste, are dominated by the informal sector. Formal activities are starting to originate in the e-waste sector for instance, yet the collection part remains largely informal and semi-formal[23]. Among the above waste streams, the agricultural waste remains as one with most informality. Highest level of formality is in industrial waste were large-scale collectors and traders directly interface with factories. Regarding municipal solid waste (MSW) from households and commercial facilities, the collection and early stages of processing involve the informal sector. In many cases, the MSW is segregated and pre-treated within informal and semiformal facilities. The material moves through various collectors and traders and as more processing takes place the formality increases. Informality in this context should not be equated with low quality of products or low efficiency. In general, doing business with the informal sector in waste can be efficient.

[23] *Informal within the context of the present study refers to firms operating without documentation and legal status – Semi-formal refers to firms operating under the umbrella of a legal status, yet a one that does not reflect the actual nature of business, for instance, collector may have a tax registration card but not a registered firm, others could register a service or trading company while conduction recycling activities*

FIBREGLASS FROM GLASS WASTE

4.3 IDENTIFIED BUSINESS OPPORTUNITIES IN MATERIAL AND INDUSTRY FEEDSTOCK

4.3.1 FIBREGLASS FROM GLASS WASTE

Outlook on product and technology. Fibreglass is a plastic reinforced with glass fibres. Fibreglass is used in many applications, such as storage tanks, insulation panels, and water pipes. In this business opportunity, chopped Fibreglass filaments are produced to be sold as feedstock for insulation panels and water pipe factories domestically and internationally. In the production process, the waste glass represents 30% of the input material for production of chopped Fibreglass and the remaining 70% is mainly sand, limestone, and additives. Sand and limestone are available in Egypt with high quality and low cost compared to international market prices. All other additives are used in small percentages and are imported, yet easily accessible in the Egyptian market. Other material and additives of the production process include soda ash, borax, and binder coating.

Waste glass is best purchased segregated and/or crushed from collectors and firms in early recycling activities of glass. The production steps include segregation, crushing and grinding which can be carried out through locally produced machinery. Further steps, which include meshing, binding and polymerizing would require imported machinery. The production process complexity and know-how are in maintaining the proper ratio and quality of input material as well as additives.

Sample of chopped fibreglass

Access to supply. Glass factories, which produce waste glass mostly utilize it on site in the production process. Hence, in Egypt the waste glass can mainly be found in MSW rather than industrial waste. Glass represents 4% of annual generated MSW (840,000 tons) and generally does not pose environmental challenges. Glass recycling is active in Egypt with activities on a microscale spread nation-wide and on a larger scale in Greater Cairo Area and Gharbiya. However, most existing businesses recycle glass into lower grade products and can rarely recover the material's original value. Generally, the collection activities are active and advanced. Therefore, the integration with collectors, traders, and early stage recyclers is more effective than engaging in collection. Glass can be acquired at varying prices along the value chain, segregated and washed, crushed and in very few cases in powdered form.

Sample of fibreglass pipes to the left and insulation panels to the right using fibreglass

Glass waste is mostly available in urban rather than rural areas. While the national average percentage of waste glass in MSW is 4%[24], it varies significantly from one place to another. Studies show that in rural areas and governorates with high percentage of rural population the percentage is about 1.5%. Hence, operations, which must be in an industrial zone, are best set around major urban areas. Two main factors would determine the location of operation to be based in or around cities with a high population density and where there is a low competition on the supply and thus lower prices, such as in Qena and Assiut or secondly in cities where collection of waste converges to recycling activities, such as Alexandria, Gharbia, and Cairo. The glass can be acquired in a segregated form at 850 EGP per ton[25]. Prices could vary within a range of 20% throughout the year, due to variation of consumption of glass bottles between winter and summer. The waste glass could also be acquired in crashed or powdered form.

[24] Zaki, T. & Khial, A., 2014. Country Report on the Solid Waste Management in Egypt, Cairo: SweepNet

[25] Prices mentioned in this report must be handled with extreme care and caution. They are based on surveys with formal and informal suppliers and the prices may vary with economic activities in Egypt as well as international markets conditions. The prices should be seen as indicative

Market size and features. If in Egypt, waste glass would be processed into fibreglass "chopped strands" of a size typically less than 50mm in length, it would have a net value of 15 billion EGP. The product itself exhibit a high value added since the waste glass can be acquired at about 850 EGP/ton. Adding the cost of additives and utility the final product can be produced at a cost of 4,600 EGP/ton and sold at a min of 7,000 EGP/ton. This takes place at a small-scale production of about 5000 tons per year. These 5000 tons represent less than 2% of available glass waste. The product selling price is stable and is determined by international market prices. Egypt's production of fibreglass is about 400,000 tons a year, which means that the 5000 annual tons of production would cover about 3% of local market needs regardless of the export potential. Additionally, it is expected that Egypt's production capacity of fibreglass is to double by 2019[26], whereas the international market is expected to grow at 5.3% until 2025. The reason for Egypt's vast increase in production capacity is mainly due to major manufacturing facilities being established to serve European and MENA markets. One of the companies investing in the field of fibreglass in Egypt is Jushi, a major international market player[27]. Based on the recent development, Egypt is expected to become a major international player and the key supplier of the European and MENA markets for fibreglass.

MARKET OUTLOOK

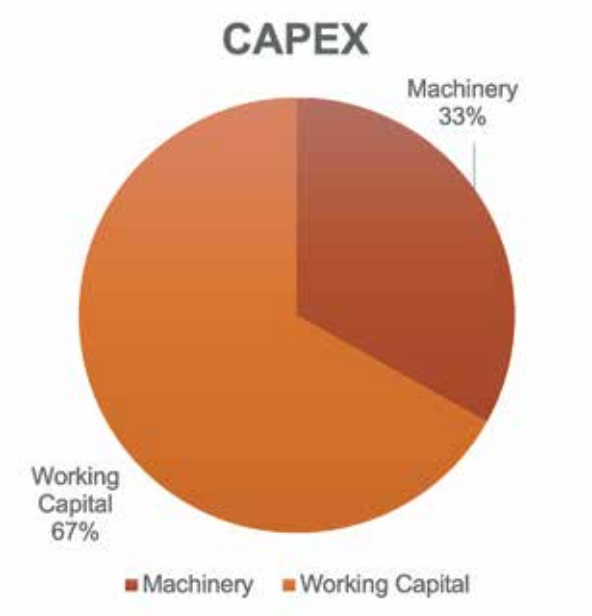
Production Capacity	15,000 ton/ year
Available Supply	800,000 ton/ year
1st year production	5000 ton/ year
Local Market Size	400,000 ton/ year
Local Market Value	2.8 billion EGP/ year
International Market	12 million tons/ year
International market growth	5.3%

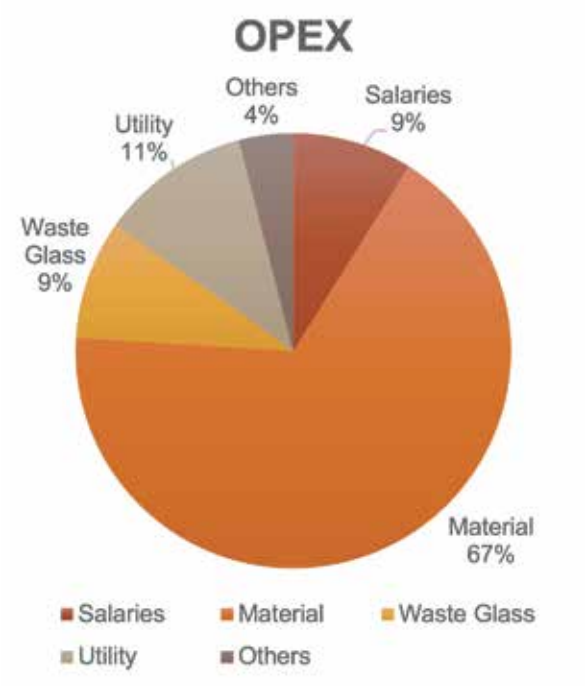
Financial features. The initial investment for starting this business is about 16 million EGP; among the highest in the present study. About 33% of the initial investments goes into production of machinery, while the rest finances the operations. The IRR is about 66% and the profitability index 10; making it one of the most lucrative opportunities investigated in the present study. The operating costs of the first year are about 24 million EGP making it one of the highest OPEX in the present study in comparison to the CAPEX. The OPEX mainly cover production material and utilities at about 50% of the total OPEX. The rest goes into transportation, factory rent (lease), and salaries. The payback period of the business is 3.5 years.

FINANCIAL OUTLOOK

CAPEX:	16 million EGP
1st Year OPEX:	24 million EGP
IRR:	66%
Profitability Index:	10
Payback period:	3.5 years
Net Present Value:	147 million EGP
Production Cost Yr1:	4800 EGP / ton
Product Selling Price:	7000 EGP / ton

[26] *Minister of Trade and Industry – January 2018 – Jushi Production Plans of Fiber Glass in Egypt*
[27] *jushiusa.com*





The main challenge. The main challenge in this opportunity is in securing daily production demand of glass waste. If supply is interrupted and production is intermittent, losses are incurred in operations. The furnaces used in the process are most economically operated in a continuous manner. Stopping and starting the operations leads to losses in raw material and energy. Hence, steady stream of supply is crucial. Interruption of natural gas supplies used for heating can also lead to losses. Mitigation measures include effective inventory management of supply and backup gas cylinders to maintain operation in case natural gas is interrupted. This opportunity offers a high profit margin and high chances for growth in export. Further details are in the business fact sheet below.

Business Opportunity Factsheet: Fibreglass from glass waste[28]	
Market	
Final Product:	Chopped fibreglass for insulation panel and water pipes production – and other products
Required Inputs:	Glass waste, limestone, sand, soda ash, borax, and binder coating
Competing Products:	Virgin glass-based fibreglass
Process	
Type of Process:	Mechanical and thermal processing
Technology:	Separation, crushing, melting, meshing, binding, polymerizing, cooling, and packaging
Equipment & Material:	Crushers, grinders, colour separators, oven, masher, binder, and chopper
Human resources:	Machine Operators, labour for manual operations, and drivers
Advantages and Risks	
Competitive Advantage:	High margins in recycling waste glass to fibreglass, - competitive selling price compared substitutes, - high value added on glass waste, – availability of high quality cost competitive sand and limestone, ingredients needed in addition to the waste glass to produce fibreglass
Barriers to Entry:	Securing a continuous level of glass waste supply to satisfy production demand, high CAPEX
Key Stakeholders:	Informal waste collectors who provide segregated and washed glass, pre-processing firms that provide crushed glass or powdered- factories using fibreglass in their products
Special Regulations:	NA
Risks and Mitigation Measures:	Ability to meet daily demand for glass waste that may lead to interruption of production, which leads high losses. Risk of unstable supply of gas to keep furnace working. Mitigation measures are having high inventory that can cover many days of operations even if waste supply was not stable and having stock of gas cylinders to use in case of natural gas cut
Economic Features	
Revenue Stream:	Sale of fibreglass for insulation panels, water pipes, or other uses
CAPEX	16 million EGP
OPEX	1st year 24 million EGP
Geography	
Location of Supply:	Supply is mostly in urban centres and large cities
Preferred operation regions:	Assiut, Alexandria, Cairo – (Suez if focus is on export)

[28] Final notes: Key figures are based on trade map data – Ministry of Trade and Industry Data in 2018 – Local and international market size data are for 2016. Local market size expected to double by 2019 due to major planned projects

MDF FROM MIXED AGRICULTURAL WASTE

4.3.2 MDF FROM MIXED AGRICULTURAL WASTE

Outlook on product and technology. Medium density fibreboards (MDF) is manufactured wood, which is widely used in the Egyptian market, especially by furniture factories and workshops as well as carpenters. MDF is used for products, such as flooring and furniture as well as home accessories. MDF provides a low-cost alternative to natural wood in a country with very limited natural wood resources. The production process relies on shredding of wood and mixing it with additives under pressure. MDF can also be produced by shredding special types of agricultural waste, mixing it with resins for binding followed by pressing the materials together. Most common resins are RUBINATE and SUPRASEC, however other additives could be included. The input raw material in this opportunity is mainly agricultural waste that acts as a source of fibre. One of the many benefits in this business opportunity, is that the majority of agricultural waste types can be used in manufacturing of MDF, but the higher cell house and fibre content the better the quality of MDF. Tree pruning, corn stalks and bagasse are the best types of agricultural waste to be used in the production of MDF in Egypt. The required production know-how is in maintaining the quality and the right mix of agricultural waste, which involves tuning the mix of additives and resins to its optimum to produce highest possible quality MDF. Hence, quality control and testing of produced panels must be regularly done in various facilities in Egypt.

Access to supply. On the positive side, agricultural waste generally suffers little variation in pricing compared to other waste streams, such as plastics and metals. Yet, the main challenge is in its seasonality. To maintain constant production of MDF, large quantities of supply must be secured in the season, in which the agricultural waste is produced that is coinciding with the harvest season. In addition, multiple waste streams could be relied upon. Seasonal operation is also possible by leveraging seasonal workers commonly involved in agricultural activities. The operation must occur in governorates with high agriculture activities and close to rural areas. The corn stalk, bagasse and tree pruning are the best options from a technical point of view. There are at least 7.4 Million tons/year of corn stalk and about 2 million tons/year of bagasse available and mostly found in sugar factories. Geographically, businesses operating mainly on bagasse could be located in Luxor and Qena. Businesses operating using corn stalk are best focused in Fayoum, Minya, and Assiut.

The startup or SME business should best not engage in collection and rather focus on accessing the supply through collectors already operational. However, it is worth noting that due to the seasonality, ensuring the presence of multiple collectors with the capacity to deliver the required quantities is crucial. In the long term, as the startup or SME grows, it might need to invest in raising the capacity of its suppliers (collectors) through training and/or access to machinery and finance. Collectors may lack access to machinery required for efficient collection. In certain regions where there is little awareness of the value of the agricultural waste, startups and SMEs can access the supply for marginal prices ranging approx. between 20 to 40 EGP. However, eventually the price of supply usually stabilizes around 100 EGP/ton. Corn stalk and bagasse already have current uses

and hence an established market price of around 100 EGP/ton. This does not include cost of transportation. Some types of waste such as banana tree waste can be sourced for free, since there is little awareness of its application as well as fewer companies working on its recycling. It can be used in the production of wood and fibres, yet the production technology is not easily accessible with only few companies in the world owning the know-how.

Medium Density Fiber Boards

Market size and features. In 2016, Egypt imported wood of various types of approx. 23 billion EGP, with imported MDF at a total value of 1.7 billion EGP. Interestingly, the total market value of MDF can be met by using merely 2% of the bagasse and corn stalk waste readily available in Egypt. Expansion beyond the 2% use of bagasse and corn stalk waste could be used for exporting MDF. In fact, Egypt already exports MDF with a total value of 70 million EGP/year, with successful activities in production of MDF from corn stalk in Sohag already being exported to regional markets. These activities can be replicated and expanded.

The opportunity faces little risks when it comes to the availability of supply. The business opportunity can be extremely profitable at an annual production rate of about 6,500 tons/year. The planned production capacity in this study is about 9,500 ton/year, which represents less than 5% of the local market size of 2016 and less than 0.1% of available supply. The opportunity offers high growth potential in local and regional markets. It is difficult to compete in European markets, mainly due to the abundance of natural wood and competition with other MDF producers. However, in the region, based on proximity, exports from Egypt would have an edge. Most countries in the region lack natural wood resources and could be importers of the Egyptian MDF products. These markets include Saudi Arabia and Jordan for instance. Egypt's consumption of wood increased by

13% on average from 2011 to 2014, yet has been declining since the floatation of the EGP in 2016. The growth of the market is highly tied to population growth and hence rapid increase in consumption of MDF is expected. The exponention 3 of MDF in the present opportunity can be produced at 2,500 EGP in the first year, which can later decrease as production increases, with the exponention 3 price of MDF at 5,000 EGP.

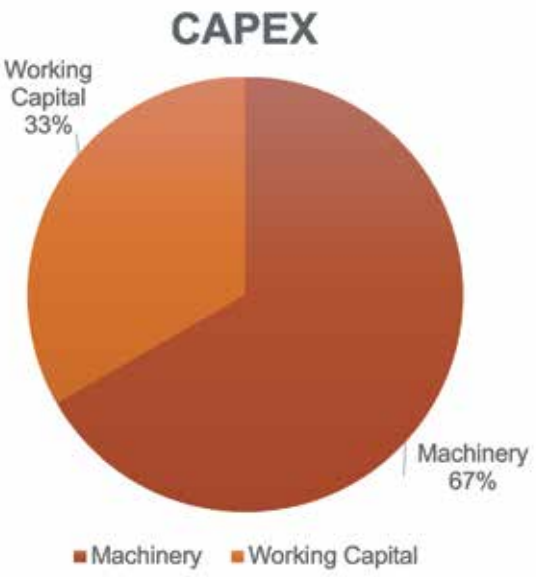
MARKET OUTLOOK

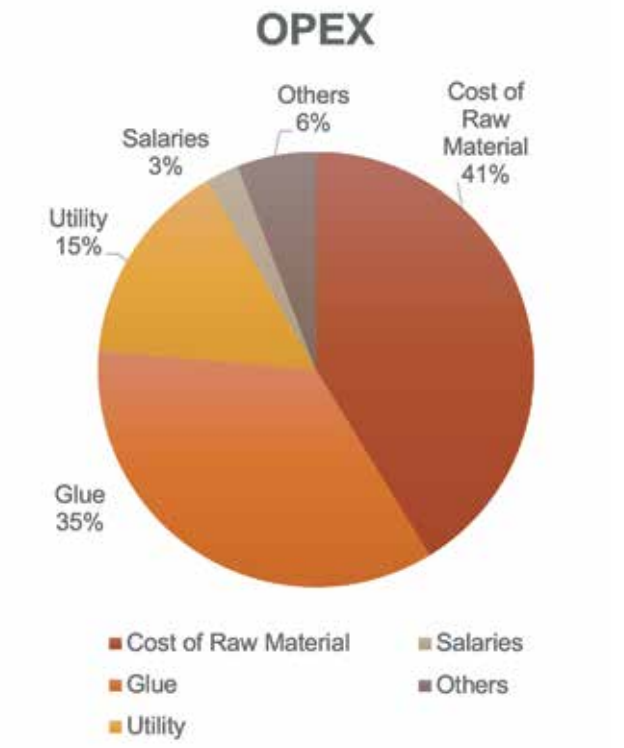
Production Capacity:	9,500 m3 / year
Available Supply:	9 million ton / year
1st year production:	6,500 ton / year
Local Market Size	340,000 m3 / year
Local Market Value	1.7 billion EGP/year
Local market growth	7% annually

Financial features. The initial investments for starting this business is about 12 million EGP, among the highest in the present study. About 67% of the capital expenditures goes into production machinery while the rest finances operations. The IRR is about 77% and the profitability index 10; making it one of the most lucrative opportunities investigated in the present study. The operating expenses in the first year are about 10 million EGP with a moderate OPEX in comparison to the CAPEX. The OPEX covers the cost of acquiring the waste, in addition to glue constituting 76% of the total OPEX. The rest of the OPEX goes mainly into utilities. The payback period of the business is 2 years

FINANCIAL OUTLOOK

CAPEX:	12 million EGP
1st Year OPEX:	10 million EGP
IRR:	77%
Profitability Index:	10
Payback period:	2 years
Net Present Value:	111 million EGP
Production Cost Yr1:	2500 EGP / ton
Product Selling Price:	5,000 EGP / ton

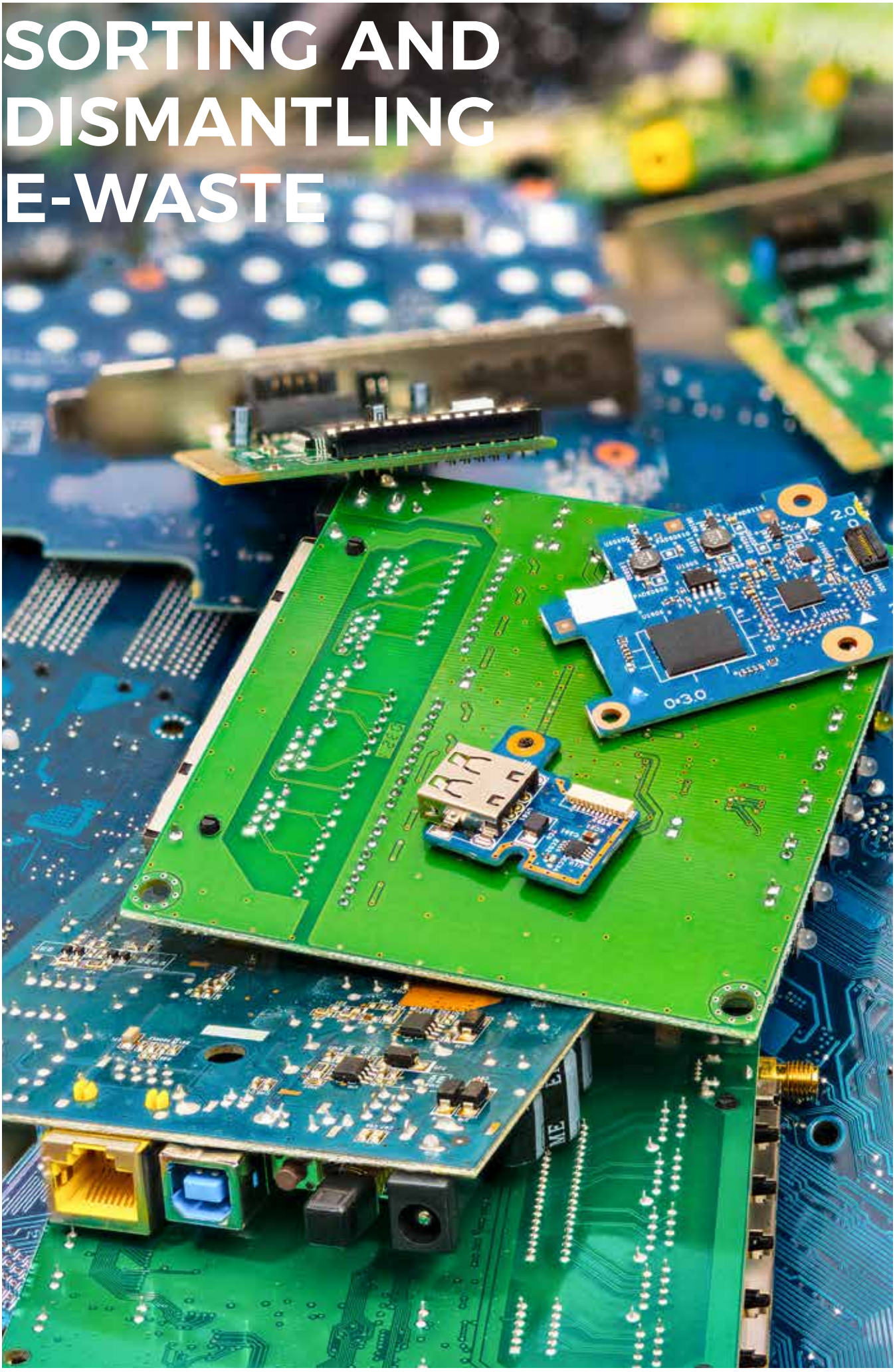




The main challenge. The main challenge in this business opportunity is maintaining an effective supply chain of agricultural waste. Collectors may fail to deliver required quantities at the needed time. Hence, having multiple collectors as suppliers and investing in a partnership with them is crucial. Collection stations and pre-processing stations might need to be developed in order to avoid transporting unprocessed waste for long distances. Collection stations would include shredders and pressing machines. Tractors could transport the agricultural waste from a certain zone around collection stations to the collection station. Shredding and balling or pressing of agricultural waste to decrease the volume of agricultural waste will take place. Then transportation from collection stations to production facility can be carried out through trucks. Multiple production sites could be set up in expansion to ensure transportation network remains cost effective. For instance, if one is to operate in Sohag, a potential expansion could take place by building a second production line to cover a different waste generation centre from the original one. This expansion could then take place by establishing production lines in various governorates. From a product quality point of view, a challenge is to ensure that the glue used and the chemical treatments are environmental compliant.

Business Opportunity Fact sheet: MDF from mixed agricultural waste	
Market	
Final Product:	Medium Density Fibreboard (MDF)
Required Inputs:	Mixed agricultural waste
Competing Products:	Imported MDF and particles boards
Process	
Type of Process:	Manual, mechanical and thermal process
Technology:	Crushing, grinding, gluing and pressing
Equipment & Material:	Manual tools, agricultural waste crusher, press machine
Human resources:	Manual labour, technical operation, drivers
Advantages and Risks	
Competitive Advantage:	Low priced product with acceptable quality in comparison with imported product
Barriers to Entry:	Managing network of agricultural waste suppliers
Key Stakeholders:	Local farmers to provide agricultural waste as raw material, local agricultural waste collectors, furniture factories and workshops
Special Regulations:	NA
Risks and Mitigation Measures:	Seasonality of agricultural waste affects the stability of supply levels and make cash flow management very challenging. Logistics of getting the agricultural waste. Therefore optimizing the location of the processing facility is key to decrease transportation cost and guarantee availability of various agricultural waste yearlong.
Economic Features	
Revenue Stream:	Sales of MDF boards
CAPEX	12 Million EGP
OPEX	1st year 10.6 Million EGP
Considerations	
Key Challenge:	Meets the quality level requirements, secure constant supply in quantity and quality regardless of seasonality
Advantages:	High demand of green wood in international market, in addition to competitive edge in quality and price locally
Geography	
Location of Supply:	Supply is mostly in Upper Egypt, Delta and Ismailia
Preferred operation regions:	Upper Egypt, Delta and Ismailia

SORTING AND DISMANTLING E-WASTE



4.3.3 SORTING AND DISMANTLING E-WASTE

Outlook on product and technology. Electronic-waste (e-waste) refers to discarded electronic devices such as computers, mobile phones, TV sets, Cathode Ray Tubes (screens) among others. The definition sometimes is extended to cover batteries. The end markets served from recycling of e-waste are mainly previous and rare earth metals extracted from the e-waste and few valuable types of plastics. Further, even precious metals, such as silver, gold and platinum as well as base metals, e.g. Aluminium and Copper can be extracted from e-waste. Apart from precious and base metals, there is the possibility to extract trace amounts of rare earth metals, such as lanthanum and gadolinium[29-30]. However, for such material to reach end markets, the value chain includes collection, sorting, dismantling, crushing and eventually multistage extractions. Establishing formal and environmentally compliant extraction facilities, in which the health of workers and communities is protected, is extremely capital intensive. Furthermore, such facilities require a steady stream of high volumes of e-waste. To grow and recover the large investments of an extraction facility, it is best to supply e-waste regionally to increase material extraction, especially since it is difficult to determine the amount of e-waste available in Egypt. The amount that is currently being collected is estimated to be 260,000 ton/year, with the potential and financial feasibility to increase these amounts by 80,000 tons/year[31]. According to the analyses of the present study, the business opportunity accessible to startups and SMEs in Egypt in the area of e-waste is in the efficient and effective sorting and dismantling, followed by export to extraction facilities. This market can absorb multiple businesses rather than a single large one since growth would be associated with running a complex supply chain. Despite the existence of active collection and trading activities in the e-waste sector in Egypt, large amounts remain untapped in households, commercial facilities and factories[32].

The edge a business would have in sorting and dismantling lies in running an effective supply network with collectors, yet more importantly, in being able to identify the precious metal content in each type of e-waste as accurately as possible. This means that each electronic component, for instance, CPUs and RAMs, are grouped together in the dismantling process based on the type of metals they include. Sorting and dismantling should be best carried out manually, given the required skillset and effectiveness of the team. Therefore, at the start the business opportunity could foremost focus on selling to exporting entities.

For e-waste collection businesses to capture most of the e-waste and extraction industry to flourish in Egypt regulations enforcing the formal collection of e-waste under the supervision of established entities, need to be developed and enforced. In that case, the business should best operate close to urban centres, as the availability of e-waste is substantially higher in urban compared to rural areas. In addition, in Upper Egypt e-waste collection is less contested by the informal sector and thus expanding businesses into cities like Assiut can lay the foundation for a hub of e-waste collection from neighbouring governorates.

[29] Rare earth elements are: Lanthanum (La), Cerium (Ce), Praseodymium (Pr), Neodymium (Nd), Promethium (Pm), Samarium (Sm), Europium (Eu), Gadolinium (Gd), Terbium (Tb), Dysprosium (Dy), Holmium (Ho), Erbium (Er), Thulium (Tm), Ytterbium (Yb) and Lutetium (Lu)
[30] Achilleas TSAMIS and Mike COYNE, "Recovery of Rare Earths from Electronic Wastes: An Opportunity for High-Tech SMEs" (European parlement, 2015).
[31] Estimates through interviews of various experts and firms
[32] As reported by interviewed companies and experts

Access to supply. The annual generated amounts of e-waste in Egypt is difficult to determine. However, collected amounts are about 260,000 tons[33]. It is also difficult to identify how much of the waste is properly dismantled and exported. Interviews with experts indicate that there is about 80,000 tons/year of e-waste which can still be collected and sorted in a profitable manner. Currently, the supply of e-waste can be accessed through three main channels:

(1) Collectors who are mostly informal and extremely active;

(2) Auctions of large discarded quantities from the public sector and major private sector facilities;

(3) E-waste from households, which is thus far untapped and uncontested by the informal sector.

Purchasing waste from collectors and focusing on sorting and dismantling e-waste remains the easiest method to set up a feasible business model. Accordingly, prices of e-waste purchased from collectors is challenging to generalize. The price of each type of waste varies based on its metal content. The average price per ton of e-waste (prior to dismantling) varies between 25,000 EGP to 50,000 EGP. Variation of pricing also comes from the lack of awareness of the actual value of each part of the e-waste. Sellers and buyers might not be aware of the metal content of certain types of e-waste. Hence, they might under or over value it. Startups and SMEs need to be fully aware of the value of the e-waste they are purchasing. Accessing e-waste from auctions can provide a cost-effective supply, however this would be more cash intensive. The informal and semi-formal collectors dominate the two collection streams from (1) industrial and commercial facilities, as well as (2) auctions. However, most recently a number of regulatory changes are under progress to favour formal firms accessing the supply of e-waste, in particular through auctions[34]. Finally, the untapped waste from households will need innovative collection mechanisms, which might include incentives and leveraging social commitment.

[33] *As reported by interviewed companies and experts.*

[34] *Will be discussed in details in the policy report*

Market size and features. The e-waste generated annually worldwide is 44.7 million tons, of which only 20% is collected[35]. If the value of the market only focuses on collection and dismantling, Egypt's untapped market potential for export based on the estimated sourcing and dismantling capacity of 80,000[36] tons/year, would reach a value of 5.6 billion EGP annually. In case Egypt forms a well-established e-waste market, the international prices of material extracted from e-waste will determine the price of each component and type of e-waste. However, this level of efficiency and formalization of the market is not yet reached. Therefore, it is recommended to focus on the current opportunity of selling RAM chips and PCBs. Revenue on selling plastic frames would be part of the earnings albeit of limited value. PCBs' current market price is at approx. 80,000 EGP/ton, while RAM chips sell at 150,000 EGP/ton. Metal pieces, which can be dismantled manually, are sold at about 2000 EGP/ton, whereas plastic frames would sell for 800 EGP/ton.

The value added comes from effectively and accurately dismantling e-waste, in addition to the capacity to acquire the e-waste containing high value-added components from collectors. Since the products, whether mixed, sorted or dismantled, have a fixed market price and are in high demand, there is no upper limit to the amount the local firms or international markets can absorb.

MARKET OUTLOOK

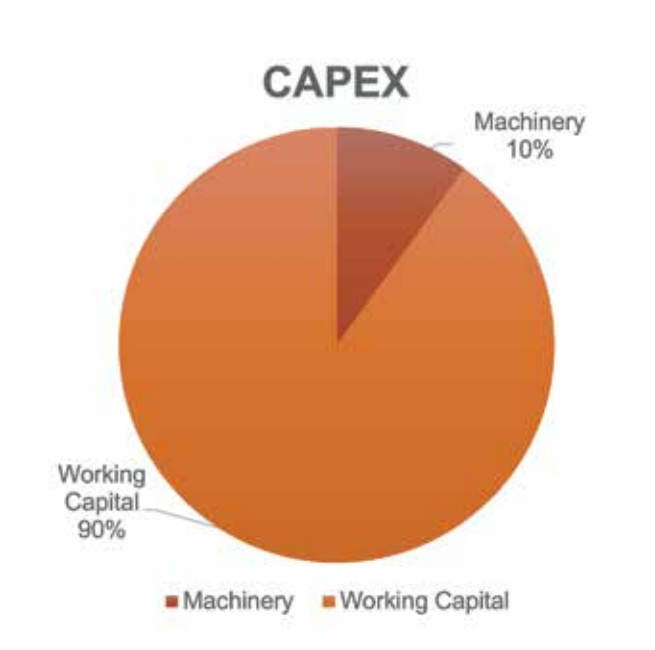
Production Capacity:	Function of labor
Available Supply:	80,000 ton / year
1st year production:	60 ton / year
Local market value:	5.6 billion EGP / year

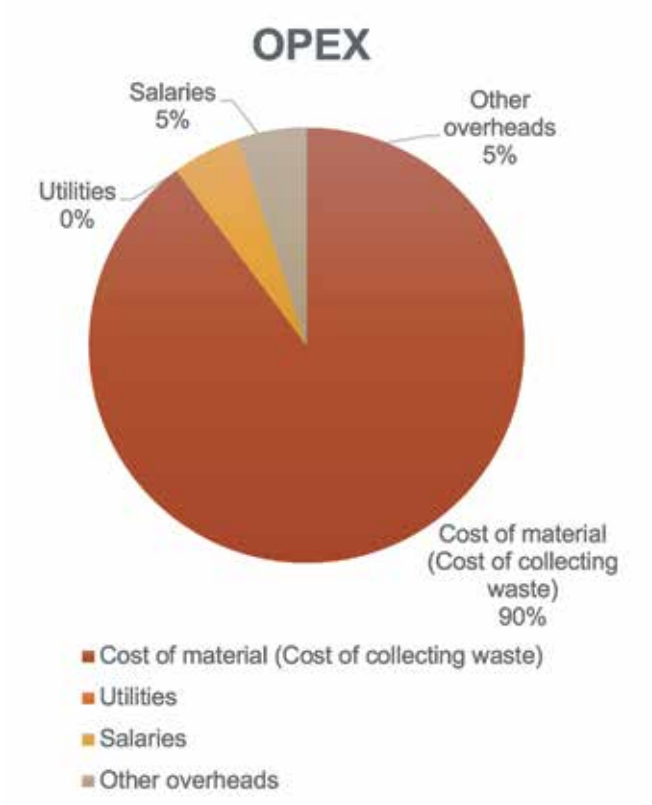
Financial features. The initial investment required is about 1 million EGP, 10% of which are fixed assets of mostly tools for dismantling and the rest is working capital. Unlike most business opportunities in the present study, the OPEX of the first year is about four million EGP. In comparison with the CAPEX, this business model has one of the highest OPEX. However, about 75% of the OPEX is in the cost of acquiring material. The business has an IRR of 63%. It is important to note that the financial features discussed can be maintained at few hundred tons annually, however scaling up would have different economic dynamics. Returns are likely to decrease as the amount of waste increases. In other words, it is a business opportunity that is easier to replicate rather than to grow. Nevertheless, there is room for multiple micro and small firms in the field of collection and dismantling. The payback period of the business is 3 years.

FINANCIAL OUTLOOK

CAPEX:	1 million EGP
1st Year OPEX:	4 million EGP
IRR:	63%
Profitability Index:	7.1
Payback period:	3 years
Net Present Value:	7.1 million EGP
Production Cost Yr1:	66,000 EGP / ton
Product Selling Price:	71,600 EGP / ton

[35] *Baldé, C. P. et al., "The Global E-Waste Monitor-Quantities, Flow and Resources" (the International Solid Waste Association –, 2017).*
[36] *Assuming the selling price per ton of dismantled e-waste is on average as 80,000 EGP*





The main challenge. The main challenge in this business opportunity is maintaining a strong relation with collectors, as entry barriers are limited. The competitive edge is having profound know-how on the metal content of many waste streams and perhaps focusing on continuous trainings in order to maintain an effective workforce. If direct export channels were to be built, contractual agreements and quality control would become a major challenge for this business opportunity. In addition to the risk of securing supply, managing hazardous waste within e-waste is challenging. For instance, CRT screens and lamps contain hazardous components and should therefore either be disposed to certified recyclers or transported effectively to landfills through safe and secure means of transportation and disposal. This could increase the operating costs of the business opportunity.

Business Opportunity Factsheet: Sorting and dismantling of e-waste	
Market	
Final Product:	Dismantled e-waste
Required Inputs:	E-waste
Competing Products:	Local/ International precious metal suppliers
Process	
Type of Process:	Manual process
Technology:	Low-tech process (Waste collection, sorting, and dismantling through basic know-how)
Equipment & Material:	Basic tools
Human resources:	Manual labour, technicians, drivers
Advantages and Risks	
Competitive Advantage:	Available supply and simple operations
Barriers to Entry:	High needed working capital
Key Stakeholders:	Maintenance centres, governmental entities, commercial companies and informal collectors
Special Regulations:	Company should be registered and approve that they are selling their products to registered entity
Risks and Mitigation Measures:	Inability to deal with hazardous waste that come with E-waste like CRT screens, mitigation measure is good training for labour to know hazardous parts and how to deal with it
Economic Features	
Revenue Stream:	Exporting/sales of dismantled waste
CAPEX	12 million EGP
OPEX	1st year 4.3 million EGP
Geography	
Location of Supply:	Greater Cairo Area and Delta region
Preferred operation regions:	Greater Cairo Area and Delta region

WASTE TIRE TO CARBON BLACK

4.3.4 WASTE TIRE TO CARBON BLACK

Outlook on product and technology. The present business opportunity relies on the pyrolysis technology. Pyrolysis is a thermochemical process, which decomposes material at high temperature in the absence of oxygen and presence of catalysts. Hydrocarbon based material decomposes in the process into liquid fuels and carbon black. In a pyrolysis reactor, the waste is heated in the deficiency of oxygen with catalysts. The key elements of an effective production process are controlling the heat rate and the catalysts used. The amounts and types of catalysts are correlating to the waste stream. The more effective the pyrolysis process is, the higher the yield in products and by-products. Most pyrolysis technologies can handle mixed wastes of tires and plastics. However, the yield of carbon black and type of fuel oil produced would vary accordingly. Pyrolysis also produces syngas, which is mostly used in heating the waste. However, in case of excess, syngas is to be flared under effective treatment to adhere to emission standards.

In the present opportunity, waste tires, after removal of steel wires, can be treated through pyrolysis to produce carbon black and liquid fuels. Hence, the opportunity produces three products, steel wires, carbon black, and pyrolysis oil, of which metal scrap can be easily sold. Carbon black is a material in high demand by various industries including paint, dye, ink, tires, and plastics. The key clients in Egypt would be paint and ink factories, which can consume smaller amounts of carbon black supplied by startups and SMEs. Pyrolysis oil is a liquid fuel, which is similar to biodiesel and Mazut. Currently, it cannot be used in transportation means as fuel due to regulatory barriers. The regulations governing the production and trading of petroleum products do not officially permit the use of pyrolysis oil as a fuel in transportation. Similar fuels are currently used in brick industry, however without a clear framework or regulation limiting the market value and increase business risk.

Hence, the main revenue stream of tires treatment through pyrolysis is from sales of carbon black. Revisiting the regulatory framework to allow the utilization of pyrolysis oils could open further revenue streams in this opportunity. These regulations must take into consideration environmental aspects as well as market conditions. Pyrolysis treatment plants can be imported or sourced from local manufacturers.

Carbon black comes in various subtypes such as acetylene black, channel black, lamp black and thermal black

Access to supply. The waste tires are generated mainly in vehicles maintenance centre and in large industrial plants. The annual amount of waste tires in Egypt has been estimated at 20 million tons[37]. Yet, this number is likely higher and it could represent the stock of waste tires accumulated over the years. Another estimate of waste tires annually generated could be deducted from the number of vehicles in Egypt. This estimate will give a figure of 564,000 tons of

[37] *Farrag Nermin Mokhtar, Ibrahim Vitta Abdel Rehim, and Elalfy Ayman Mahmoud, "APPLICABILITY OF USING RECYCLED RUBBER-TIRE MATERIALS FOR ACOUSTIC INSULATION IN BARRIERS OF RESIDENTIAL AREAS IN EGYPT," 2017.*

waste tires generated annually[38]. Waste tires can be accessed through large scale auctions by industrial facilities and major public institutions, e.g. city transport authorities and others. Further, waste tires can be purchased from collectors and traders. Due to higher concentration of vehicles in Greater Cairo Area, the majority of waste tires are present in its vicinity. Another hub of waste tires collection exists between Suez and Al-Sharkia. In addition, Qena is considered another centre for waste tires. It is very difficult to access waste from auctions directly, as it requires a large amount of cash and good coordination with the established traders. Again, as in many cases, purchasing the waste from traders and collectors is the most risk averse approach. Waste tires can be purchased as a whole or shredded. The price per ton of whole waste tires ranges between 500 EGP to 750 EGP excluding transportation fees. Shredded tires normally cost 150% of the cost of entire waste tires including transportation. Hence, it is recommended that the supply is a mix of tires and shredded tires with more focus on whole tires.

Sample of pyrolysis oil which is a by-product that can be used as fuel

[38] *Based on the number of registered vehicles in Egypt of 9.4 Million and assuming vehicles tires are changed yearly with average weight of tire 15 Kg. Source of number: CAPMAS*

Market size and features. Carbon black prices are pegged by international market prices. The local market size of carbon black is 187 million EGP annually, whereas Egypt's exports of carbon black amount to 3.2 billion EGP annually. Startups and SMEs are likely to target local markets as a start and then may explore export opportunities. In 2016, Egypt's local demand of carbon black was estimated to be approx. 24,000 tons with projected growth of 0.1% annually until 2021[39]. The entire locally available amount of waste tires would produce around168,000 tons of carbon black. The business opportunity assumes the utilization of about 1800 tons of tires annually, which is less than 1% of the available waste. Hence, the local carbon black market can absorb 13% of waste tires.

MARKET OUTLOOK

Production Capacity:	600 tons / year
Available Supply produces:	560,000 ton / year
1st year production:	250 ton / year
Local Market Value:	187 million EGP / year
Local market growth:	9% annually
Market value with export:	1.5 billion EGP / year

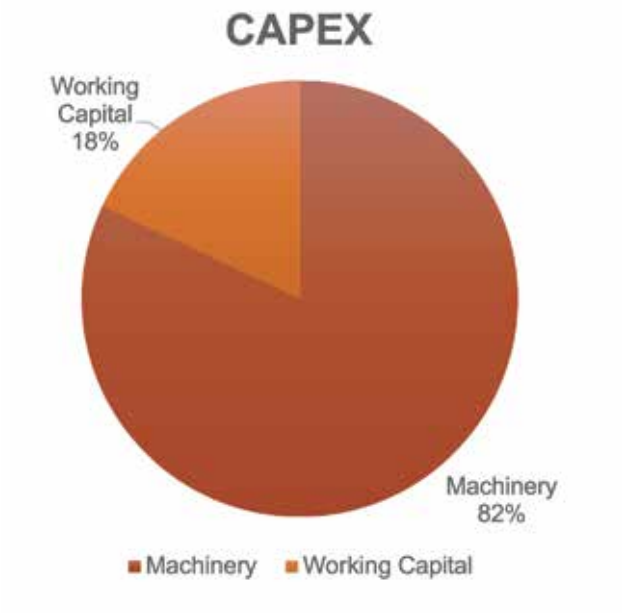
Financial features. The initial investment requires about 3 million EGP, of which 83% are fixed assets, e.g. mostly locally sources pyrolysis reactors and tire shredders, and the rest is working capital. The OPEX in the first year is about 1.4 million EGP. In comparison to the CAPEX this is one of the businesses with moderate OPEX. Only 25% of the OPEX is in the cost of acquiring material. Cost of labour is about 35% of the OPEX, which makes it one of the highest labour cost intensive opportunities. Most of the labour will focus on dismantling steel wires from waste tires, shredding the tires, loading, and unloading the reactor. Operating the reactor requires very limited labour, however qualified chemists and chemical engineers must follow up on the reactor. The payback period is 2.5 years.

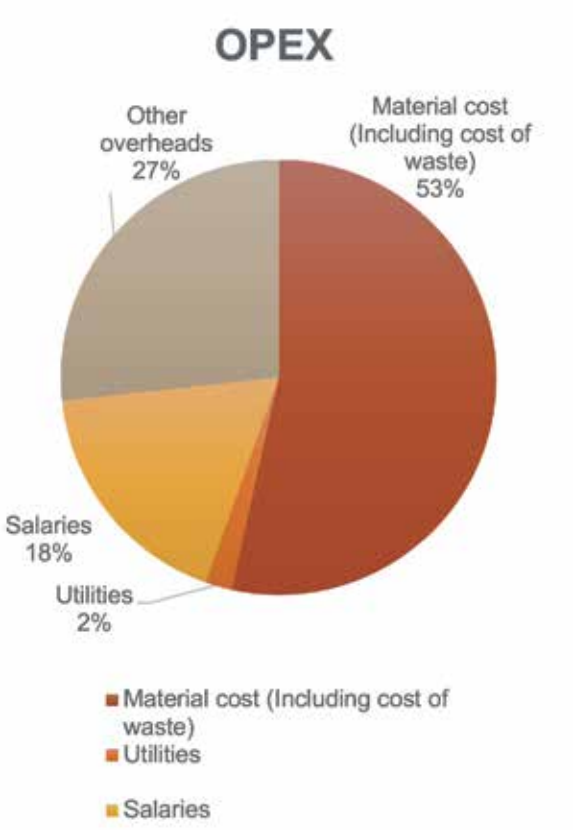
Based on the market size and required investments, the business would have an IRR of 64%. As production volume increases, higher efficiency reactors can be imported. The needed waste tires are assumed to be purchased at 850 EGP/ ton with the opportunity to achieve lower prices, depending on supplier relation. The conversion factor to carbon black is about 1/3, which means that a ton of carbon black requires 2250 EGP in waste tires and can be sold for about 8000 EGP/ton locally.

FINANCIAL OUTLOOK

CAPEX:	3 million EGP
1st Year OPEX:	1.4 million EGP
IRR:	64%
Profitability Index:	6.7
Payback period:	2.5 years
Net Present Value:	18 million EGP
Production Cost Yr1:	5,300 EGP / ton
Product Selling Price:	8,000 EGP / ton

[39] *Notch: Carbon Black Global Outlook 2017*

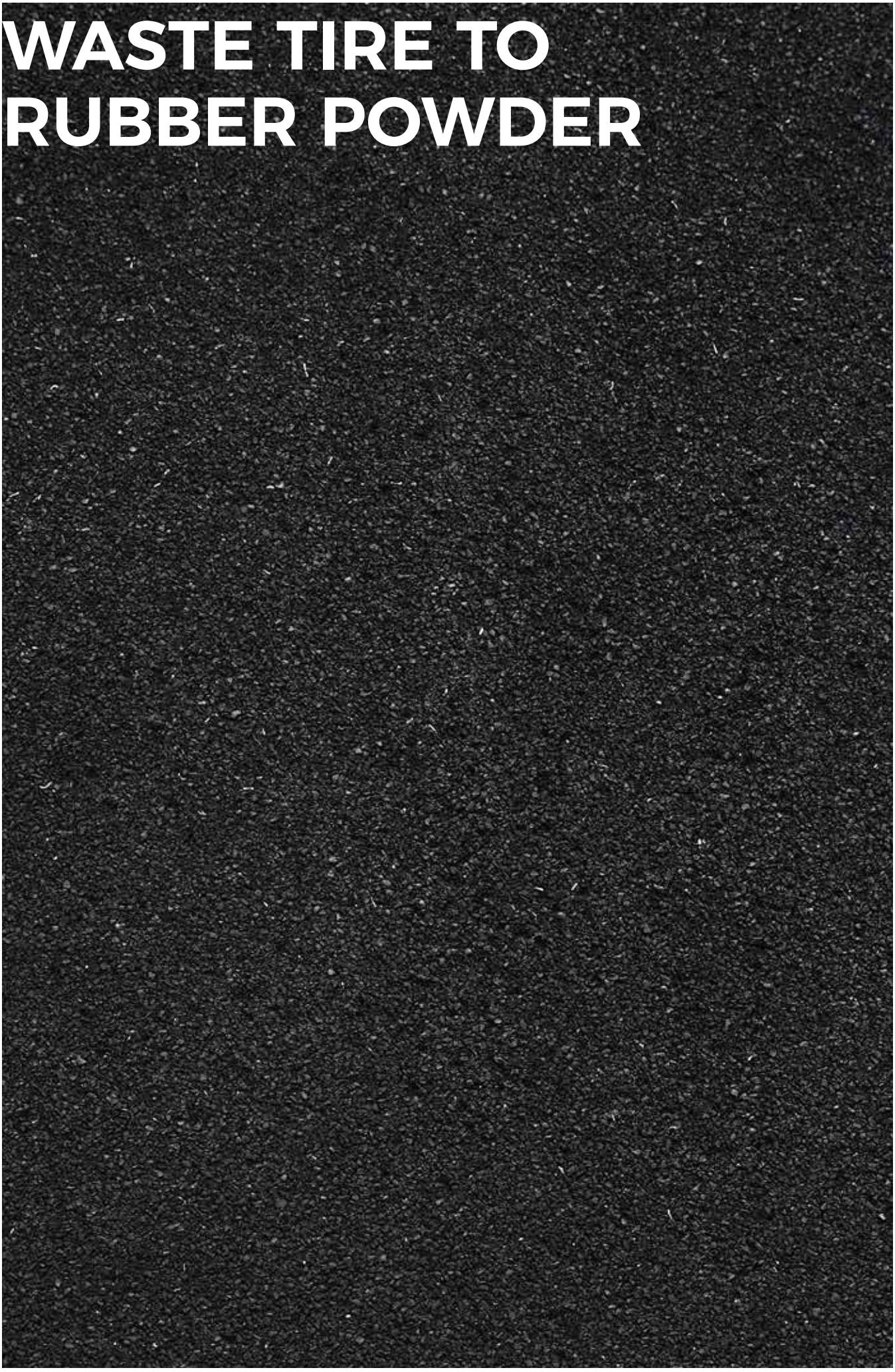




The main challenge. The main challenge in this opportunity is maintaining high environmental as well as health and safety standards in the operations and production. The process of manually handling tires requires a high level of quality control to protect workers from injuries, especially since the syngas flaring can produce SOx and NOx. Therefore, the syngas must be properly treated to ensure environmental compliance. Maintaining the product quality under variations in supply is crucial. Investments in product testing, health and safety officers, and quality control systems can overcome such challenges.

Business Opportunity Fact Sheet: Waste tires to carbon black	
Market	
Final Product:	Carbon black and pyrolysis oil
Required Inputs:	Used tires
Competing Products:	Liquid fossil fuel mainly diesel and virgin carbon
Process	
Type of Process:	Advanced thermal technology
Technology:	Collection, shredding and pyrolysis
Equipment & Material:	Pyrolysis production line (Burners, Reactor, Catalyst Towers, Cooling Towers)
Human resources:	Technicians, skilled labour, engineers
Advantages and Risks	
Competitive Advantage:	Low cost local source for feedstock material
Barriers to Entry:	Securing supply of tires, getting license for transporting oil
Key Stakeholders:	Informal waste collectors, Ministry of Environment, Ministry of Petroleum and Mineral Resources, painting and ink factories
Special Regulations:	License of transporting pyrolysis oil
Risks and Mitigation Measures:	Weak ability to meet daily demand for tires waste that may lead to stop production. Mitigation measure is having high inventory that can cover many days of operations even if waste supply was not stable.
Economic Features	
Revenue Stream:	Selling of carbon black, in addition to liquid fuel as an alternative to diesel, selling pyrolysis oil-based solvents to factories and workshops using boilers running on diesel
CAPEX	3 million EGP
OPEX	1st year 4.3 million EGP
Considerations	
Key Challenge:	Meets the quality level requirements, secure constant supply in quantity and quality regardless of seasonality
Advantages:	High demand of green wood in international market, in addition to competitive edge in quality and price locally
Geography	
Location of Supply:	Greater Cairo Area and Delta region
Preferred operation regions:	Greater Cairo Area and Delta region

WASTE TIRE TO RUBBER POWDER



4.3.5 WASTE TIRE TO RUBBER POWDER

Outlook on product and technology. The opportunity focuses on selling powdered waste tires. Through simply crushing and granulating waste tires and after the extraction of steel wires waste tire powder is produced. Powdered tires can act as a replacement of virgin rubber used in manufacturing of many rubber products or even in the production of new tires. It can also be sold as high quality Tire Derived Fuel (TDF) to energy intensive industries as alternative fuel. The technology is simple and does not requires high level of experience. Steel wires are extracted manually or using machineries, such as debidders and magnets in the shredding process. Tires are then shredded and granulated through mechanical processes. The machinery can be manufactured locally, yet imported alternatives have a higher efficiency and a longer lifetime. Powdered tires can be integrated in products including parking stoppers, automobile floor mats, speed bumps, carpet padding or underlay, flooring materials, patio decks, railroad crossing blocks, livestock mats, sidewalks, rubber tiles and bricks, as well as vibration absorbers. In the future, this opportunity can be expanded by the startup or SME to produce the final product as discussed in the following business opportunity, as access to supply is almost identical to the previous opportunity.

Granulated scrap tires powder

Market size and features. The supply of powdered tires can be absorbed fully in the local market. In fact, Egypt imports about 13 billion EGP worth of rubber in various forms annually. However, powdered tires would not produce the specifications that can cover such a large market size. Powdered tires can replace about 1 billion EGP worth of imported synthetic rubber. Important to note, prices are pegged to the international price of virgin rubber. Usually, clients include a percentage of powdered tires with virgin rubber. Depending on the final product of the manufacturing facility, the specification of granule size and material is determined. In general, prices should be around 2,000 EGP/ ton based on such specifications.

Although, exporting powdered tires is possible, it is difficult due to challenges in meeting the required specifications and logistics. Egypt in fact imports only a limited amount of powdered tires. However, when the powder is sold as fuel, it could reach 100 EGP/ton. In terms of fuel, the powdered tires market would have an annual value of 530 million EGP/year. This means that the business can serve two markets; the energy and material and industry feedstock. Having the option of serving two markets increases the resilience and sustainability of the business. The diversification of markets should be done with a predetermined mix of products which serves the business strategy rather than responding to buyers.

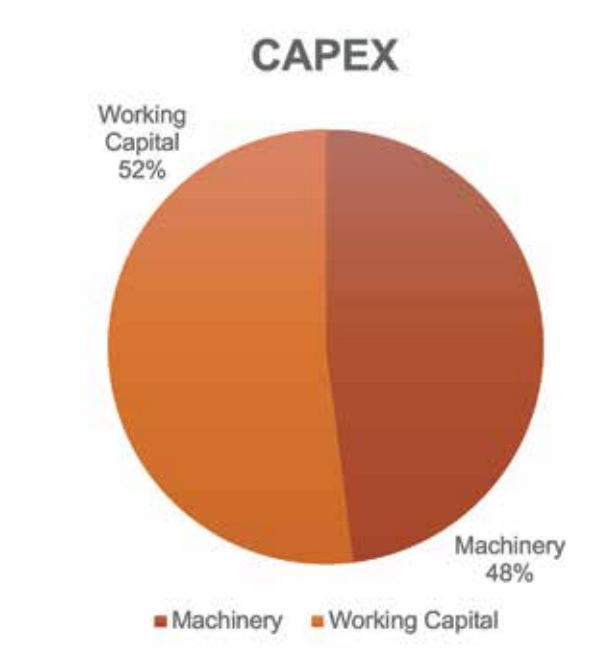
MARKET OUTLOOK

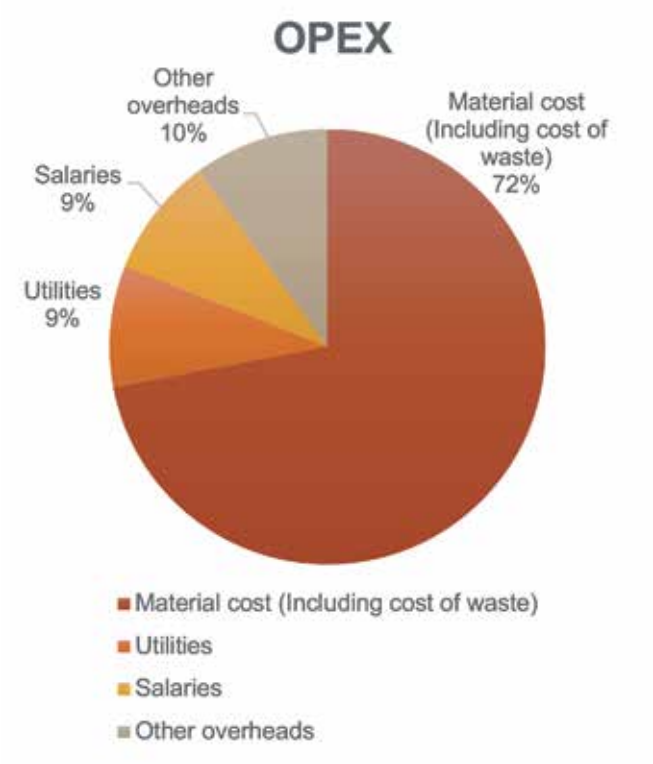
Production Capacity:	4800 tons/ year
Available Supply:	560,000 tons / year
1st year production:	3600 tons/ year
Local Market Value:	1 billion EGP / year
Local Market Value in fuel:	530 million EGP / year

Financial features. The initial investment requires about 4.1 million EGP, of which 48% are fixed assets, e.g. local tire shredders, metal separator, granulator, and the rest is working capital. The first year OPEX is about 5.8 million EGP hence, with comparison with the CAPEX this is one of the businesses with high OPEX. About 72% of the OPEX is in the cost of acquiring material. The high percentage of cost of material in the OPEX is mainly due to the low production cost and limited needs for hiring and utilities. The business would have an IRR of 30%, among the lowest in the present study. Tires are assumed to be purchased at 850 EGP / ton (despite lower prices can be achieved in the market). The cost of producing one ton in the first year is 1,330 EGP and could decrease to 800 EGP/ton, as production increases. The selling price would be 2000 EGP per ton for manufacturing facilities. The payback period of the business is 5 years. Growth in this opportunity is limited due to low margins and it is likely to be replicated by multiple micro firms than dominated by few large ones.

FINANCIAL OUTLOOK

CAPEX:	4.1 million EGP
1st Year OPEX:	5.8 million EGP
IRR:	30%
Profitability Index:	3.3
Payback period:	5 years
Net Present Value:	9.6 million EGP
Production Cost Yr1:	1,330 EGP/ ton
Product Selling Price:	2,000 EGP/ ton





The main challenge in this opportunity is keeping industrial clients regularly supplied with powder while maintaining quantities and quality agreed upon in contracts. This would mean the supply sources must be diversified as much as possible. The IRR of the present business is quite low and growth by increasing production is cash intensive. Hence, growth of the business can be challenging. Similar to the e-waste business model, it is again a business that is easier replicated than grown. Rapid growth can be achieved by building upon this business opportunity and upgrading to pyrolysis or to production of final rubber products as discussed in the coming opportunity.

Business Opportunity Fact Sheet: Waste tires to rubber powder	
Market	
Final Product:	Rubber powder and steel
Required Inputs:	Used tires
Competing Products:	Natural rubber
Process	
Type of Process:	Mechanical process
Technology:	shredding, granulating, steel separation and packing
Equipment & Material:	Shredder, granulator, Steel separator, packing machine
Human resources:	Manual labour and engineers
Advantages and Risks	
Competitive Advantage:	Low cost alternative for virgin rubber and high energy low cost alternative fuel
Barriers to Entry:	Securing a continuous level of raw material supply with fixed prices satisfy high demand of factories
Key Stakeholders:	Transportation companies, car service centres & tyres recycling
Special Regulations:	NA
Risks and Mitigation Measures:	To ensure the end product specs with the required standards. Mitigation measure is having accurate
Economic Features	
Revenue Stream:	Sale of rubber powder to tires recycling factories that produce tires or rubber or energy intensive factories
CAPEX	4.1 million EGP
OPEX	1st year 5.8 million EGP
Geography	
Location of Supply:	Greater Cairo Area and Al-Sharkia, Suez, and Qena
Preferred operation regions:	Greater Cairo Area and Al-Sharkia, Suez, and Qena

WASTE TIRE TO RUBBER PRODUCTS

4.3.6 WASTE TIRE TO RUBBER PRODUCTS

Outlook on product and technology. Many products, which use virgin rubber as a raw material and can use recycled tires instead. Out of the products discussed in the previous subsection, the easier products to produce include automobile floor mats, exercising and playground mats as well as tiles. The idea behind recommending these products is that they are easier to produce, unlike speed bumps, they entail lower liability than other products, such as shock absorbers, and can be sold in small quantities. The startup or SME can choose its favourable product mix based on its strategy of operation and capacity. Careful market analysis is needed to choose which product are best to produce. Hence, the above are merely recommendations. This opportunity is likely to come as an expansion of the previous two business opportunities. Here, the startup or SME moves from the market of material and industry feedstock to consumer products. The client is likely to be a retail outlet. In return, the IRR is at 88% and thus is much higher than the two previous opportunities serving the waste tire stream.

The key technology used is vulcanization which is a chemical process. Steel wires are separated from tires and sold as scrap steel as a by-product and a valuable waste stream. The tires are then shredded and granulated. Vulcanization refers to heating the material in the presence of Sulphur and other accelerators. The process could include control agents to inhibit vulcanization. Thereafter, compression moulding is used to produce the final product. Mixing with virgin material might be required to meet certain client requirements. The vulcanization system is best imported. Access to supply is similar to both previous opportunities.

Sample product from waste tires

Market size and features. The powdered tires can be absorbed fully in the local market of rubber products. Egypt's local market of rubber products is at least 65 Billion EGP worth annually. If all waste tires were transformed into rubber products it would have a market value of 3.6 billion EGP. Hence, it is safe to assume that the local market can absorb most of the waste tires. The product type depicts the market dynamics and it is therefore difficult to generalize. The edge is mainly in the cost advantage of replacing virgin rubber with recycled material. The material is produced at about 3,500 EGP/ton in the first year of operations and could reach lower values. However, the selling price of 10,000 EGP/ton would be competitive with virgin rubber material. Significant value could be added if the product was marketed as a green, recycled product for niche clients.

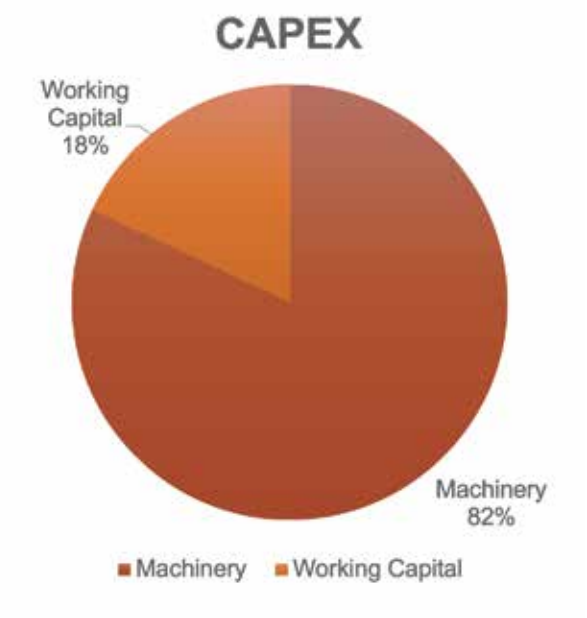
MARKET OUTLOOK

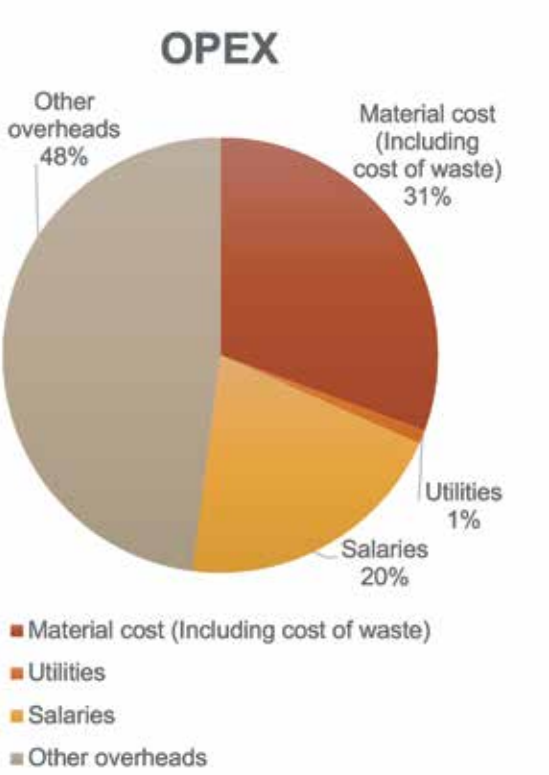
Production Capacity	1,800 tons/year
Available Supply	560,000 tons/year
1st year production	600 tons/year
Local Market Value	3.6 billion EGP/year

Financial features. Initial investments required is about 4.8 million EGP, of which 82% are fixed assets (e.g. local tire shredders, metal separators, granulators, and imported vulcanization equipment) and the rest is working capital. The OPEX in the first year is about 2.7 million EGP and in comparison with the CAPEX this is one of the businesses with low OPEX. About 31% of the OPEX is in the cost of acquiring material. The low percentage of cost of material compared to the two previous waste tire opportunities is due to the limited amount of material required for operations, in addition to the high percentage of other OPEX items. Labour cost is higher since more skilled labour force is needed, including chemists and engineers. According to the underlying of this study, the business would have an IRR of 88%. Tires are assumed to be purchased at 850 EGP/ton, with the potential of even more competitive prices in the market. The cost of producing one ton of the rubber products in the first year is 1,500 EGP/ton and the selling price could reach up to 10,000 EGP/ton. The payback period of the business is 2.5 years.

FINANCIAL OUTLOOK

CAPEX:	4.8 million EGP
1st Year OPEX:	2.7 million EGP
IRR:	88%
Profitability Index:	14.1
Payback period:	2.5 years
Net Present Value:	63.6 million EGP
Production Cost Yr1:	1,500 EGP / ton
Product Selling Price:	10,000 EGP / ton





The main challenge. The main challenge in this opportunity is choosing the right product mix and building strong marketing channels. Long-term sales contracts must be developed. This challenge should not be underestimated, as interruption in sales will be detrimental to the business.

Business Opportunity Fact Sheet: Recycled tires to products	
Market	
Final Product:	Parking stops, automobile floor mats, speed bumps and humps, and pipes vibration absorbers
Required Inputs:	Waste tires
Competing Products:	Virgin rubber source
Process	
Type of Process:	Mechanical process
Technology:	Process involving shredding, magnetic separation, pressing and vulcanizing
Equipment & Material:	Shredder, magnetic separator, rubber vulcanizing press
Human resources:	Technicians, skilled labour, engineers
Economic Features	
Revenue Stream:	Selling raw material for playground surfaces, parking stops, automobile floor mats, speed bumps and humps, and waste cans manufacturers
CAPEX	4.8 million EGP
OPEX	1st year 2.7 million EGP
Geography	
Location of Supply:	Greater Cairo Area, Al-Sharkia, Suez, and Qena – Urban
Preferred operation regions:	Greater Cairo Area (closer to market) – Urban

4.4 OUTLOOK ON FINANCIALS OF TOP RANKED BUSINESS OPPORTUNITIES

The top ranked opportunities vary in initial investment requirements (Figure 39). The internal rate of return (IRR)[40] and profitability index[41] of each varies as well. Some lower capital opportunities, such as the rubber products production has a high IRR and profitability index. The initial investments vary from 1 million EGP to 16 million EGP. For startups and SMEs with limited access to capital, business opportunities of high initial investments are not recommended, thus fibreglass and MDF production requiring investments of 16 million and 12 million EGP, respectively, might not be feasible. All other opportunities are below 4.5 million EGP of initial investments and thus more accessible for smaller businesses. The variety in capital investment needed, offer opportunities to investors, startups, and SMEs with varying appetite and resources. The e-waste opportunity has the lowest initial investment requirements, as it does not require investments in machinery nor high cost fixed assets. The process is mostly manual and relies on know-how and skills in sorting and dismantling. The fibreglass opportunity has the highest required initial investment and would only succeed at high production rates (Figure 39). Despite not having the highest IRR and profitability index, fiberglass production has the highest growth potential to serve the local market as well as export markets. The key factor in determining initial investments is not the working capital, but the technology complexity and requirements. Yet, in general, the market of material and feedstock has higher investment requirements than the following markets.

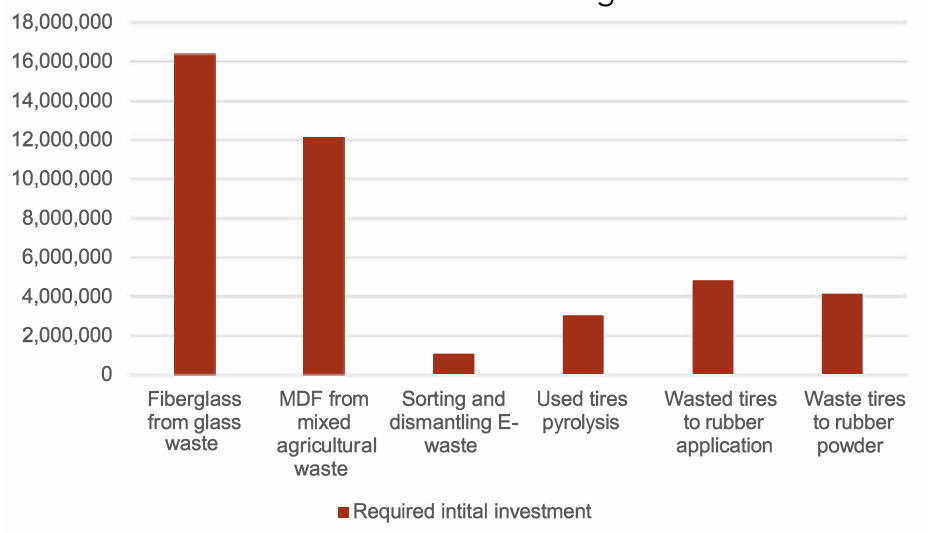


Figure 39: Required initial investment for business opportunities in materials, metals and precious metals from waste market

The IRR and the profitability index are shown in (Figure 40), it is important to note that these results are based on a five-years' time span and could be different if the analysis were done on a longer time span. The IRR of the opportunities varies between 30% and 90%. With most opportunities in the range of 60-70% IRR. For typical investment options, this IRR is considered quite high. Yet, in general, in most entrepreneurial endeavours such IRRs are common, particularly in the waste management sector.

[40] *Internal rate of return (IRR) is a metric used in capital budgeting measuring the profitability of potential investments. Internal rate of return is a discount rate that makes the net present value (NPV) of all cash flows from a particular project equal to zero.*
[41] *Profitability index: is an index that attempts to identify the relationship between the costs and benefits of a proposed project. Profitability index is an appraisal technique applied to potential capital outlays. The technique divides the projected capital inflow by the projected capital outflow to determine the profitability of a project.*

4.5 SOCIO-ECONOMIC AND ENVIRONMENTAL IMPACT

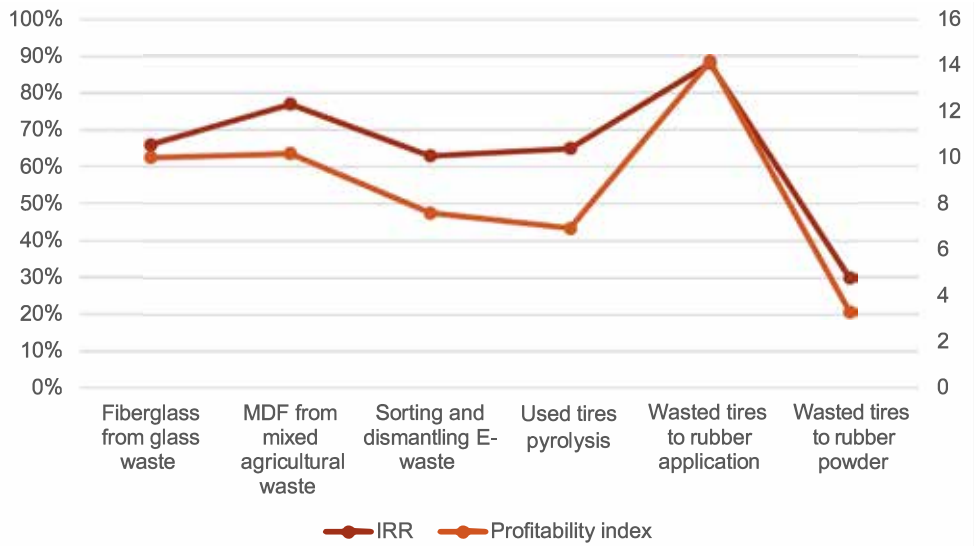


Figure 40: Internal rate of return and profitability index of for top ranked opportunities in materials, metals and precious metals from waste market

The IRR is not a function of initial investment size. In general, most opportunities have a comparable IRR, despite the higher variation in investment sizes. The fibreglass production opportunity has the third highest IRR, despite having the highest capital requirement. What mostly affects the IRR is the value added per ton of input material (Figure 41). This value added per ton of waste[42] in the MDF opportunity is by far higher than the others are, as the cost of agricultural waste is relatively low. The higher the value added, the higher the margins and the faster the growth is.

Aside from the financial indicators above, other qualitative parameters affect the favourability of the opportunity, including the business model, operating costs, and perceived market price of the waste stream compared to the product. In addition, what needs to be considered in the business decision is the growth potential as well as risks associated with the business. Furthermore, the feasibility of the business is sometimes determined by the geographical location in comparison to its clients and suppliers.

[42] *Value added per ton percentage of increase in price of product in comparison to price of input raw material. (Price of product - price of raw material) /price of raw material.*

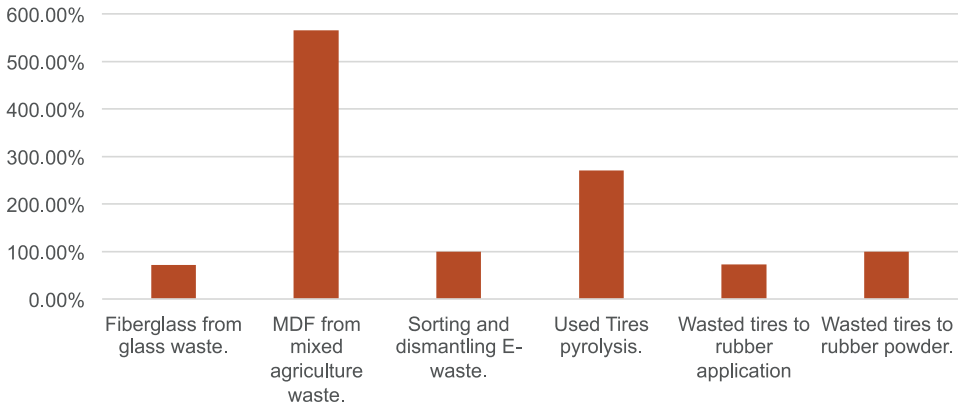


Figure 41: Value per ton of waste for top ranked opportunities in materials, metals and precious metals from waste market

Economic impact. The economic impact of the identified business opportunities can be summarized in the following three main points:

(1) Improving the country's trade balance through opportunities either replacing imports or eventually leading to export;
(2) Increasing the Egyptian industry competitiveness and sustainability by providing sustainable cost competitive alternatives to virgin material;
(3) Adding to the country's industrial GDP.

To quantify the economic impact, a critical assumption regarding the amount of waste to be utilized must be made. Generally, it is challenging for any market to recover almost all quantities of certain waste streams. In Egypt, once the waste has a "high enough" monetary value, the collection recovers most of the material. Therefore, the analysis is based on the assumption that all needed waste in the market is recovered. If export is considered, international markets are large enough to absorb most of the waste quantities, however export potential is not considered in the analysis. Indirect economic gains in terms of environmental protection are also not considered, albeit having a high value.

The product market size compared to the available waste must be taken into account when evaluating a business opportunity. The best outcome from an environmental and social point of view is when the market size is significantly larger compared to the amount of waste available. Hence, such markets can absorb most if not all of the waste stream, as in the case of the local market for waste tires. On the contrary, the MDF opportunity can only absorb 2% of the available waste streams. From a startup or SME point of view, it is difficult to make a generalization. At one extreme, when the market size is larger than the available waste, growth potential is high and market saturation risks are low. However, businesses need to make sure that the accessible amount of waste is enough to make an impact on their client's operation and hence extremely low quantities of available supply compared to market size is also problematic.

The ***fibreglass*** annual market value is 2.8 billion EGP and can absorb most of the glass waste. However, glass is currently being recycled effectively. Diverting part of the recycled glass to fibreglass will create higher value added products, but will not have a higher environmental impact compared to current glass recycling markets.

For ***waste tires*** opportunities, the market size varies between the different applications of waste tires. In general, the markets identified can absorb as much waste tires as collected and processed. From a technical point of view, the fraction of waste tires that reach landfills can hence be eliminated. This creates an annual market value of 1.5 billion EGP for pyrolysis and carbon black as well as 3.5 billion EGP for rubber products. It is important to note that tires are currently being used in productive activities, such as fuel for the cement industry and in the production of rubber products on a very limited scale. This means not all of the 3.5 billion EGP would be translated into added value to the GDP.

For ***MDF*** the local annual market size is about 1.7 billion EGP, however export potential is high and would add to the value significantly. Large amounts of agricultural waste are burnt or utilized in negligible value-added activities. Hence, the annual market value will be added to the GDP without diverting waste from other significant productive activities.

For the ***e-waste*** business opportunities to capture a high value added, recovery facilities must be established. On the other hand, recovery facilities require continuous operation with large amounts of waste to be profitable. Recovering facilities established in Egypt must be capable of acquiring most of the e-waste in Egypt and perhaps even from neighbouring countries to be profitable. The market value of 6.4 billion EGP can be added to the GDP, as all collected e-waste can be absorbed by the international market.

In short, the waste streams in the analysed opportunities can create a total annual market value of 14.4 billion EGP. Not all of this value will be in addition to the current GDP, since some opportunities divert waste to higher value-added activities. The opportunities could however reflect positively on the country's trade balance by 800 Million USD annually[43].

The social impact. The social impact of recycling can be seen through various lenses. We focus the discussion on the one that is easiest to measure and also the most urgent for the Egyptian economy; job creation. Other aspects of social impact are raising the sustainability of the sector through utilizing recycled waste by decreasing the reliance on virgin material, particularly imported material. It is difficult to definitely account for job creation, especially indirect job creation. However, the approach followed in this analysis is to account for jobs created in a single business and relating the number of jobs to tons recycled per business. Thereafter, an assumption is made that each ton of waste of the relevant waste stream creates a specific number of jobs, adjusted to the different settings. Most of the business opportunities presented can lead to export and hence larger amounts of waste will be recycled, which will in turn create further jobs. However, jobs due to export are not accounted for in the present study.

The ***fibreglass*** from glass waste business creates 20-30 direct business opportunities and about 500 indirect job opportunities in transportation and collection of waste[44]. If the full market demand for fibreglass were satisfied, its production would create 1,600 direct and 25,000 indirect jobs.

[43] *Assuming waste tires, MDF, e-waste replaces imports or goes to export, while fibre glass competes with local production*

[44] *Job creation in waste management sector can be calculated as an industry average which was estimated for Egypt to be about one direct job per 56 tons of waste by UNIDO in 2014 "Entrepreneurship in Waste Management". The markets targeted in the present study can absorb 13 Million tons of waste. Using the industry average this would lead to potentially 232,000 direct jobs. The approach followed in this study was to account for actual jobs which will be created in each market as per the business model assumed in the pre-feasibility analysis – this provides a number of jobs per ton in each market – follows the potential amounts of tons which each market can absorb was calculated and accordingly the number of jobs was calculated for each market. The total jobs calculated using this approach are 850,000 direct and indirect jobs.*

For ***MDF*** from agricultural waste, 5-6 direct jobs are created and about 200 indirect jobs. The limited number of direct jobs in comparison to indirect jobs reflects the business model, which relies heavily on outsourcing the collection and transportation of waste. Direct jobs are hence restricted to operating the production line, which is simple and not labour intensive. In order to meet market demand, about 200 direct jobs and 3600 indirect jobs would be created.

The sorting and dismantling ***e-waste*** business opportunity can create 15-17 direct business opportunities and about 5 indirect job opportunities in transportation. In order to cover the market needs, about 20,000 direct and 6,500 indirect jobs would be created. The waste tire markets can create 10-15 direct job opportunities per business and about 100 indirect job opportunities in transportation and collection of waste. If the demand for rubber powder were fully met, about 3,800 direct and 30,000 indirect jobs of additional employment were to be created.
Therefore, the market of material and industry feedstock markets can create approx. 25,600 direct full time jobs and 65,000 indirect jobs (could be part-time). The majority of direct job opportunities require skilled labour with a relatively high level of experience, while indirect job opportunities do not require skilled labour and can be easily learnt. Hence, the jobs serve a segment of the population struggling with employment.

Environmental impact. First and foremost, it is difficult to quantify the environmental impact of recycling businesses. The environmental impact of recycling is based on the creation of a market pull for the waste streams. This market pull encourages waste collection and divert it from reaching landfills, dumpsites, or of being burnt. In many cases, the productive use is more environmentally friendly than landfilling. However, distinction needs to be made between opportunities that divert a waste stream to a higher value added one and opportunities, which utilize a waste stream that is misused. For instance, fibreglass production utilizes waste glass, which is already well utilized in lower value-added recycling activities of mostly producing lower grade glass. Yet, when a higher value-added recycling activity absorbs the waste, it creates higher revenues for collectors and entities upstream of the value chain, which ensures effective collection. In some cases, the high value added activity also means better environmental impact. For instance, production of rubber products from waste tires is more environmentally friendly than burning tires in cement kilns as a source of fuel and even more environmentally friendly than the pyrolysis-based opportunity discussed in the present work. Given this frame of work, commentary about the environmental impact on targeted waste streams is discussed below.

For ***fiberglass*** production, the opportunity operates on a waste stream, which does not represent an environmental challenge in Egypt. The environmental impact comes from diverting this waste to proper industrial facilities where working conditions are better and revenues are high enough to ensure production activities to be carried out in a more compliant method. When it comes to waste tires, the situation is different.

Current uses of ***waste tires*** are significantly less environmentally friendly than the proposed activities in the present study. Especially compared to the reuse of tires in transportation after refurbishing, which negatively affects road safety. Again, pushing the industry to high value added activities would mean a market pull could divert waste tires to more environmentally friendly activities. Generally, the environmental impact of opportunities related to rubber production is more positive than opportunities of producing carbon black or the current utilization as fuel in cement kilns. The opportunities above can absorb the 0.5 Million tons of waste tires generated annually.

The ***MDF*** opportunity for the local market will have only a minimal environmental impact on agricultural waste management. The local market can only absorb less than 2% of the relevant waste stream. If corn stalk and bagasse were utilized, the impact on emissions would be minimal since these streams are rarely burnt. Finally, the ***e-waste*** opportunity will capture a waste that is currently unutilized and can absorb about 80,000 tons of waste. In all cases, the markets above can absorb collectively about 1.8 Million tons of waste annually in a more environmentally-friendly manner compared to current practices.

SECTION 5

FOOD MARKET

5.1 OVERVIEW OF THE MARKET

Serving one of Egypt's highest growing markets. The business opportunities discussed in the present section focus on the food market. Startups in this market either sell final consumer products or materials and additives to the food industry. The food industry is one of the largest and fastest growing industries in Egypt. In 2016, Food, beverages and tobacco sales reached 92 Billion USD, which is equivalent to approx. 1000 USD per capita[45]. The food industry serves both local and international markets. Most production facilities in the food industry rely on local agricultural produce. The industry leverages one of the key competitive advantage of Egypt, its high-quality agricultural produce. Egypt's food and beverage consumption has a high growth rate due to the increase of the population, of about 2.5% annually as discussed in section 2, as well as the increase of per-capita consumption. The local food market size is expected to reach 114 Billion USD in 2020 at a growth rate of about 5.5% annually[46]. BMI has projected that the per-capita consumption of food in Egypt will reach 9% in 2019. The opportunities in this section target final consumer products for retail and additives to be used by local food production facilities. While the food industry relies on local agriculture produce, various high value additives are imported and used in the production processes. These additives include flavours, chemicals, preservatives, among others. The opportunities in this section target biochemical additives that are otherwise mostly imported in Egypt. Agro-industrial waste can be utilized to produce various additives. In addition, vegetables and fruits that are considered second grade by retail due to shape and size, not quality, can also be utilized in productive processes.

Capturing the competitive advantage of local production. Food prices increased after the currency floatation in 2016 by about 25% in December 2017[47]. This drove the food industry to decrease its production costs in order to maintain competitive pricing. Hence, locally produced additives, which replace imported material, became a key element in cutting production cost. The cost of imported alternatives in EGP has almost tripled since 2014, due to the weakening of the EGP against the USD. Again, within the challenges of currency floatation and inflation, a competitive edge has been created for the waste management sector. Locally produced additives and products from waste, which replace imported alternatives leverage the lower cost of waste derived products compared to virgin produce as well as the advantages of local manufacturing versus imports. The situation is similar to the market of material and industry feedstock.

Forgotten waste streams to high value-added products. In the present section, forgotten waste streams are targeted. One of the forgotten waste streams is the waste of fruits and vegetables in the markets, which can be significant. The other is the organic fraction of agro-industrial waste. Most of this waste is either thrown in dumpsites or used as animal feed. This does not capture the true value of these uncontaminated waste streams. In fact, both streams should be considered high quality by-products, which are waiting to be captured.

[45] *GAIN report "Egypt retail foods", 2017*
[46] *Global Agriculture Information Network, Egypt Retails Food, 2017 – all information in the paragraph are based on the report*
[47] *Source: Trading economics*

5.2 KEY OPPORTUNITIES AND WASTE STREAMS

Key opportunities. The study identified three main business opportunities serving the food industry:

1. Citrus oil from waste citrus peel to flavours;
2. Pectin from waste citrus peel to jam industry;
3. Second grade tomato to dried tomato for retail markets.

The three selected opportunities represent a wider class of businesses that could be based on agro-industrial waste and rejected vegetables and fruits. The business opportunities address niche markets that are small in volume, yet high in economic value. The first two opportunities address the markets of additives for the food industry through citrus oil and pectin. The third addresses the food retail market through final products of dried tomatoes.

Waste Streams. Using waste in the production for the food industry, requires careful collection and separation at the source of its generation in order to avoid contamination. Accordingly, agro-industrial waste and waste at fresh produce markets[48] are considered of higher quality and easier accessible when compared to the organic fraction of MSW or agricultural waste. The waste is generated in a segregated manner in large quantities at centralized locations, which is favourable from a supply chain perspective.

One key stream of focus is second grade tomato, i.e. rejected tomato, at markets that represent at least 10% of the produced amounts of tomatoes in Egypt every year (equivalent to 800,000 kg[49]). This must be distinguished from the much higher amount of tomatoes, which are not being collected from the field and may amount to 30% of total produce[50]. The amount of agro-industrial waste is difficult to determine, however it is marginal compared to the total amount of industrial or agricultural waste in Egypt. The African Development Bank and the Egyptian National Cleaner Production Centre within the project "Green Growth: Industrial Waste. Management and SME Entrepreneurship Hub in Egypt" have developed an inventory of waste in the industrial zones of 10th of Ramadan and 6th of October, which is considered the first of its kind in Egypt. This inventory can address the breakdown of industrial waste by type. However, the business opportunities identified in the present study operate on very limited amount of production and would hence face little challenges in acquiring sufficient feedstock for production.

Features of the value chain. As in most value chains in waste management, the earlier stages close to the generation of waste are dominated by the informal sector. Highest level of formality is in industrial waste, where large scale collectors and traders directly interface with factories. The MSW collection and early stages of processing are dominated by the informal sector. Startups and SMEs are therefore advised to purchase waste from collectors instead of engaging in collection. However, in the case of industrial waste, direct contracting with factories is possible. Factories, which have a policy to ensure their waste is used in a productive manner, may prefer to contract recyclers. From a logistics point of view, it is easy to manage agro-industrial waste since it is generated

[48] *Waste of agriculture crops after going through industrial processes.*
[49] *FAO statistics*
[50] *UNIDO 2014*

with fixed quantities in a central location[51]. In case of rejected vegetables and fruits, direct collection is challenging and the supply chain is complex. Again, it is recommended for startups and SMEs to directly purchase waste from collectors. agro-industrial waste and waste from vegetables and fruit markets usually end in dumpsites or are utilized as a low value animal feed. For the right price, these streams can be shifted to higher value-added markets identified in the present study. The next subsection discusses the identified opportunities in the food industry.

AGRO-INDUSTRIAL WASTE TO BAKERY FLAVORS

5.2.1 AGRO-INDUSTRIAL WASTE TO BAKERY FLAVORS

Outlook on product and technology. Citrus oil is an essential oil, which can be extracted from citrus peels in liquid form with a high density and concentration. The oil can be used in many applications including pest control, food industry additives, or medical applications. The level of purity, concentration and quality control determines the product grade. Pharmaceutical grades are challenging and expensive to produce. In addition, the licensing procedures can be a lengthy process. The fastest grade to commercialize is the one serving as pesticide, yet the market is complex. The food grade option is the most recommended for startups and SMEs. Yet, selling the product as high-quality aroma and flavour to large factories is challenging, as large amounts of waste must be secured. The product which fits startups and SMEs is essential oils to be used by bakeries and dessert shops. This product allows firms to enter the market with less strict requirements, limited production capacity and hence less intensive capital investments than all other options. The used technology is cold pressing followed by extraction and filtration. These are all simple mechanical processes for which machinery can be locally manufactured.

Access to supply. The supply is generated at juice shops and factories processing citrus. The waste is commonly taken for free by collectors in exchange for the service of removing the waste. The waste represents a major problem for juice shops and factories, as it is generated at large quantities and accumulates rapidly at facilities. Storage of waste, which might rot, becomes a cost burden as well as a health risk. Hence, the timely collection service offered by collectors is crucial for factories and juice shops. Hence, they are willing to forgo the material for free in exchange for timely collection. Therefore, engaging in collection is not recommended due to the strict requirements by clients and challenges associated with logistics. Purchasing the waste from collectors is recommended. Collectors normally sell the waste or utilize it as animal feed. Sometimes the waste ends up at dumpsites, as it is perceived of low value, which is also reflected in the price. The market survey shows that the price can vary between 30 EGP/ton and 100 EGP/ton. The price of waste is likely to increase overtime once a significant market pull is created. Although in many cases operations can continue with free access to waste material, while only covering transportation. However, it is safer to assume that the price would settle around 100 EGP/ton in the financial planning. Operations require about 6 tons/month. With such low quantities, competition on supply will be limited and startups and SMEs can secure the waste amounts easily.

[51] *AFDB "Green Growth: Industrial Waste Management and SME Entrepreneurship Hub in Egypt", 2015*

Market size and features. The market size is expected to be 240 tons/year. The growth of the market can be taken as the growth of Egypt's food consumption of about 5.5% as discussed previously. The local market value is 17.8 million EGP and the international one around 7 billion EGP. To access a larger market share, upgrading the production facility and equipment would be necessary, in order to supply large factories instead of bakeries and dessert shops. The local market alone can absorb at least 240 tons/year of production compared to a projected 78 tons of production in the first year at only 33% of the market needs.

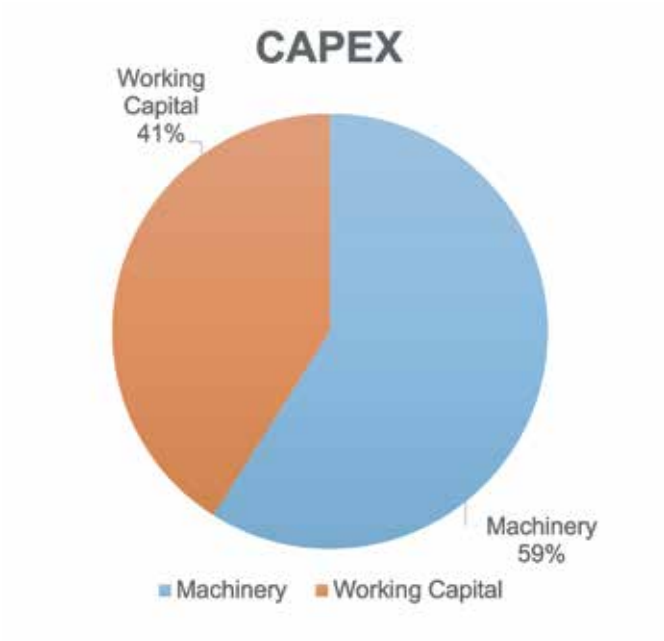
MARKET OUTLOOK

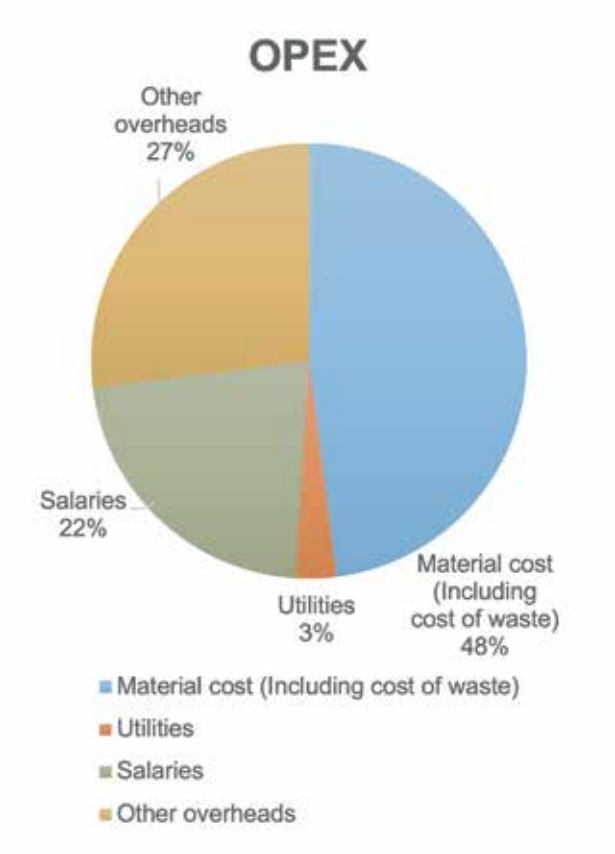
Production capacity:	105 ton/year
Available supply:	Large enough
1st year production:	78 ton/year
Local market size:	240 ton/year
International market size:	9,400 ton/year
Local market value:	17.8 million EGP /year
International Market	7 billion EGP/ year
CAGR	5.3%

Financial features. Despite what appears to be a timid amount of waste used in the present opportunity, the financial features are attractive. The initial investments are about 3.4 million EGP. About 60% of the initial investment is required to purchase the equipment, such as a cold press, an extraction and filtration machine. Equipment can be produced locally, except high quality filtration equipment, which could be imported. About 40% of initial investments is working capital. The OPEX in the 1st year amounts of 3.4 million EGP are high compared to the required CAPEX. About 48% of the OPEX goes to acquiring waste including transportation. The low percentage of material in the OPEX in comparison with previous opportunities is related to the higher requirements of operations, in terms of number and quality of labour as well as utilities. This is compounded by the low-cost waste stream. About 80 tons of product will be produced in the first year at about 65,000 EGP/ton and can be sold at about 75,000 EGP/ton. In the following years, the cost per ton produced can be decreased to 50,000 EGP. The IRR and profitability index are 57% and 6.1, respectively, which ranks this opportunity in the upper middle range for profitability of opportunities identified in the present study. The payback period of the business is 3.5 years.

FINANCIAL OUTLOOK

CAPEX:	3.4 million EGP
1st Year OPEX:	3.4 million EGP
IRR:	57%
Profitability Index:	6.1
Payback period:	3.5 years
Net Present Value:	17.4 million EGP
Production Cost Yr1:	65,000 EGP / ton
Product Selling Price:	75,000 EGP/ton





The main challenge. The main challenge in this opportunity is maintaining quality of both supply and product. The product quality will affect the flavour. Since the opportunity serves the food market, high food safety control measures must be considered. Quality of waste purchased must be controlled to avoid any contamination or spoiled batches. Strict rules for purchase and rejection of supply must be established with traders. Investing in testing of product and supply can mitigate the challenges in this market. Planning for a certain margin of defect products to be rejected by clients is also important.

Business Opportunity Factsheet: Agro-industrial waste to bakery flavours	
Market	
Final Product:	Citrus essential oil for food flavouring to bakeries and dessert shops
Required Inputs:	Orange peel, grapefruit peel, lemon peel, lime peel, tangerine peel
Competing Products:	Other suppliers of flavours
Process	
Type of Process:	Mechanical process
Technology:	Extraction process by; cold pressing, washing/cleaning, oil extraction, separation
Equipment & Material:	Containers, crusher, filters, purifier, refiner, and packaging material
Human resources:	Skilled labour, drivers, chemist, and machine operators
Advantages and Risks	
Competitive Advantage:	Increase value added of waste citrus peels to be used in various products
Barriers to Entry:	Collection of waste material, competition with artificial additives
Key Stakeholders:	Factories providing fruit peel waste, local waste traders
Special Regulations:	NA
Risks and Mitigation Measures:	Perfecting production technique and quality control in order to compete with synthetic flavours Mitigation measures are investing in R&D and gradual testing of the market and validation of supply chain
Economic Features	
Revenue Stream:	Sale of essential citrus oils
CAPEX	3.4 million EGP
OPEX	1st year 3.4 million EGP
Considerations	
Key Challenge:	Perfecting production technique and quality control
Advantages:	Increase value added of citrus waste
Geography	
Location of Supply:	Supply is mostly in urban Greater Cairo Area and Alexandria
Preferred operation regions:	Greater Cairo Area and Suez region

SPECIAL BIOCHEMICAL FROM AGRO-INDUSTRIAL WASTE

5.2.2 SPECIAL BIOCHEMICAL FROM AGRO-INDUSTRIAL WASTE

Outlook on product and technology. Pectin is a chemical substance in the peels of many fruits, but mostly citrus fruits. It can be extracted from citrus peels in the form of powder. Pectin is an essential input material for many food industries, such as jams, juices and sweets. Pectin can be used as a filling material for desserts and pastries. In this opportunity pectin is to be sold as feedstock for the food industry, particularly jam factories. In case of quality improvements, the target market could switch to pharmaceutical industries with much higher margins than in the food industry. The product also has a good export potential. In this business opportunity, pectin is produced from citrus peels using steam distillation. Steam distillation is a process that separates temperature sensitive material, such as aromatic compounds, biochemical and essential oils. Distillation is followed by extraction and separation. The final step is the drying process, after which the product reaches its powdered form. The powder could be mixed with additives to meet clients' specifications. The process requires experienced chemists. Production equipment can be produced locally for food grade production. The main revenue stream comes from selling pectin to jam factories.

Access to supply. The access to supply is similar to the previous market. However, focus should be given to agro-industrial waste where quality control is easier. Pectin is used in limited amounts by industrial facilities, thus low amounts of waste are needed (e.g. about 200 tons/year to operate profitably and meet client's demand). The low waste amount required simplifies the supply chain management.

Market size and features. The general market features are those discussed above for the food industry. In 2016, the pectin market in Egypt reached a value of 125 million EGP/ year with a growth of 5% annually since 2013. Production targets are 200 tons in the first year of production, which covers approx. 15% of the local market needs. The export potential is high. Egypt already started exporting pectin with limited quantities in 2017 to markets such as Libya and Kenya. The international market is growing rapidly at about 7%/ year. The available supply locally could not be assessed but it can easily meet export needs.

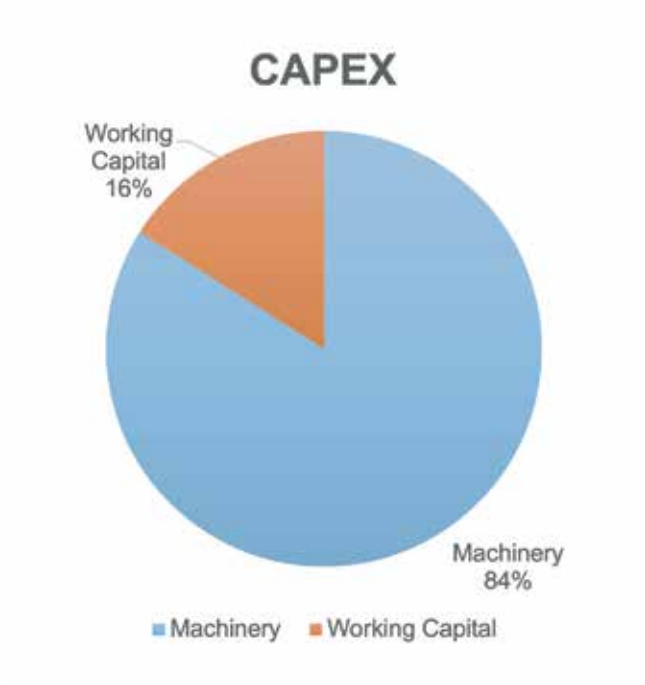
MARKET OUTLOOK

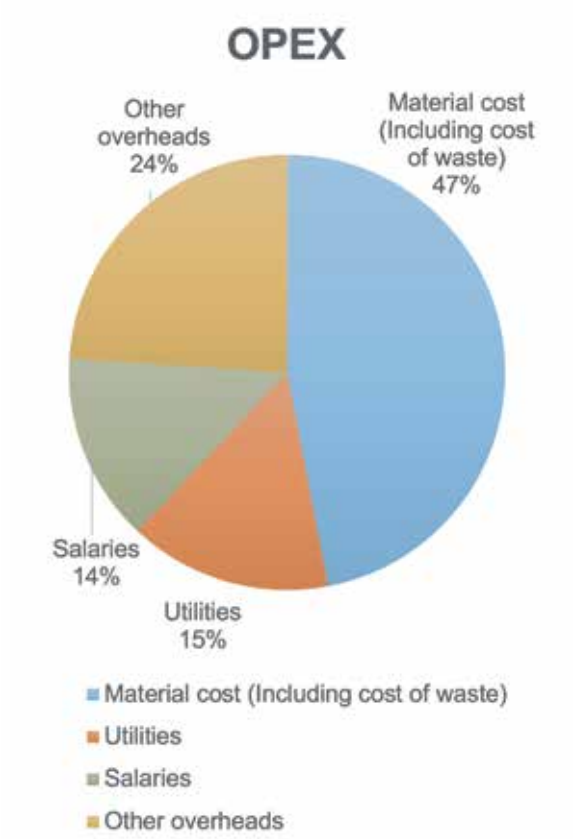
Production Capacity	269 ton / year
Available Supply	large enough
1st year production	202 ton / year
Local Market Size	1400 ton / year
Local Market Value	125 million EGP / year
International Market	15 billion EGP / year
Local market CAGR	5%
International CAGR	7.1%

Financial features. The opportunity requires an initial investment of 5.8 million EGP. The first year of operations requires 3.4 million EGP, which makes the OPEX relatively low compared to the initial investment. The initial investment is highly reliant on machinery and equipment cost. Machinery represents about 85% of the initial investment. In terms of OPEX, the cost of acquiring the waste including transportation is only at 48%. This is relatively low due to the high cost of utility and qualified/skilled labour force needed. The business is among those with the highest profitability in the present study. The IRR is 147% and the profitability index is 19.2. In the first year, the ton can be produced at 10,000 EGP and sold for 90,000 EGP/ton. It is one of the markets with the highest value added in the present study. The payback period of the business is approx. one year

FINANCIAL OUTLOOK

CAPEX:	5.8 million EGP
1st Year OPEX:	3.4 million EGP
IRR:	147%
Profitability Index:	19.15
Payback period:	1 year
Net Present Value:	105.8 million EGP
Production Cost Yr1:	10,000 EGP / ton
Product Selling Price:	90,000 EGP / ton





The main challenge. The main challenge in this opportunity is maintaining the quality of both supply and product. Since the opportunity serves the food industry, high food safety control measures must be considered. Quality of waste collected must be ensured to avoid any contamination or spoiled batches. Strict rules for purchase and rejection of supply must be established with traders. Investing in product testing and supply can mitigate the challenges in this market. Planning for a certain margin of defect products to be rejected by clients is also important. Another challenge is that growth would involve export, which requires further investment in meeting higher quality standards. It also requires building special export channels.

Business Opportunity Factsheet: Special biochemical from agro-industrial waste	
Market	
Final Product:	Pectin
Required Inputs:	By-products from the production of juice from ripe fruits (Citrus peels waste)
Competing Products:	Other suppliers of pectin and d-limonene
Process	
Type of Process:	Mechanical and thermal
Technology:	Extraction process by; steam distillation, washing/cleaning, drying, oil extraction, separation
Equipment & Material:	Washing tanks, rotary dryer, oil extractor (steam distillation), decanter
Human resources:	Skilled labour, drivers, and chemists
Advantages and Risks	
Competitive Advantage:	Competitive price
Barriers to Entry:	Collection of waste material, competition with the artificial additives
Key Stakeholders:	Factories providing fruit peel waste, local waste traders
Special Regulations:	NA
Risks and Mitigation Measures:	Perfecting production technique and quality control in order to compete with synthetic flavours Mitigation measures are investing in R&D and take enough time for trials at the beginning of production
Economic Features	
Revenue Stream:	Sale of Pectin and d-limonene
CAPEX	5.8 million EGP
OPEX	1st year 3.4 million EGP
Geography	
Location of Supply:	Supply is mostly in urban Greater Cairo Area
Preferred operation regions:	Greater Cairo Area and Suez region

SECOND GRADE TOMATO TO DRIED TOMATO

5.2.3 SECOND GRADE TOMATO TO DRIED TOMATO

Outlook on product and technology. The present section aims to draw the attention to the high market value of rejected vegetables and fruits, which represent an immense loss for the Egyptian economy. While there are multiple business opportunities in rejected produce, the present one is highly profitable and indicates the potential, which can be captured for the second rejected produce markets at large. Tomatoes are defined as refused or rejected when they are very small, smashed or over grown/ripe. Rejected tomatoes are normally disposed in wholesale markets in large quantities or in agro-industrial facilities. Rejected tomatoes can be dried to have a stronger flavour, better appearance and longer shelf-life. The dried tomatoes can be sold to restaurants or to final consumers through retailers. Dried tomatoes could also be packed and sold as snacks. Further, they could also be exported to many countries. The technology used is hot air drying. Chambers, which can take trays of sliced tomatoes, are constructed and lined with stainless steel. The chambers are heated with steam pipes through boilers. Automatic slicers can be utilized. Vacuum packing machines are then used. The process produces high quality dried tomatoes which is similar in texture and appearance to sundried tomatoes. The equipment can all be manufactured locally.

Access to supply. Rejected tomatoes are generated in large amounts at wholesale markets, such as Elobour for instance. Rejected produce is usually disposed through collectors for limited prices of 300 to 700 EGP/ton. At times, the rejected produce is handed over to collectors at no cost. Usually, the rejected produce from the markets are either sold as animal feed or disposed at dumpsites. As in previous opportunities, startups and SMEs can purchase the waste from collectors. In the case of operations being expanded, the rejected produce can be purchased directly from wholesale traders without having to go through the collector. In that case, traders can be asked to apply a more effective segregation of the produce to remove the reject and ship it off directly to the drying facility. This opportunity does not consider high quality produce that is not harvested due to variation of prices.

Market Size and Features. It is difficult to estimate the market size of such a niche product in Egypt. However, the general features of the market are expected to be those of the food and beverage market of Egypt. Egypt imports of dried produce reached 155 million EGP in 2016. Egypt has started exporting sun-dried tomatoes with limited quantities in recent years. This was initiated through UNIDO green trade initiative. The project has demonstrated the potential Egypt has in opening export market for dried agriculture produce. The world imports of sun-dried tomatoes are 41 billion EGP per year. Starting by targeting the local market then expanding to export is recommended. A key difference between the present opportunity and others in the study is that it serves a niche market. However, profitability can be gradually increased overtime, whereas growth opportunities mainly lie within export markets rather than increasing local production.

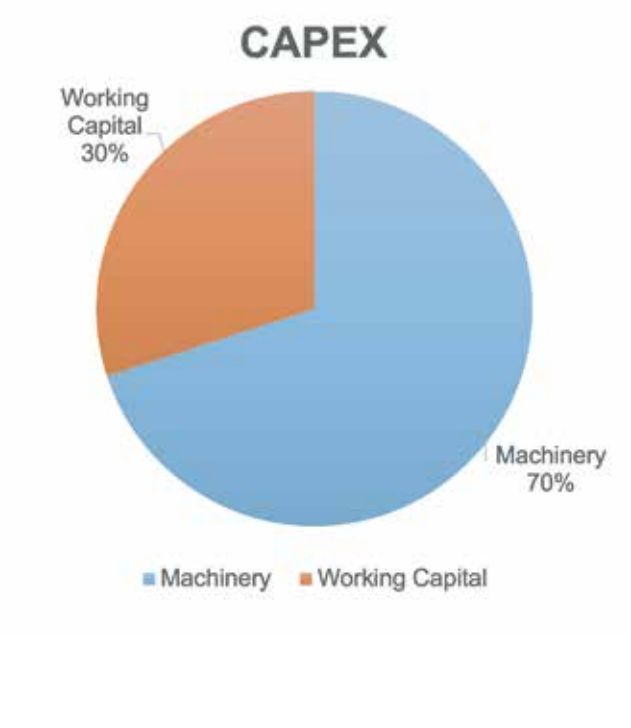
MARKET OUTLOOK

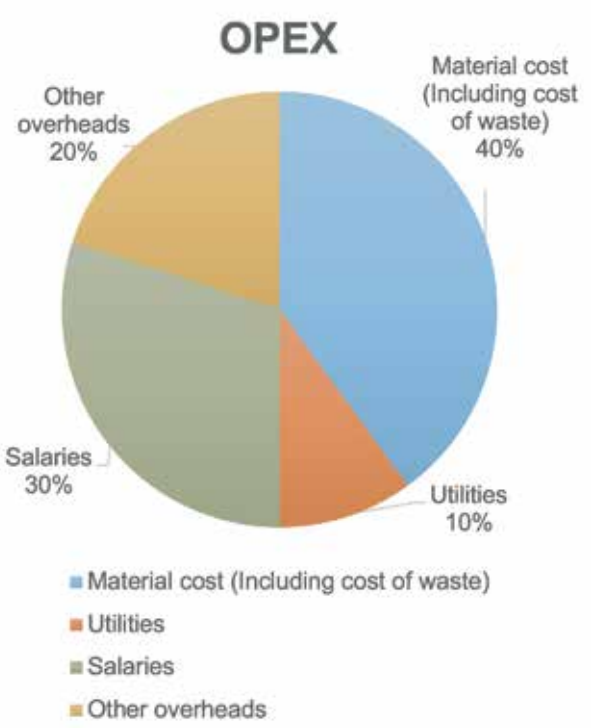
Production Capacity	36 ton/ year
Available Supply	800,000 ton/ year
1st year production	18 ton/ year
Local Market Size	--
Local Market Value	--
International Market	41 billion EGP/ year
Local market CAGR	5.5%

Financial features. The initial investment for this opportunity is among the lowest in the present study at only 390,000 EGP. The operating costs are 391,000 EGP in the first year, which makes it high relative to the initial investment. About 70% of the initial investment is in the cost of machinery. Acquiring the tomatoes including transportation costs is about 40% of OPEX, making it one of the lowest percentage cost of material. The material has an extremely low value and labour costs are significant. The labour cost is among the highest percentages of OPEX in the present study at about 30%. Manual labour is required extensively in washing, slicing and laying the tomatoes on the drying trays. Loading and unloading the trays into the dryer is also labour intensive. The IRR and the profitability index are 41% and 4, respectively, is ranking this opportunity on the lower side of profitability among the opportunities in the study. The ton can be produced at 10,750 EGP in the first year and sold for about 25,000 EGP/ton. The higher the quality and packing, the higher the selling price. With proper branding and quality control, the product can be sold for higher prices in niche retail outlets. The payback period of the business is 2.5 years.

FINANCIAL OUTLOOK

CAPEX:	390,000 EGP
1st Year OPEX:	391,000 EGP
IRR:	41%
Profitability Index:	4
Payback period:	2.5 years
Net Present Value:	1.3 million EGP
Production Cost Yr1:	10,750 EGP/ ton
Product Selling Price:	25,000 EGP/ ton





The main challenge. The main challenge is the fast transportation of the rejected tomatoes from the wholesale markets to the drying facility. Pricing of rejected produce must be strongly tied to its quality in clear agreements with collectors. In addition, the business should eventually purchase directly from traders. Another challenge is to ensuring and maintaining hygiene and food safety standards at all stages of the production. This can take place through investment into quality control measures and training of staff.

Business Opportunity Factsheet: Second grade tomatoes to dried tomatoes	
Market	
Final Product:	Dried tomatoes
Required Inputs:	Rejected tomatoes at wholesale markets
Competing Products:	Imported dried tomato
Process	
Type of Process:	Material handling – Thermal treatment process
Technology:	Collection – washing – drying - packaging
Equipment & Material:	Solar dryer, trays
Human resources:	Unskilled labour - drivers
Economic Features	
Revenue Stream:	Sale of dried tomato locally and export
CAPEX	390,000 EGP
OPEX	1st year 391,000 EGP
Advantages and Risks	
Competitive Advantage:	Low cost product with long shelf life
Barriers to Entry:	Highly uncontrolled operating conditions - Capacity per unit area of dryer is limited
Key Stakeholders:	Traders and equipment suppliers
Special Regulations:	NA
Risks and Mitigation Measures:	Marketing challenges as people are not familiar with similar product in Egypt. Mitigation measures are attempts to market the product before large scale production and strong business development
Geography	
Location of Supply:	Large vegetable markets but mostly in and around Greater Cairo Area
Preferred operation regions:	Greater Cairo Area

5.3 OUTLOOK ON FINANCIALS OF TOP RANKED BUSINESS OPPORTUNITIES

The three opportunities in the food market vary in capital investment. However, they are generally less than those in the market material and industry feedstock. The production of citrus essential oil, at an initial investment of 3 million EGP, is in the middle investment range (1 to 5 million EGP) identified in the present study. The dried tomatoes opportunity is among the lowest in terms of capital requirement at 390,000 (low range opportunities are below 1 million EGP). The initial investment in the production of pectin is about 6 million EGP, which is in the upper bracket of investments (5 to 10 million EGP). The uniqueness in the present market is that the cost of machinery represents less than 50% of the initial investment. This is due to the relatively simple machinery required in comparison with the material and feedstock or energy markets. The working capital is quite high, usually to cover the cost of material and salaries. The percentage of salaries and utilities is quite significant in the present market (about 30% of OPEX), due to the energy requirements in the production process and labour intensity. At times, a highly qualified work force is needed (Figure 42).

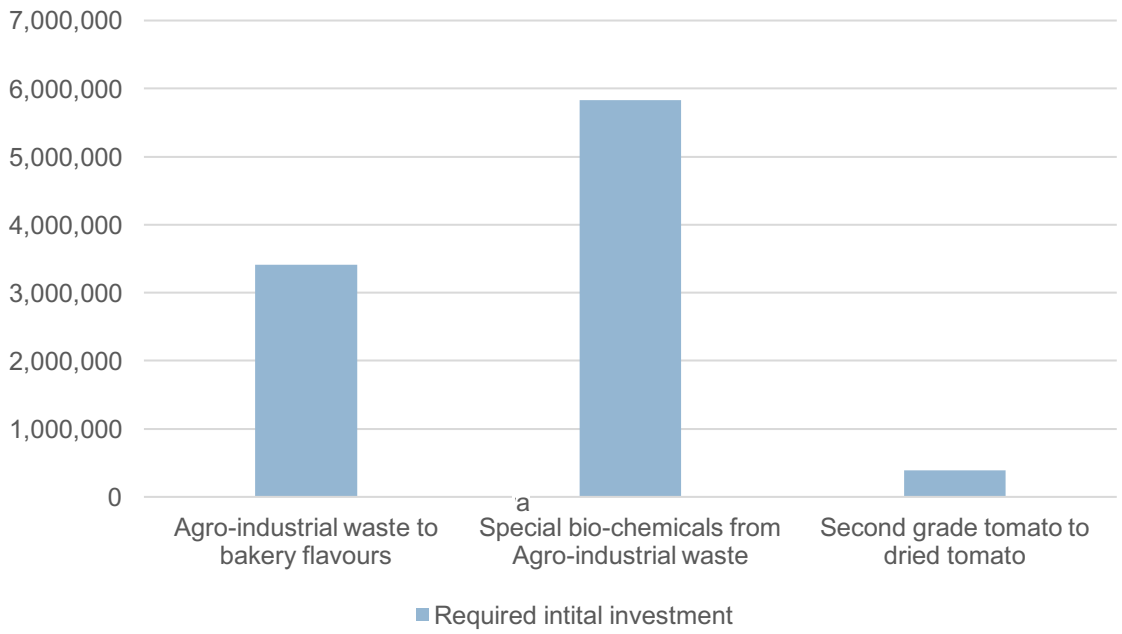


Figure 42: Required initial investment for top ranked business opportunities in the food market

In terms of profitability, the citrus oil opportunity is moderate, while the dried tomatoes opportunity is low. The production of pectin offers the highest IRR in the study. This is expected, since one of the lowest value waste stream is transformed into the highest value (EGP/ton) material in the present study. This opportunity demonstrates the range of value added that could be achieved in waste management by focusing on unique, advanced products.

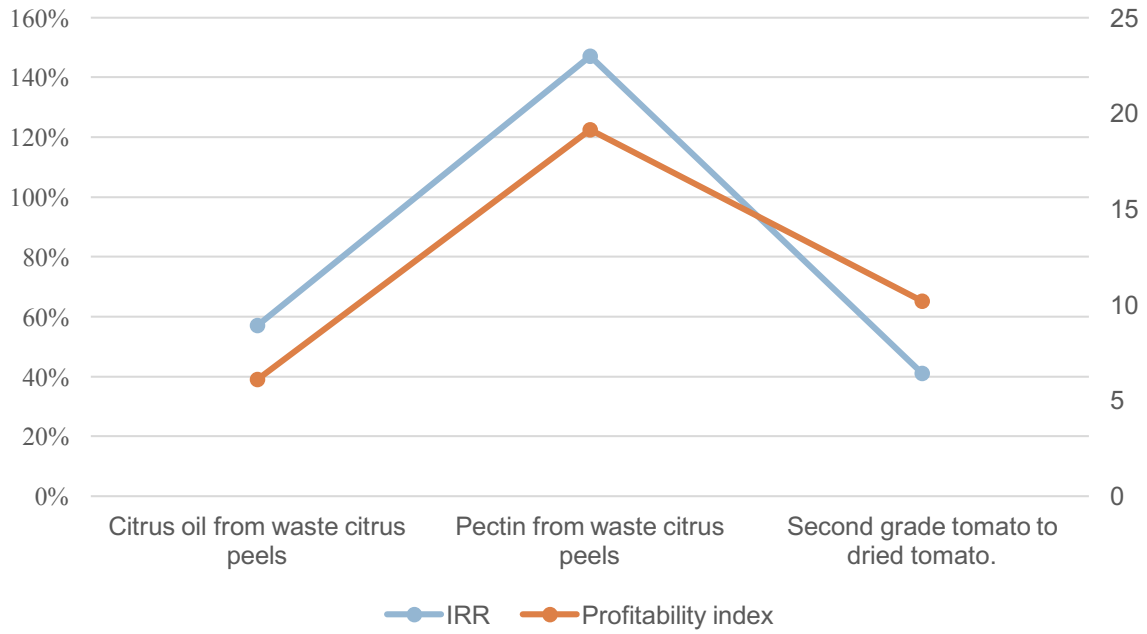


Figure 43: Internal rate of return and profitability index for top ranked opportunities in the food market

5.4 SOCIO-ECONOMIC AND ENVIRONMENTAL IMPACT

Economic impact. The opportunities in this market do not absorb large amounts of waste. The pectin and citrus oil are specialty products, which are in high demand yet in small quantities. Internationally, there is a shift towards relying on biochemical and natural additives in the food industry instead of chemical alternatives. The citrus oil can have an economic impact of 17 million EGP per year. However, in terms of export, the international market can absorb a net worth of 7 billion EGP worth of product. The pectin local market size is 125 million EGP/year and the international market can absorb a net worth of 15 billion EGP/year. Despite the limited economic impact on the local market, the export potential is high. Egypt exported a net worth of 355 million EGP of citrus oil in 2017. These opportunities represent specialty markets that can offer extremely high profits for the firms as discussed in previous sections. The dried tomato market is large in size. It is difficult to estimate how much of the dried tomato can be absorbed in the Egyptian market, as it is a new product. However, the available supply of 800,000 tons/year would have a value of 3.75 billion EGP/year as dried produce.

Social impact. The business opportunity citrus oil from waste citrus peel creates 9-11 direct jobs and about 5 indirect job opportunities in transportation. If all waste citrus peel that can cover the citrus oil market were collected and processed, this would create about 910 direct and 455 indirect jobs. The pectin from waste citrus peel opportunity creates 10-12 direct jobs are created and about 5 indirect business opportunities. If all waste citrus peel that can cover the pectin market were utilized, this would create about 55 direct and 25 indirect jobs. Thus, these two markets do not create high number of jobs, due to the limited market size in tons. Finally, the business opportunity based on dried tomatoes from second grade tomatoes creates 4-6 direct job opportunities and about 10 indirect job opportunities in transportation and collection of waste. If all waste second grade tomatoes that can cover the dried tomatoes market were utilized, this would create about 1700 direct and 850 indirect jobs.

The food and beverage from waste market alone can create approximately 2670 direct and 1350 indirect job opportunities. Majority of direct and indirect job opportunities do not require skilled/educated labour and can be easily learnt. Also, at least 25% of job opportunities could be suitable for female employment.

Environmental impact. The citrus peel waste, which is generated at industrial facilities, is not an environmentally challenging stream. The waste is normally collected from industrial facilities in a relatively professional manner and usually used as animal feed. Therefore, the identified markets can absorb limited amounts of such waste amounting to about 30,000 tons of citrus peel waste. However, the rejected tomatoes stream is a problematic one. The large amount of 800,000 tons may be sold as animal feed, yet considerable amounts reach dumpsites. Diverting this to a productive use has a significant environmental impact. It also helps raising hygiene standards at wholesale vegetable and fruit markets.

6.1 OVERVIEW OF THE MARKET

Fuel from waste. Each material holds an energy content that can be released in various ways. One of the most direct ways of releasing the energy content of a material is through combustion (i.e. burning). The energy content of fossil fuels, in either solid or liquid form, is released through burning. In fact, despite fossil fuels, most waste does have an energy content as well that can be released through combustion. Agricultural waste has been used as a source of fuel for baking ovens in Egypt. Despite burning rarely being the optimum way to recover value from waste, there are certain waste streams that are best utilized as fuel from a market point view. In the energy market, various sorts of solid fuel derived from waste can be used in the industrial sector. Startups and SMEs can provide the energy intensive industry in Egypt with solid fuel that can substitute coal, natural gas, and Mazut. Technically, waste derived solid fuel can be used in electricity generation for the steel, fertilizers and cement industry. In Egypt, as well as worldwide, the utilization of solid fuels derived from waste is most common, profitable, and environmentally compliant in the cement industry. The startups and SMEs in this market operate as energy companies supplying the cement industry with alternative fuel. Despite viewing themselves as waste management firms, startups and SMEs working in this market are more affected by the energy market rules and dynamics than any other market.

Growing market and a competitive advantage. The cement industry in Egypt is one of the largest worldwide (ranking 9th). In 2017, Egypt produced 58,000 tons of cement with a growth rate of 16% from 2013 figures, despite the economic slowdown[52]. Egypt is planning to expand licenses for cement production. The rapid population growth will ensure continuously growing demand on cement from the construction sector. The same applies to steel production, as it is highly tied to the construction sector. Egypt also has a strong fertilizer industry. All the above will ensure continuous increase in demand on waste derived fuels. The currency floatation and increasing demand on energy for both households and industrial use created high level of stress on the energy market in Egypt.

In 2010, Egypt was an exporter for natural gas, yet a net importer for energy. After 2011, Egypt faced increasing local demand and thus even natural gas was imported[53-54]. Today, Egypt is moving again towards being self-sufficient and a net exporter of natural gas, after recent discoveries of natural gas in the Mediterranean Sea. Yet, Egypt will remain a net importer of energy. In terms of fuel, Egypt has a gap between supply and demand, which is met by imports. Hence, energy prices and subsidies are highly reliant on the foreign exchange. The removal of subsidies and higher energy prices due to floatation has forced energy consumers to look for local sources, particularly when it comes to fuel. The Egyptian energy intensive industries either import coal or pay for locally supplied natural gas under a tariff tied to the

[52] *IFC, "Unlocking Value: Alternative Fuels For Egypt's Cement Industry" (IFC, 2016).*
[53] *"Bid to Be a Regional Energy Hub" (BNP PARIBAS, 2017).*
[54] *IFC, "Unlocking Value: Alternative Fuels For Egypt's Cement Industry."*

USD. Currently, for the same energy unit, waste can provide the industry with a cost competitive alternative that is less tied to the foreign exchange rate. Cement, steel, and fertilizers are all energy intensive industries, which represents a backbone for the national economy. As much as it is a challenge for them to meet their energy needs, as it is an opportunity for entrepreneurs, startups and SMEs to offer new, innovative solutions to the energy market from waste.

6.2 KEY WASTE STREAMS AND OPPORTUNITIES

In general, solid waste can be used after sorting and treatment as a solid source of energy, such as biomass and Refused Derived Fuel (RDF). RDF refers to solid fuel recovered from the rejected fraction of MSW. Further distinction in solid waste for energy can take place as in Tires Derived Fuel (TDF), which was discussed in the previous section, as well as solid recovered fuel (SRF). RDF is used as a general term covering all waste that can be derived from MSW and industrial waste, excluding tires. The pricing reflects the energy content in relevance to alternatives, such as coal and natural gas. Currently in Egypt, RDF offers industries the lowest cost of energy among available alternatives. Another source of solid fuel is agricultural waste, of mainly stalks and tree pruning, which can be used to produce bio-char. Despite being one of the lower value added options to utilize agricultural waste, bi-coal production is less capital intensive and does fill a market gap. Bio-char can also be used in domestic applications for barbeque, heating, and smoking devices.

Various technology options and waste streams. Waste can be transformed into solid, liquid, and gaseous fuel. Solid fuel is easy to transport and falls within a straight forward regulatory framework, unlike liquid and gaseous fuels, which are both more difficult to transform and are thus governed by a more complex regulatory framework, restricting trading. Waste can generate biogas for which there is current: no framework that

allows trading or injecting it to the natural gas grid. At current electricity prices, large scale utilization of biogas in electricity generation is not yet cost competitive. Waste can be used to produce liquid fuels, such as pyrolysis oils (discussed in the previous section) and biodiesel. Trading in biodiesel locally requires special licensing from the Ministry of Petroleum and Mineral Resources. Egyptian companies working in biodiesel rely mainly on exports. The framework related to utilization of pyrolysis oil is not clear. Hence, solid fuels remain the key option for large scale utilization of waste in the energy sector in Egypt, given the current framework[55]. Waste based solid fuels can come from various sources and are priced based on its calorific value.

6.3 IDENTIFIED BUSINESS OPPORTUNITIES IN THE ENERGY MARKET

Key opportunities. The process, through which the promising business opportunities are determined, is discussed in section 3. The identified opportunities in the energy market utilizes the key waste streams of MSW, industrial waste, and agricultural waste. There are multiple firms operating within these markets, yet the market size allows for new entries. The market also offers opportunities for sub-contractors to work through the existing players.

In the next sections, the following waste-to-energy business opportunities are discussed:

- MSW and industrial waste to sorted RDF for energy intensive industries;
- MSW and industrial waste to shredded RDF (preliminary);
- Agricultural waste Torrefaction to bio-char for energy intensive industries and domestic use.

Waste streams. Hence the key waste streams are:

- Stalks and tree pruning (about 400,000 tons can be captured annually)
- MSW and industrial waste (about 2.9 Million tons can be captured annually)

Features of the value chain. The same as for most value chains in waste management, the earlier stages close to the generation of waste are dominated by the informal sector. Among the streams above, agricultural waste remains as the one with most informality.

[55] *Utilization of biogas from animal manure is currently profitable given the utilization of energy is done on site – however, animal manure is not included in the present study as a waste stream.*

Highest level of formality is in industrial waste, where large scale collectors and traders directly interface with factories. Industrial facilities may require and prefer to operate directly with recyclers, who can ensure their waste has been handled properly. In MSW from households and commercial facilities, collection and early stages of processing mainly involve the informal sector. However, in the present market, the waste used for energy production (RDF) is the refused fraction of MSW (i.e. none recyclable waste). This means that RDF is likely to be captured at dumpsites and landfills. Therefore, these landfills and dumpsites are controlled by both formal and informal operators. Usually, the waste is sold for a flat fee with little regards to the energy content of whatever could be salvaged from the dumpsite.

The annual amount of agricultural waste is about 30 million tons. Agricultural waste offers a large potential waste stream for energy[56]. For instance, organic waste has a moisture content that is a concern in dealing with agricultural waste. Accordingly, it should be dried before being processed to be used as source of energy. The price of agricultural waste varies based on waste type and the amount of money that should be paid to the farmer in order to access the waste. The price of agricultural waste in the Egyptian market is not based on the calorific value of the waste stream, but rather on its perceived value by the farmer. Agricultural waste without alternative uses has a lower price. For example, corn stalks or palm tree waste have traditional productive uses and hence their price tends to be much higher than banana tree waste. In general, the average price per ton of agricultural waste is 100 EGP/ton, excluding cost of transportation.

[56] *Shredded and dried agricultural waste that is burnt as alternative solid fuel*

MSW TO SORTED RDF FOR ENERGY INTENSIVE INDUSTRIES

6.3.1 MSW TO SORTED RDF FOR ENERGY INTENSIVE INDUSTRIES

Outlook on product and technology. This opportunity focuses on sorting RDF from MSW. The business opportunity is in either selling it to RDF companies that shred it to increase its value or directly to energy intensive factories that shred RDF on site. The technology is simple, it relies on selecting waste material from dumpsites and landfills that are non-recyclables and controlling its humidity by sun drying or humidifying, if necessary. The challenges are within the segregation and sorting of waste material with the highest calorific value. The process can be done manually or through mechanical lines for segregation and sorting. After sorting, baling takes place to reduce volumes and facilitate transportation. The process of sorting is guided by maintaining a mix of waste with almost a fixed calorific value. Typically, sorted RDF can have a calorific value ranging from 3.1 to 3.6 Gcal/ ton. Since industrial waste has well-known and fixed properties, it can be transferred directly to energy intensive industries. In this case, the final consumer, startups or SMEs, must provide documentation for the industrial facility.

Access to supply. Two key streams serve this opportunity, (1) industrial waste, and (2) MSW. The cost competitiveness of RDF is determined by the natural energy content of the waste and the distance the RDF is transported. Industrial waste in Egypt is mainly concentrated in Greater Cairo Area, Alexandria, and Suez Governorates. These regional areas are also close to energy intensive industry consumers. Industrial waste is more likely to be accessed by a formal entity. Startups and SMEs may hence purchase the waste from formal collectors. However, unlike the previous opportunities, startups and SMEs may directly contract industrial facilities. Some industrial facilities would prefer their waste to be utilized by trusted entities in an environmentally compliant manner. Other entities may want to ensure that their waste/rejected products do not reach the market and are misused. Using the waste as fuel in a cement factory provides this assurance. The MSW is not purchased directly from collectors and traders since the fraction used in RDF represents the non-recyclables, hence the word "refused". This refused fraction can appear in waste sorting facilities that directly sells it to the industry or at dumpsites. To access the refused waste, interactions with municipalities are necessary. There are few formal landfills in Egypt, whereas most dumpsites are usually informally controlled by waste contractor. Access to the waste has to go through them, either based on a flat rate or in another form of partnership. The amount of refused waste that can be transformed to RDF is about 1 million tons annually[57], all of which can be absorbed as fuel in the cement industry. For RDF from MSW, the price varies from 100-150 EGP/ ton. The price of industrial waste that can be used as fuel is extremely difficult to decide. Therefore, the industrial facility might not charge any fees for the waste since its calorific value could potentially be low. In others, the facility pays to ensure its waste has been handled properly.

Geographically, the opportunities lie around urban centres, where large amounts of MSW is generated and enough proximity to cement factories ensured. This is the case in Greater Cairo Area, Suez, Menya, Assiut, and Qena. Cement factories in Qena are yet to absorb RDF, but preparations are under progress. The operations are likely to be in urban areas.

[57] *5% of annual generated amounts of MSW (conservative assumption). RDF production is expected to reach 1.3 million tons by 2025 IFC, "Unlocking Value: Alternative Fuels For Egypt's Cement Industry."*

Market size and features. The local market size is determined by the amount of waste that can be absorbed in the energy intensive industries. By 2025, about 2.9 million tons/year of RDF can be absorbed by the cement industry alone[58]. In total, Egypt's energy intensive industry can absorb 11 million tons of RDF annually, assuming the required quantity of RDF is available. The market size will continue to grow rapidly. The cement and steel industry are strongly tied to the construction sector, which in turn is tied to the population growth. Egypt's rapid population growth, high demand on real estate, as well as national housing and development projects, will ensure a rapid growth in the cement and steel industry. Despite the economic slowdown of 2013-2016, the cement production in Egypt grew by 16%. However, there are a few licenses granted by the government for new cement factories, of which recently three have already been granted and another 11 licenses are pending[59]. Egypt's consumption of natural gas and coal is rapidly growing. Egypt's consumption of natural gas and coal is rapidly growing. Natural gas consumption increased by 7.7% from 2016 to 2017, while coal consumption increased by 5% from 2016 to 2017[60]. This reflects the rising demand on fuel and hence would be reflected as well on the increasing demand of RDF.

MARKET OUTLOOK

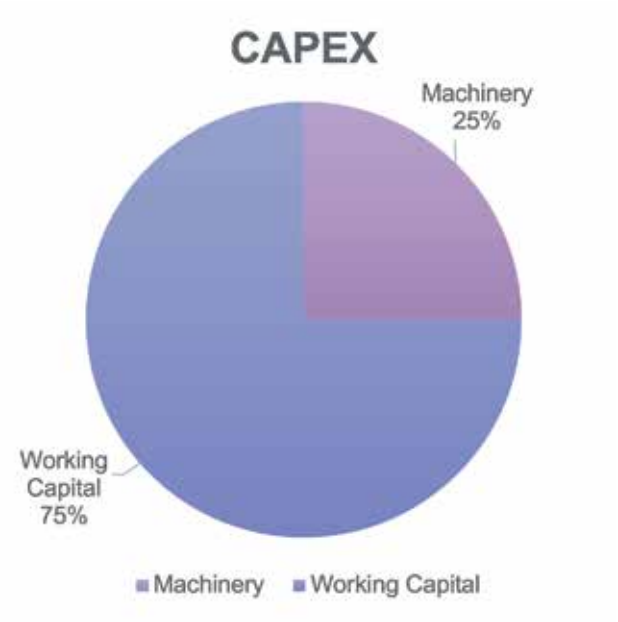
Production Capacity	12,600 ton / year
Available Supply	1 million ton / year
1st year production	9,450 ton / year
Local Market Size	1 million ton / year
Local Market Value	400 million EGP /year
CAGR	5%

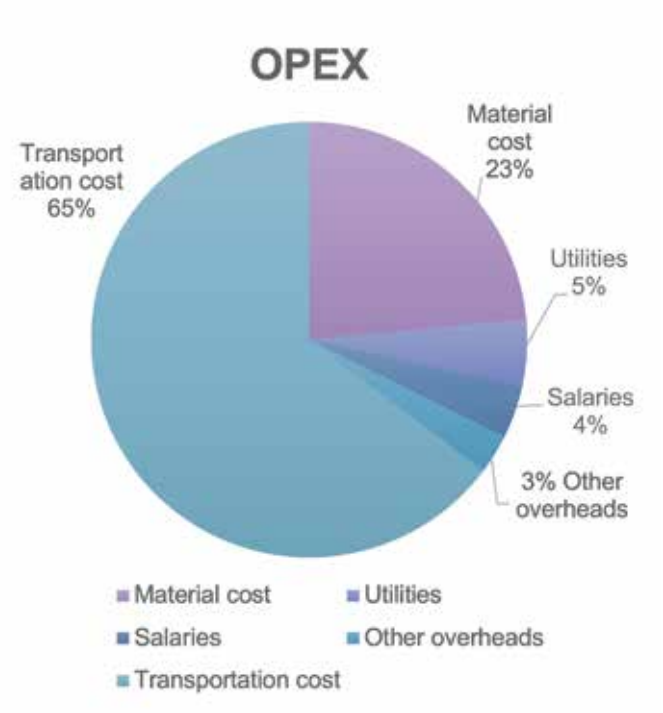
Financial features. The initial investment for starting this business is about 1.2 million EGP. About 75% of the initial investment is in working capital and the rest in pressing machines and other equipment that might help in sorting and compaction. The IRR is about 43% and the profitability index 5.3, ranking this opportunity on the lower side of opportunities, present in the current study. The operating costs of the first year are about 2.7 million EGP, making it one of the highest OPEX in comparison to its CAPEX in the present study. OPEX mainly cover the cost of material at approx. 23% and material transportation about 65% of OPEX, which is significant. While material can be produced at a cost of 270 EGP/ton it can be sold at 400EGP/ton, which provides limited margins for growth. The growth in this opportunity will come from shifting to more advanced operations at a later stage, such as shredding of the RDF to increase its calorific value. The payback period of the business is 3.5 years. These numbers are relevant to a business model based on producing at various sites close to the waste secures, compared to a centralised production site to which the waste is transported to.

FINANCIAL OUTLOOK

CAPEX:	1.2 million EGP
1st Year OPEX:	2.7 million EGP
IRR:	43%
Profitability Index:	5.3
Payback period:	3.5 years
Net Present Value:	5.5 million EGP
Production Cost Yr1:	270 EGP/ton
Product Selling Price:	400 EGP/ton

[58] *IFC.*
[59] *Source: Al Mal, 2017*
[60] *The growth of the RDF market be taken as that of the increase of Egypt coal consumption since it is mostly consumed by the cement industry*





The main challenge. The main challenge in this opportunity is to be able to continuously supply clients large amounts of fuel every month. There is also a challenge to maintain a healthy cash flow, especially since suppliers are paid directly, while most factories pay within 60-90 days after delivery. Factories are unlikely to contract suppliers for amounts of less than 500 tons/ month. This challenge can be overcome by diversifying sources of supply and a strong financial management. Another challenge would become clear at growth stage. Maintaining the high IRR is a large function of being able to create various sourcing/production sites of waste. This business model can sustain production of about 10,000 to 20,000 tons/year. To exceed these amounts, more centralised production needs to be established and hence IRR will go down, yet profits would still increase with increasing production.

Business Opportunity Fact sheet: MSW to sorted RDF for energy intensive industries	
Market	
Final Product:	Alternative fuel in the form of RDF
Required Inputs:	Fluff sorted energy rich fraction (ERF) of Municipal solid waste
Competing Products:	Fossil fuel and Biomass
Process	
Type of Process:	Material handling – Mechanical processing
Technology:	ERF sorting + dehumidification + compacting
Equipment & Material:	Screen, baler
Human resources:	Labour, machines operators, drivers
Advantages and Risks	
Competitive Advantage:	Low cost fuel for energy intensive industries that meets environmental standards set by the government and lowers total expenditures on increasingly expensive conventional energy due to subsidy removal
Barriers to Entry:	Securing a continuous level of supply to satisfy high demand of factories
Key Stakeholders:	Local waste collectors, factories providing waste as RDF, factories as product consumers, local waste traders
Special Regulations:	NA
Risks and Mitigation Measures:	Complicated or absent regulations for landfill concession, local traders affecting the supply levels of MSW, as well as maintaining calorific value of the RDF, so it's important to have a diverse supply of MSW in order to ensure consistency in both quantity and quality of end product Scattered sources of supply complicate logistics and increase overall costs of transportation, therefore optimizing the location of the processing facility is key
Economic Features	
CAPEX	1.2 million EGP
OPEX	1st year 2.7 million EGP
Geography	
Location of Supply:	Supply is mostly in Delta region and Greater Cairo Area, Suez, Qena, Assiut, and Menya
Preferred operation regions:	Greater Cairo Area, Suez, Menya, Assiut, and Qena

MSW AND INDUSTRIAL WASTE TO SHREDDED RDF (PRELIMINARY) FOR ENERGY INTENSIVE INDUSTRIES

6.3.2 MSW AND INDUSTRIAL WASTE TO SHREDDED RDF (PRELIMINARY) FOR ENERGY INTENSIVE INDUSTRIES

Outlook on product and technology. This business opportunity can be seen as an upgrade of the previous one. Access to supply and market features are similar to the one discussed above. However, an extra processing step is added. After the MSW and industrial waste are collected, segregated, and humidity is adjusted, shredding of the waste takes place. Shredded RDF has a higher calorific value and is more effective as a source of fuel. Shredders can vary in cost from a few million to a few tens of millions. This variation is based on production capacity, but more importantly based on the material that can be shredded as well as the size of shredded output. The size of shredded RDF reflects the calorific value.

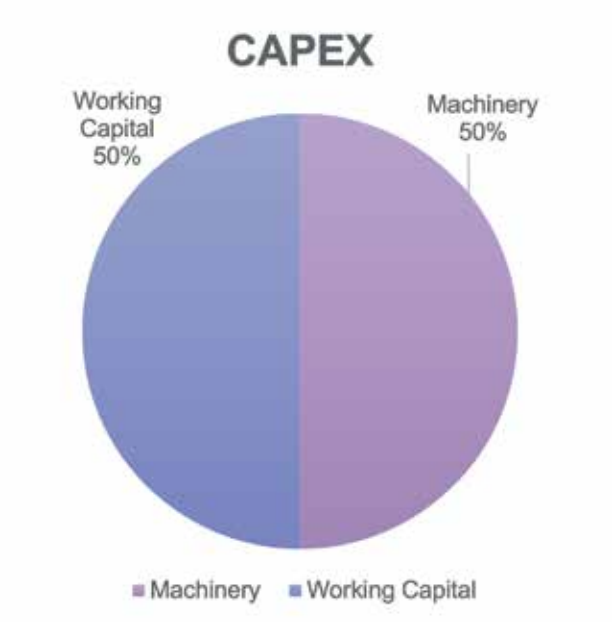
In this opportunity, the most basic shredding is targeted to maintain capital investment within the means of startups and SMEs. The shredders can shred packing material, small pieces of plastics, and agricultural waste. This increases the calorific value and hence the selling price compared to only sorted RDF. The market sizing is similar in terms of amount of waste to the previous opportunities. However, financially the market size is larger, as the ton has a higher market value, of 750 EGP/ton compared to 400 EGP/ton for sorted RDF. Shredding is likely to take place in a centralized facility. It is of outmost importance to carefully select the location of the facility. Hence, the business model will be shifted from the one introduced in the previous opportunity. This business opportunity has a higher growth potential compared to just focusing on sorting the refused waste and production from multiple smaller sites. The only difference in the access to supply from the previous opportunity is that sorted RDF can be sourced from others firms. Hence, the business can focus on shredding as well as producing high fuel mixes.

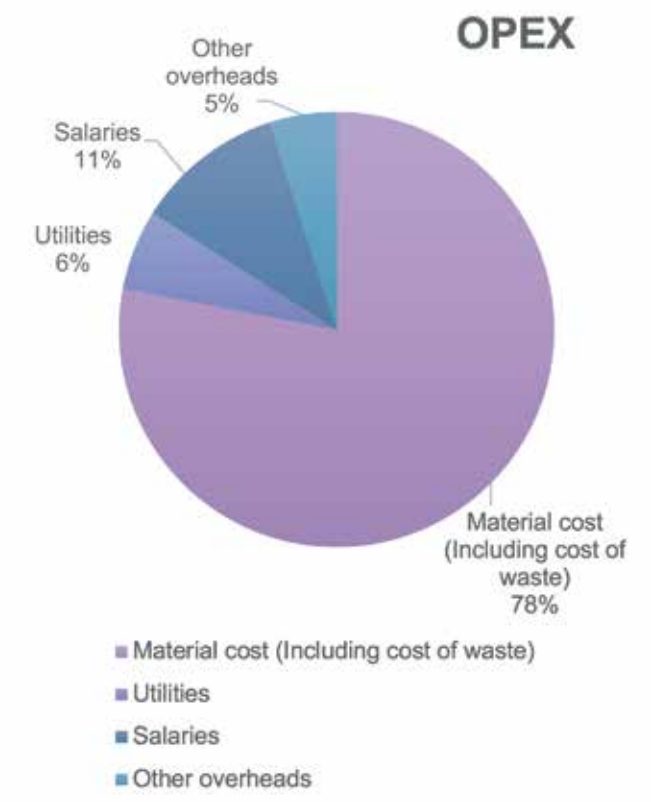
Financial features. The initial investment for starting this business is about 2.6 million EGP. About 50% of the initial investment is in working capital and the rest in machinery, of mainly the shredder(s). The IRR is about 57% and the profitability index 7.3, which are both higher than in the case of sorted RDF due to the higher value added. The operating costs of the first year are about 2.7 million EGP, making it one of the highest OPEX in comparison to the CAPEX in the present study. The OPEX mainly cover the cost of waste including transportation, which represents 78% of the OPEX in the first year. While material can be produced at a cost of 390 EGP/ ton, it can be sold at 750 EGP/ ton. Thus, this opportunity provides higher margins for growth than sorted RDF. The opportunity has a high growth potential, however successive shredding could raise the material cost to 1,000 EGP/ton. The payback period of the business is 2.5 years. The price of shredders varies extremely based on production capacity, type of waste they can handle as well as quality. It is difficult to come with one representative model. Hence, the present model assumes having access to a rented shredder or a joint venture with a shredder owner. In case startups have to purchase shredder, CAPEX will exceed 10 million EGP. In order to move to production exceeding 100,000 tons per year shift to an industrialized facility will be necessary. This will decrease IRR yet profits will increase due to growth in production amount.

FINANCIAL OUTLOOK*

CAPEX:	2.6 million EGP
1st Year OPEX:	2.7 million EGP
IRR:	57%
Profitability Index:	7.3
Payback period:	2.5 years
Net Present Value:	16.5 million EGP
Production Cost Yr1:	390 EGP/ton
Product Selling Price:	750 EGP/ton

*high variation depending on scale, type of waste, technology and location.


CAPEX
Working Capital 50%
Machinery 50%
Machinery
Working Capital


OPEX
Other overheads 5%
Salaries 11%
Utilities 6%
Material cost (Including cost of waste) 78%
Material cost (Including cost of waste)
Utilities
Salaries
Other overheads

Business Opportunity Fact sheet: MSW and Industrial Waste to shredded RDF (preliminary) for energy Intensive industries	
Market	
Final Product:	Alternative fuel in the form of shredded and compacted RDF
Required Inputs:	Fluff sorted energy rich fraction (ERF) of MSW
Competing Products:	Fossil fuel and Biomass
Process	
Type of Process:	Material handling – Mechanical process
Technology:	ERF sorting, dehumidification, shredding, compacting
Equipment & Material:	Screen, shredder, baler
Human resources:	Labour, machines operators, drivers
Advantages and Risks	
Competitive Advantage:	Low cost fuel for energy intensive industries that meets environmental standards set by the government and lowers total expenditures on increasingly expensive conventional energy due to subsidy removal
Barriers to Entry:	Securing a continuous level of supply to satisfy high demand of factories
Key Stakeholders:	Local waste collectors, factories providing waste as RDF, factories as product consumers, local waste traders
Special Regulations:	NA
Risks and Mitigation Measures:	Complicated or absent regulations for landfill concession, local traders affecting the supply levels of MSW, as well as maintaining calorific value of the RDF, so it's important to have a diverse supply of MSW in order to ensure consistency in both quantity and quality of end product Scattered sources of supply complicate logistics and increase overall costs of transportation, therefore optimizing the location of the processing facility is key
Economic Features	
Revenue Stream:	Sales of shredded RDF, sales of recyclables (if available)
CAPEX	2.6 million EGP
OPEX	1st year 2.7 million EGP
Geography	
Location of Supply:	Supply is mostly in Delta region and Greater Cairo Area, but Upper Egypt also could be key location of supply especially cities around cement factories
Preferred operation regions:	Greater Cairo Area, Suez Canal Region, Delta and Upper Egypt

AGRICULTURAL WASTE TORREFECTION TO BIO-CHAR

6.3.3 AGRICULTURAL WASTE TORREFECTION TO BIO-CHAR

Outlook on product and technology. Torrefaction is a thermal treatment technology that increases the fuel quality of agricultural waste through anaerobic[61] thermal treatment. As pyrolysis refers to heating in the absence of oxygen, torrefaction can be seen as a mild form of pyrolysis at temperatures of 200-320 degree Celsius. The agricultural waste is heated in reactors under the deficiency of oxygen at an atmospheric pressure. No additives are needed and the temperature is less than in the case of pyrolysis. The product is referred to as bio-char. Bio-char can be sold in small packages for personal use (e.g. barbeque, heating, etc.) or as in this business opportunity, be sold in large quantities to energy intensive industries. Energy intensive industries would use bio-char instead of biomass for its better quality and higher calorific value. The market features for the energy intensive industries is as discussed above in the section on RDF. The market of personal use can be a niche market, which relies on producing high quality bio-char that generates higher margins than working with the energy industry per ton. However, the market size is limited and strong marketing channels are needed. Torrefaction reactors are better imported in the beginning. However, with increased experience, the reactors could be developed by local manufacturers.

Access to supply. The input material is agricultural waste of mainly stalks and tree pruning to be used for torrefaction. Very few other options can be used in the production of bio-char. Agricultural waste generally suffers from little variation in pricing compared to other waste streams, such as plastics and metals. Yet, the main challenge with agricultural waste is its seasonality. To maintain constant production that satisfies the needs of the industrial sector, large quantities of supply must be secured in the season in which the agricultural waste is produced, which is coinciding with the harvest season. In addition, multiple waste streams could be relied upon, where the harvest seasons become complimentary over the year. Seasonal operation is not possible since the industry requires long-term and constant supply of energy and do not prefer a high supplier turnover. The corn stalk, cotton stalk, and tree pruning are excellent streams for torrefaction. The available quantities of agricultural waste that can be turned into bio-char is around 7 million tons/year[62]. The available quantity is assuming that only 50% of the amount is available for bio-char production and the rest is already utilized. Therefore, 3.5 million tons can be turned into 2.8 million tons of bio-char. The supply is found in rural areas and in most governorates. Hot spots could be in the Delta region and Ismailia were tree pruning is found in larger amounts than in Upper Egypt. Yet, operations must be close to cement factories.

[61] *Anaerobic: in absence of oxygen.*
[62] *Fruit tree waste+ cotton stalks + corn stalks + sorghum stalks = 3M+2M+1M+1M, Source: Chemonics Egypt data*

The business should not engage in collection, but rather focus on accessing supply through already operational collectors. However, it is worth noting that due to the seasonality, ensuring the presence of multiple collectors with the capacity to deliver the required quantities is crucial. In the long-term, as the startup grows, it might be necessary to invest in raising the capacity of the suppliers (collectors) through training and/or access to machinery and finance. Especially, since the collectors may lack access to machinery required for efficient collection. In certain regions, where there is little awareness of the value of the agricultural waste, startups can access the supply for marginal prices of around 20-40 EGP/ton. However, eventually the price of supply stabilizes around 100 EGP/ton. Cotton stalk and tree pruning could have lower prices than corn stalk, since corn stalk has multiple applications in Egyptian villages.

Market size and features. If the energy intensive industry markets were targeted, the features would be similar as discussed in the previous opportunity. Another potential market is bio-char as a consumer product. It can be used for barbecue, heating, and smoking. However, this market is of a smaller size. While in energy intensive industry markets production needs to be at least of 500 tons/month, it is possible to operate bio-char for consumer products at much smaller quantities. The main challenge would be in the establishment of strong marketing channels and building a network with retailers for the product. In terms of value, producing bio-char for the energy intensive industry has a higher monetary value compared to RDF, due to the higher calorific value of bio-char. The market size in tons would be 400,000 tons every year, with a net value of 2.7 billion EGP/year.

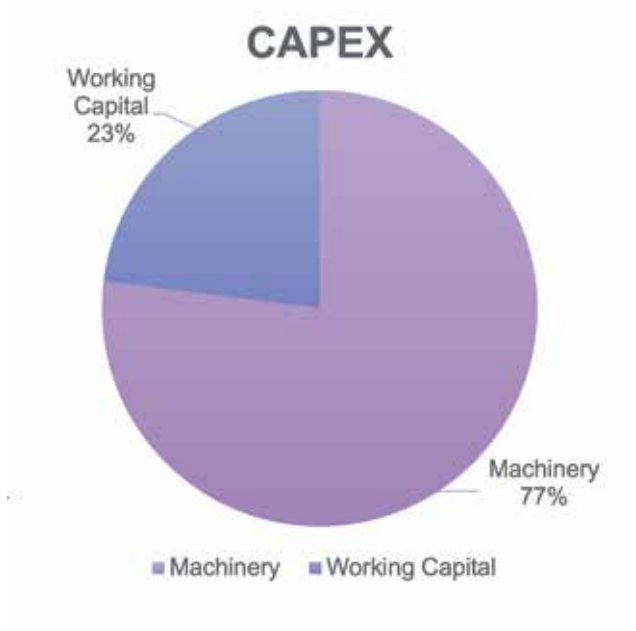
MARKET OUTLOOK

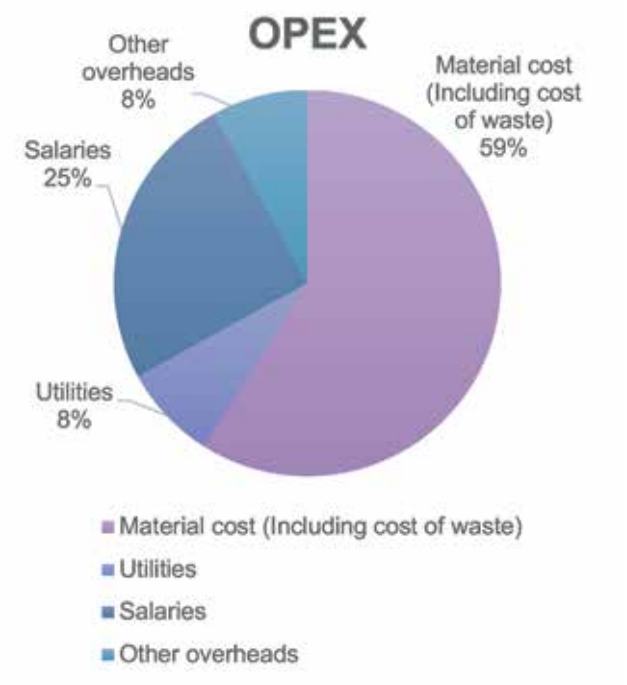
Production Capacity	6,000 ton/year
Available Supply	7,000,000 ton/year
1st year production	3,000 ton/year
Local Market Size	400,000 ton/year
Local Market Value	2.7 billion EGP/year

Financial features. The initial investment for starting this business opportunity is about 1.8 million EGP. This is among the lowest in the present study. About 77% of the investment goes into production machinery, while the rest finances operations. The IRR is about 88% and the profitability index is 11.9. Thus, making it one of the most lucrative opportunities investigated in the study. The operating expenses in the first year are about 1.05 million EGP, which is a moderate OPEX in comparison to the CAPEX. The OPEX mainly covers the cost of acquiring the waste at 59%, while labour cost is high compared to other opportunities and represents 25% of the OPEX. Labour costs are significant, as operations require manual processing related to shredding and pelleting of the product. The ton can be produced at 235 EGP/ton in the first year of operations and sold at 1000 EGP/ton. This high value added and profit margins can be reflected in healthy growing startups and generate excellent returns for investors. The high margins also reduce cash flow challenges.

FINANCIAL OUTLOOK

CAPEX:	1.8 million EGP
1st Year OPEX:	1.05 million EGP
IRR:	88%
Profitability Index:	11.9
Net Present Value:	20.6 million EGP
Production Cost Yr1:	235 EGP/ton
Product Selling Price:	1,000 EGP/ton





The main challenge. The main challenge in this opportunity is the ability to secure serving the clients with continuous large amounts of fuel every month, whilst managing the supply seasonality. There is also a challenge in expanding without over stretching the supply chain. This challenge can be met through setting up various strategically located operation sites. Developing partnerships with collectors and supporting them with knowledge and capacity building are also important factors for the sustainability of the business.

Business Opportunity Factsheet: Agricultural waste torrefaction to bio-char	
Market	
Final Product:	Solid biofuels (Bio-char)
Required Inputs:	Agricultural waste
Competing Products:	Solid fossil fuel (Coal mostly)
Process	
Type of Process:	Thermal treatment (Torrefaction)
Technology:	Sorting, shredding, torrefaction, pelletizing operations units
Equipment & Material:	Torrefaction reactors, combustor, cooler, densification equipment
Human resources:	Manual labour, engineers
Advantages and Risks	
Competitive Advantage:	High demand and high calorific value
Barriers to Entry:	Securing large amounts of supply
Key Stakeholders:	Local farmers to providing agricultural waste as biomass, factories providing waste as biomass, factories as energy consumers, local waste traders
Special Regulations:	NA
Risks and Mitigation Measures:	High power of suppliers and possible competition with them in case they tried to copy the business. Mitigation measures are diversification of supply
Economic Features	
Revenue Stream:	Sales of bio-char
CAPEX	1.8 million EGP
OPEX	1st year 1.05 million EGP
Geography	
Location of Supply:	Supply is mostly in Delta region and Upper Egypt
Preferred operation regions:	Ismailia, Delta Region, Upper Egypt

6.4 OUTLOOK ON FINANCIALS OF BUSINESS OPPORTUNITIES

The three business opportunities vary in capital cost. However, all of them can be categorized as moderate capital cost opportunities, ranging from 1-5 million EGP (Figure 44). The torrefaction business opportunity has the highest IRR (88%) and profitability index (12) due to the high value addition in the process. The impact of advanced processing leads to high value added products and clear profitability. This is also seen when comparing the IRR and profitability index to sorted RDF versus preliminary shredded RDF. The shredding adds one extra process to the production of sorted RDF, which raises the value of the product and hence the IRR from 44% to 58%. This must be seen in the light of the conclusion that most of Egypt's recycling market is in low value-added products and processes. In the long term, Egypt's waste management sector needs to move towards higher value added products.

The highest IRR among the three opportunities is in production of bio-char (88%). This is followed by shredded RDF (58%) and sorted RDF (43%). From an energy point of view, the IRR of each opportunity reflects the calorific value of the product. In terms of value-added, the opportunities presented here are not the highest in waste to fuel markets. Advanced shredding of RDF can increase the value added on waste. High capacity shredders process larger pieces of waste and produce smaller size RDF, which will increase the value added per ton of waste and hence the selling price will rise. However, initial investment in advanced shredding of RDF would exceed 20 million EGP. The supply chain complexity will increase to maintain high production levels that are needed to recover the investments.

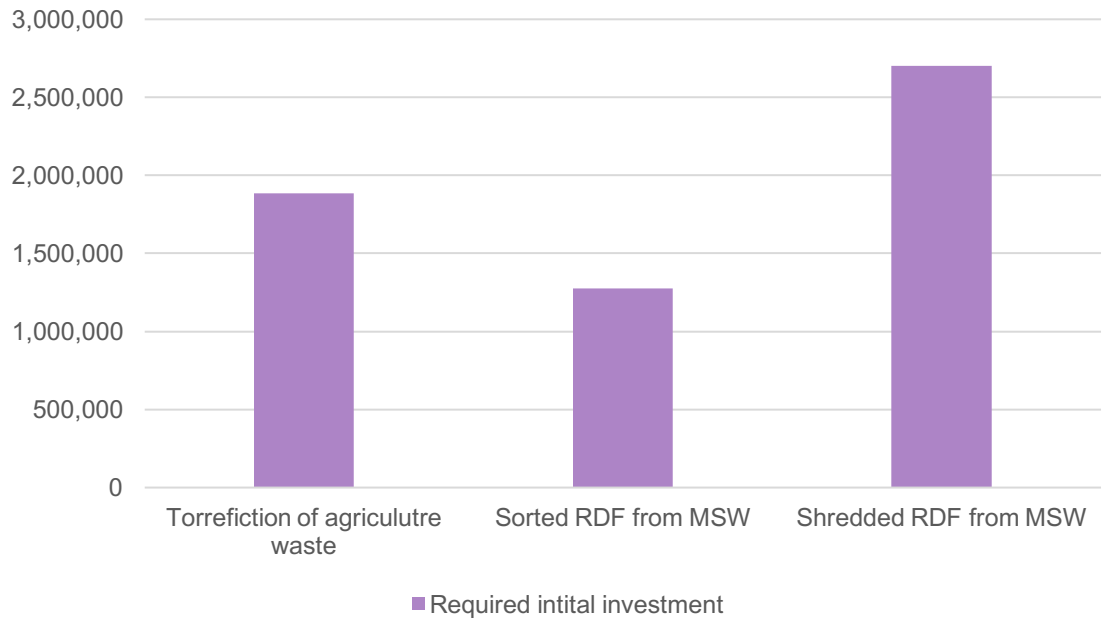


Figure 44: Required initial investment for top ranked business opportunities in energy from waste market

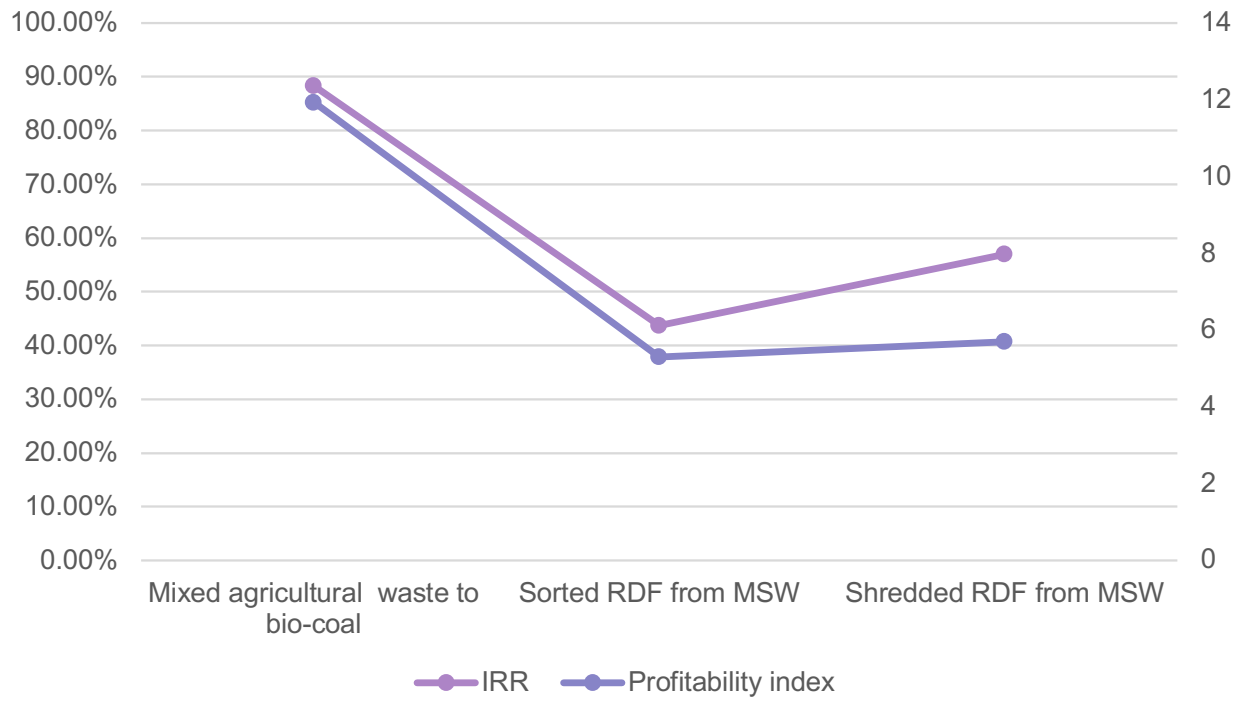


Figure 45: Internal rate of return for the top ranked opportunities

6.5 SOCIO-ECONOMIC AND ENVIRONMENTAL IMPACT

Economic impact. The economic impact of the present opportunities is tied to the value captured in the fuel market of energy intensive industries. Since all the opportunities target the same market, the potential market size would eventually be divided between the three opportunities. It is difficult to breakdown the potential share of bio-char, sorted RDF, and preliminary shredded RDF. The amount available of agricultural waste that can be turned into bio-char is 7 million tons/year and available MSW that can serve as RDF is 3.5 million tons annually. IFC's study project on alternative fuels will cover 9M Gcal by only meeting cement factories' energy demand by 2025[63]. Given the energy content per ton of dry RDF at min 3.1 Gcal, the energy intensive industry can capture about 2.9 million tons/year of sorted RDF and about 1.6 million tons/year of shredded RDF. Shredded RDF has a higher calorific value than sorted RDF[64]. Following the same analysis, the energy intensive markets can absorb 2 million tons of bio-char from agricultural waste. If the whole market were to be captured by sorted RDF, it would have a net value of 1.2 billion EGP/year, which is the same market size in terms of preliminary shredded RDF. For bio-char the market size would be 2 billion EGP per year. Taking the average of the three, by using the most straightforward assumption of equal distribution of the market among the three opportunities, the market size could be 1.5 billion EGP per year for the three opportunities. This can be considered the minimum of the economic impact since the market sizing does not take into consideration the expansion in housing and infrastructure projects as well as the increase in cement manufacturing licenses issued by the Government of Egypt lately.

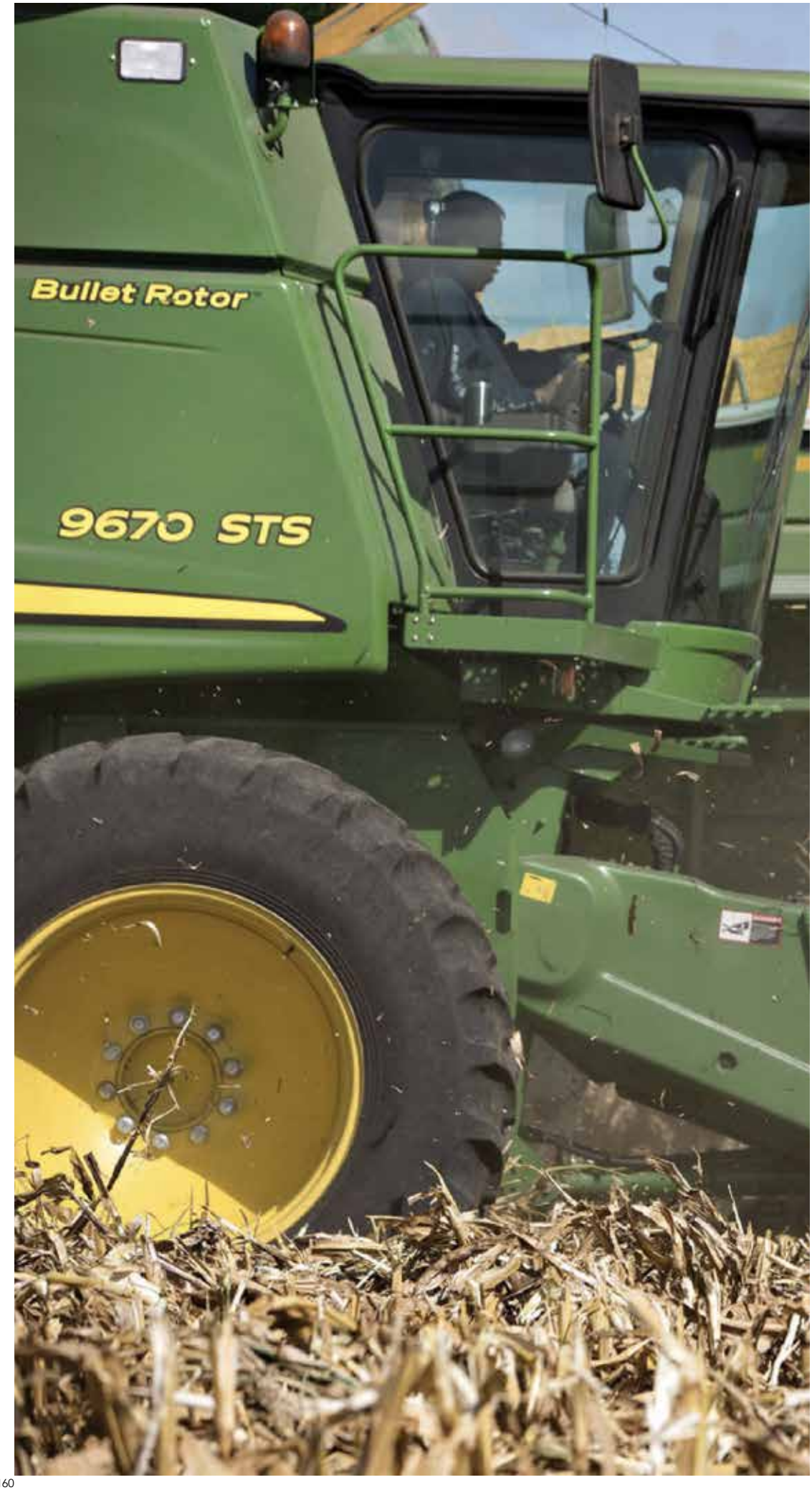
The indirect economic impact of this market is important to take into consideration. Any replacement of fossil fuels by waste derived fuel, such as coal, natural gas, or Mazut, will reflect positively on Egypt's trade balance. Egypt is a net importer of coal and Mazut, while Egypt is about to become self-sufficient and perhaps an exporter of natural gas. Thus, any savings in local natural gas consumption can add to Egypt exports. Hence, most of the market value will be translated to a positive addition to Egypt's trade balance. Furthermore, the utilization of alternative fuels contributes to Egypt's energy sustainability by decreasing its reliance on fossil fuels. Finally, it also boosts the competitiveness of the cement sector and its sustainability.

Social impact. The bio-char business creates 5-6 direct and about 200 indirect job opportunities in transportation and waste collection. If all available agricultural waste that can cover the bio-char market were utilized, this would create about 2,500 direct and about 90,500 indirect job opportunities. For the sorted RDF opportunity, 8-9 direct and 400 indirect jobs were to be created, whereas to cover the market needs, about 900-1035 direct and 46,000 indirect job opportunities were to be created. The shredded RDF business opportunity creates 10-11 direct and about 400 indirect job opportunities in transportation and waste collection, whereas to cover the market needs, about 1230-1350 direct job and 49,200 indirect job opportunities are created. In a nutshell, the

[63] *IFC, "Unlocking Value: Alternative Fuels For Egypt's Cement Industry."*
[64] *Dry RDF at density 350kg/m3*

energy from waste market alone can create approximately 190,000 direct and indirect jobs. The majority of direct and indirect job opportunities do not require skilled labour. Also, at least 10% of the job opportunities are suitable for female employment. The social impact of job creation should be looked at beyond the numbers. The waste to energy market creates jobs in the local areas where waste is generated. It means that jobs are created in rural areas in the case of agricultural waste and in the fringes of urban areas where refused waste is usually accumulated. This contributes to the livelihood of communities that are economically struggling. Furthermore, in this market there are many opportunities for semi-skilled and unskilled labour who can easily be trained to acquire the skillset through training on the job. The energy market is intensive in job creation compared to the two previous markets of material and industry feedstock as well as the food industry. This is due to the nature of the business, where extensive direct jobs are needed to sort the waste, the labour intensive production processes as well as the need for a high number of indirect jobs. In addition, in terms of tons, the energy market can absorb 1 million tons of MSW and 3.5 million tons of agricultural waste compared to the food industry market of 830,000 tons of waste and the material and industry feedstock market 1.8 million tons/ year.

Environmental impact. From an environmental point of view, this market is extremely impactful. First of all, it operates on waste streams which have otherwise little use. By definition, RDF utilizes the refused (rejected) fraction of MSW. This fraction is not suitable for recycling and hence usually accumulates in dumpsites or in the best-case scenario at landfills. Out of the rejected 3.5 million tons/year of MSW, 1.6 to 2.9 tons can be absorbed in the energy intensive market. This has the potential of diverting 50% of one of the most problematic waste streams in Egypt to a productive use. These values reflect the potential of the market and its environmental impact. For this to be implemented, various support mechanisms and full development of the value chain must take place. When it comes to torrefaction and production of bio-char, the opportunity is also applicable in agricultural waste streams that are less useful in current production activities. The market can absorb about 7 million tons/ year of such waste. It is possible to assume that these 7 million tons/year would have otherwise been openly burnt.


Bullet Rotor
9670 STS

SECTION 7

AGRICULTURAL MARKET

7.1 OVERVIEW OF THE MARKET

Agricultural and organic waste can provide a multitude of products that serve the agricultural market. These products include fertilizers, in the form of compost, as well as products that serve animal breeding and aquaculture. The multitude of products that can serve the agricultural industry are produced from agricultural waste and/or the organic fraction of MSW. The products include compost, fibre bedding, as well as feed for cattle and sheep, poultry, and fish. The markets served by these products indirectly contribute to the competitiveness of the food industry, which exhibits high growth as previously discussed. The products serve the agricultural sector that contributes to 12% of the GDP and 25% of the job market[65]. A closer look to the fertilizer, animal breeding as well as aquaculture market follows.

High value-added products impact the competitiveness of the agricultural process. Through simple mechanical processes and various biological technologies, agricultural waste and/or the organic fraction of MSW are turned into high quality fertilizers and animal feed. Both products represent a significant part of farmers spending. The cost of animal feed and fertilizers reflect significantly on the cost of produced meat and agricultural products. The increased prices of chemical fertilizers as well as animal feed translate into increased prices for food in Egypt. The higher fertilizers and feed cost also burdens farmers who are in many cases already struggling economically. Waste based alternatives to fertilizers and compost are comparable in quality and sometimes may exceed those of chemical and mass-produced alternatives that dominate the market. Moreover, for the same quality, compost and feed from waste can be 20-30% less in price than those currently dominating the markets. The nutritious content of waste-based feed can exceed alternatives in protein and sugar content. Compost is at times in high demand by farmers who export and aim at organic farming. Furthermore, compost can be the best option in desert farming, when it comes to improving the productivity of the soil and its water retention. Providing farmers, cattle and sheep breeders, poultry farms, as well as fisheries with such cost competitive alternatives will provide higher margins to the agricultural sector. While many of the products in this section are novel and unfamiliar, experience in Egypt has demonstrated that once the farmers develop awareness of the value of the waste-based products, the demand rapidly increases and adoption accelerates

Proven markets with uncaptured potential in quantity and quality. A key advantage of operating in the market opportunities identified in the present section is that the products have already penetrated the Egyptian market and created success. There are various firms that produce compost, fibre bedding, as well as animal feed from agricultural waste. In addition, other manufacturers produce compost from the organic fraction of MSW. Various organic waste streams are also used as fish feed. However, these products have gained attention in limited areas only, where the public and private sector, and/or international organizations carried out effective marketing and awareness measures. Yet, the vast majority of the potential market remains uncaptured. Furthermore, most of the production techniques and technologies

[65] *Ministry of Planning 2015*

create low quality products with limited value-added. There is a large market value, that is not captured in terms of quantity and quality. Compost created through agricultural waste for instance, based on quality, can have value that ranges from 200 to 1200 EGP/ton. Most of the compost produced in the Egyptian market has a value of 300 EGP/ton. The opportunities identified in this study focuses on the higher value added versions of the products through utilization of appropriate production techniques. This will not only raise the profitability of the businesses, but also meet clients' demand.

7.2 KEY WASTE STREAMS AND OPPORTUNITIES

Key opportunities. The business opportunities identified serve the fertilizers, animal/fish feed, and fibre bedding markets. In total, five opportunities are identified, of which two opportunities focus on the compost market, two opportunities on cattle, sheep, poultry and fish feed, and one opportunity on fibre bedding, a material to cover the floor of animal housing. Composting and animal feed production relies on aerobic and anaerobic digestion technologies that are currently applied in the Egyptian market. However, adaptation and refinements are needed. The vermi-composting and poultry and fish feed opportunities focus on bio-digestion technologies, which are less utilized in Egypt. This is due to a lack of (1) awareness, (2) technical know-how, and (3) quality control. Combined, these shortcoming hinder the exploration of these technologies. The waste streams the business opportunities operate with are agricultural waste and the organic fraction of MSW. One opportunity utilizes the organic fraction of MSW and the other four focus on agricultural waste. Each of the four opportunities based on agricultural waste utilizes a sub stream that serves the final product requirements the most. In this section, the markets of focus are among the ones that can absorb the most amounts

of waste. In addition, businesses in this market can operate in rural and urban areas across the country. The identified business opportunities are:

- Aerobic digestion of agricultural waste to high quality compost;
- Agricultural waste to fibre bedding;
- Agricultural waste to animal feed;
- Organic waste to fish and poultry feed;
- Agricultural waste to vermi-compost.

Waste streams. The waste streams identified are agricultural waste and the organic fraction of MSW. The identified business opportunities have the potential to absorb the following waste amounts:

- 13 million tons of agricultural waste
- 372,000 tons of organic fraction of MSW

Technically, the agro-industry waste can be added to the streams above. However, since organic waste generated at industrial sites is far from the markets of the agricultural sector, the logistics and transportation would be challenging. Hence, the focus is on agricultural waste and MSW from particularly rural areas and urban habitat close to farms. The organic waste represents 60% of generated MSW, which is about 12 million tons/year. The annual generated amounts of agricultural waste are more than twice this amount of approx. 30 million tons/year. The two opportunities that operate using the organic fraction of MSW can only absorb at most 5.3 million tons/year of the waste stream. This stream is one of the most problematic ones in Egypt.

The organic fraction of MSW often accumulates in dumpsites and streets. To be able to absorb the organic fraction of MSW into productive uses, the compost and animal feed markets need to be leveraged. Technically, any organic matter can serve as feedstock for compost and animal feed. From a market point of view, agricultural waste represents a much higher quality feedstock than the organic fraction of MSW. While a ton of agricultural waste can have a price of 100 EGP/ton, organic fraction of MSW can still be acquired for free or for a price not exceeding 40 EGP/ton. The price of agricultural waste varies by type. The price also is reliant on the perceived value of the waste by the farmer. Some types of waste are easily obtained, such as banana tree leaves, as it has no existing market nor is perceived as valuable by the farmers. Other types of waste are sold at a well-known market price, such as corn stalks or palm tree waste[66]. The organic fraction of MSW has no market value and mostly producers of waste pay a disposal fee. It is possible for MSW processing facilities to operate with a gate fee to enhance their business model, since the market price of compost from organic MSW is quite low (70-100 EGP/ton compared to 200-500 EGP/ton for compost from agricultural waste.

Value chain. The needed agricultural waste for producing animal feed, fibre bedding, and compost can be accessed through traders/collectors and in some areas directly from farmers. Unlike the MDF case, where the agricultural waste streams (e.g. corn stalks) usually have collectors, compost and animal feed could target streams where there is no active network of collectors. This includes, for instance banana tree waste and sugarcane straw. In streams and areas where there are no active collectors, it is difficult to establish

[66] *The average price per ton of agricultural waste currently in Egypt can reach 100 EGP but this price does not include cost of transportation or labor cost. This price should also be considered with caution, despite it being an upper limit, the variation under this limit is large and the price tends to change. On contrast municipal organic waste can be easily collected for free or at most purchased for 30 EGP/ton.*

large-scale production, as farmers can at most collect the waste and pre-process it on site, but will not transport it to startups and SMEs. Establishing a network of collectors is possible, however, this would require firms to support collectors with knowledge and at times equipment. It is not advised to establish and operate the full supply chain from farm to production site.

The value chain of organic MSW fails to transport most of material to productive activities. In rural areas and some cities, municipalities collect the waste and dispose it. Most of the organic fraction is not integrated in any productive activities. In large cities and in some rural areas, the collection service is inefficient and hence waste accumulates close to households, at dumpsites and at times in waterways. Informal collectors who pick up recyclables and leave the organic fraction, which is almost of no value, segregate this waste on site. The organic fraction eventually rotes and creates negative environmental and hygienic conditions. Certain amounts of organic waste are collected formally and reach recycling facilities or landfills. Some amounts of organic waste are used as animal feed directly under conditions, which are questionable from a health perspective. The organic fraction of MSW value chain is one of the most complex and least functioning in Egypt.

7.3 IDENTIFIED BUSINESS OPPORTUNITIES ALONG THE VALUE CHAIN

The study identified business opportunities along the value chain of compost and animal breeding markets. Due to the previously mentioned challenges in using MSW, most of the business opportunities are utilizing agricultural waste. In the upcoming sections, each of the below mentioned business opportunities will be further explored:

- Aerobic compost from agricultural waste;
- Agricultural waste to fibre bedding;
- Agricultural waste to animal feed;
- Organic waste to fish and poultry feed;
- Mixed agricultural waste to vermi-compost.

AEROBIC COMPOSTING FROM AGRICULTURE WASTE

7.3.1 AEROBIC COMPOSTING FROM AGRICULTURE WASTE

Outlook on product and technology. Compost refers to organic fertilizers that result from the decomposition of agricultural waste with or without animal waste. Additives could be added to the mix to compensate deficient nutrients and hence raise the value of the compost. Compost is used as fertilizer to support the development of agricultural produce and to improve soil fertility, particularly in desert farming and less fertile land. As a result, compost can support the water retention of the soil. Further, compost can be sold in a loose form in trucks or as granulate in packets to large farms or individuals, such as gardeners and home growers. In the present opportunity, the product targets farming applications rather than gardening. As a start, the product can be sold in a loose form and be upgraded to packets of 50kg, for instance. The technology used is aerobic digestion, in which the organic matter decomposes in open air. The agricultural waste is typically shredded and potentially mixed with animal waste. Long piles of about 1-2 meters' width, 1 meter height, and few tens of meters long are created manually or through loaders. The matter inside the pile, which is unexposed to air, starts decomposing. The piles are turned over periodically and water could be added. Other additives could be included to either accelerate digestion (i.e. fermentation) through biological agents or to improve the nutritious quality of the product. The fermentation takes 2 to 3 months depending on temperature and weather. Adding animal waste, biological agents, or additivities is a business decision that affects the speed of production and the quality of produce. The presented business opportunities target high quality compost, which is likely to be supported with additives and may be adjusted to soil and crop needs. It also involves constant testing and selection of mixes of agricultural waste to maintain high quality of production.

Market size and features. The agricultural sector in Egypt is expanding and the need for fertilizers in general and compost in specific is increasing rapidly. Despite the continuous land degradation in the Delta region and the Nile valley, the percentage of agricultural land increased in Egypt by 0.5% from 2000 to 2015[67]. Public programs to reclaim desert lands contributed to increasing the total agricultural area.

This growth in the reclaimed land area is expected to increase further under the government's initiative to reclaim an additional 1.5 million feddan (feddan = approx. 1 acre) in the desert. In general, Egypt suffers from shortage of essential types of chemical fertilizers, despite being a net exporter of fertilizers of mostly phosphate based fertilizer. Compost cannot replace chemical fertilizers completely, yet it is essential for organic and desert farming to support the soil. The demand on compost in 2017 was estimated at 83 million ton[68] or about 24 billion EGP. This does not consider the demand on compost created by the 1.5 million feddan initiative. The market grows by about 5.3% annually. The targeted production of 4,500 tons per year in the proposed opportunity can only capture less than 0.05% of the market size. The demand for compost is higher in Upper Egypt than in the Delta region, where there are fewer suppliers and more desert farms. Compost also becomes one of very few choices for organic farms and those focusing on export.

MARKET OUTLOOK

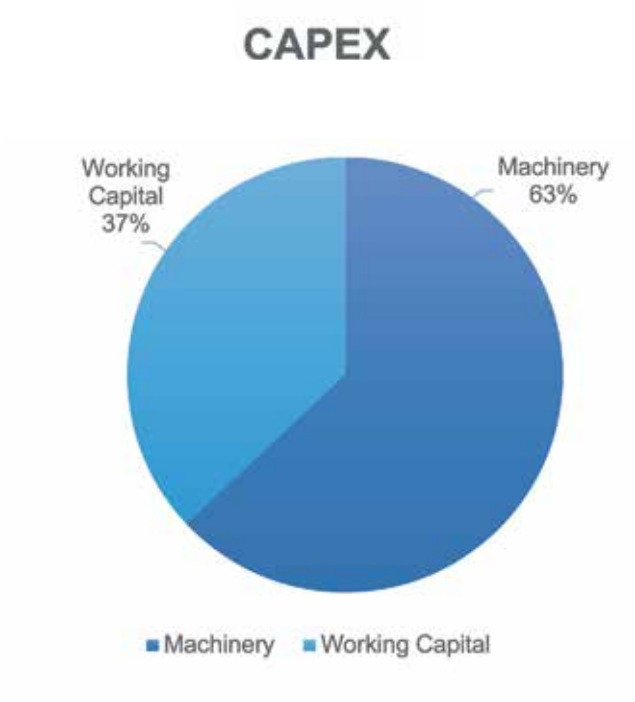
Production Capacity	4,500 ton / year
Available Supply	15 million ton / year
1st year production	3000 ton / year
Local Market Size	5.3 million ton / year
Local Market Value	3.2 billion EGP / year
CAGR	5.3%

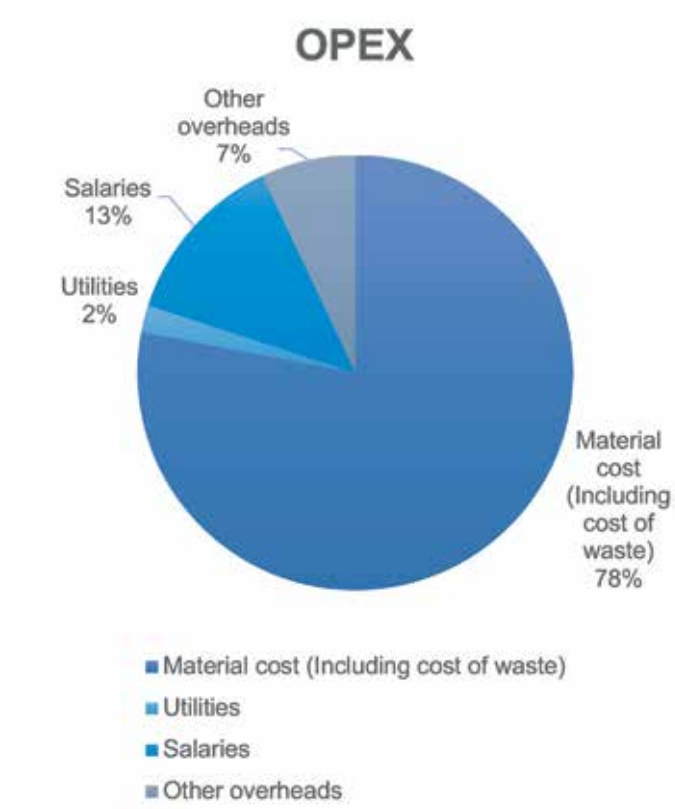
Financial features. This business opportunity requires a medium-low investment of 1.5 million EGP. About 63% of the initial investment goes into machinery of mostly shredders and loaders and the rest is working capital. The 1st year OPEX is 1.3 million, hence it is considered high when comparing to initial investment. The cost of waste including transportation is 78% of the OPEX, which is among the highest in the study. This can be correlated with the simplicity of technology and operations, which relies on seasonal workers and semi-skilled and unskilled labour at large. In the beginning, the product can be sold for 600 EGP/ton. It can be produced in the first year of operations at 360 EGP/ton. The IRR and profitability index are 25% and 2.8, respectively, which are among the lowest in terms of profitability in the study. Raising the quality of compost and packing increase the price to 800-900 EGP/ton. This is an opportunity that is easier replicated by multiple micro-firms, rather than supporting the growth of only a few. The payback period of the business is 4 years.

FINANCIAL OUTLOOK

CAPEX	1.5 million EGP
1st year OPEX	1.3 million EGP
IRR	25%
Profitability Index	2.8
Payback period	4 years
Net Present Value	2.8 million EGP
Production Cost Yr1	360 EGP / ton
Product Selling Price	600 EGP / ton

[67] *World Bank data*
[68] *Mohamed Elfeki and Emil Tkadlec, "Treatment of Municipal Organic Solid Waste in Egypt," 2014.*





The main challenge. The main challenges in this opportunity are cash flow management and quality control. The agricultural produce is seasonal. To cover sales throughout the year, large amounts of waste needs to be purchased at the right season. Furthermore, farmers may opt to deferred payment as common in the agricultural sector. In addition, the production cycle takes from 2-3 months. Hence, maintaining a healthy cash flow and to ensure for quality control can be challenging. In case animal waste or contaminated agricultural waste are used, harmful pests and biological agents may develop. Clients who are willing to pay in cash and for a higher quality product often complain about the variation of the quality of compost in terms of nutrients in Egypt. The mitigation measures involve mixing agricultural waste streams with complimentary seasons for improved cash flow. Planned production and avoiding sudden market pulls can also support a healthy cash flow. Finally, an investment is needed to acquire know-how and finance continuous testing, while implementing quality assurance measures in production.

Business Opportunity Fact sheet: Aerobic compost from agricultural waste	
Market	
Final Product:	Low cost organic bio fertilizer
Required Inputs:	Bedding mixed with litter, cattle manure, plant residual, or possibly additives (bacterial additives)
Competing Products:	Fertilizers, compost agricultural waste
Process	
Type of Process:	Manual handling, mechanical processing and Aerobic digestion
Technology:	Collection, pressing, shredding, laying and creation of piles, selection of additives, mixing (possibly manual, loader, adapted tractors, or mixing machine), aerobic digestion and loading
Equipment & Material:	Shredder, tractor and water pipes
Human resources:	Manual labour, technical operation, agriculture specialist
Advantages and Risks	
Competitive Advantage:	Aerobic decomposition allows a control and tuning of the quality of the product, competitive edge in pricing as compared to chemical fertilizers
Barriers to Entry:	Technical knowledge to reach the mix of types of feedstock (type and ration of various feedstock) matched with proper mineral and micro-organism additive
Key Stakeholders:	Farmers, Agriculture Directorate, Research centres, accredited laboratories (public and private sector)
Special Regulations:	NA
Risks and Mitigation Measures:	Variation of weather conditions and type of feedstock could change the quality, the possibility of contamination due to variability of the process steps: continuous quality monitoring and control through laboratory testing, as well as simple testing on site and proper statistical selection for sampling Seasonality of agricultural waste: (proper selection of type of feedstock in season as well as keeping a planned inventory) - Lack of awareness; marketing through samples, agriculture consultation and awareness raising of doses, benefits and uses
Economic Features	
Revenue Stream:	Sales of fertilizers to farmers
CAPEX	1.5 million EGP
OPEX	1st year 1.3 million EGP
Geography	
Location of Supply:	Supply is mostly in Delta region and Upper
Preferred operation regions:	Delta and Upper Egypt

MIXED AGRICULTURE WASTE TO VERMI-COMPOST

7.3.2 MIXED AGRICULTURE WASTE TO VERMI-COMPOST

Outlook on product and technology. Vermi-composting is a less commonly known technology in the Egyptian market. It is based on breeding special species of worms that can feed on large amounts of organic waste. These include red wigglers, white worms, earth worms, among others. The worms casting (i.e. feces) is used as fertilizers that usually have less contaminants and higher concentration of nutrients than original organic waste. The major advantage of the technology is that it reduces contamination and produces relatively uniform output despite the mixed waste input. The technology is well adapted to handle mixed waste from various sources. Hence, when operating in rural areas, household organic waste can be mixed with agricultural waste. One of the key advantages of vermi-compost is that the cash conversion cycle is fast, as the production can take from 3 to 6 weeks compared to 2 to 3 months in case of aerobic digestion. Special species are used in the beginning of operations as fast breeders. Worms are kept in containers that can be made of plastics or bricks, including bedding material. The product is usually referred to as compost tea, as it is used in packets. It can be used for landscaping and farming, whereas in the present study the business opportunity for farming is targeted. The main revenue stream is from selling compost, but potential revenue streams include selling worms for other breeders.

Access to supply. The focus in this opportunity is on agricultural waste that is accessed through collectors as in the previous opportunity. Access to supply is similar to that in the market of aerobic digestion to produce compost. However, in vermi-composting profitability is achieved at extremely low amounts of production reaching one or two tons a month. The targeted production in this market is 600 tons/year compared to 4,500 tons/year in aerobic composting. This flexibility in volume of operation decreases the value chain risks. In the previous opportunity, compost production needs to be planned well in order to secure that the 2-3 months production cycles are staggered to maintain a steady output. The challenge is less evident in vermi-composting due to shorter production cycles.

Market size and features. Market features and sizing are identical to the previous opportunity. However, vermi-compost is considered a high value added product and can sell for 800 EGP/ton compared to 600 EGP/ton in the case of aerobic compost. In addition, targeting more diverse markets can provide resilience to the business. This can include selling small packs of compost tea for hobbyists, gardeners, and landscaping. The business operates profitably under 600 tons/ year with the first year's production at as little as 300 tons. The market growth is 5.3%.

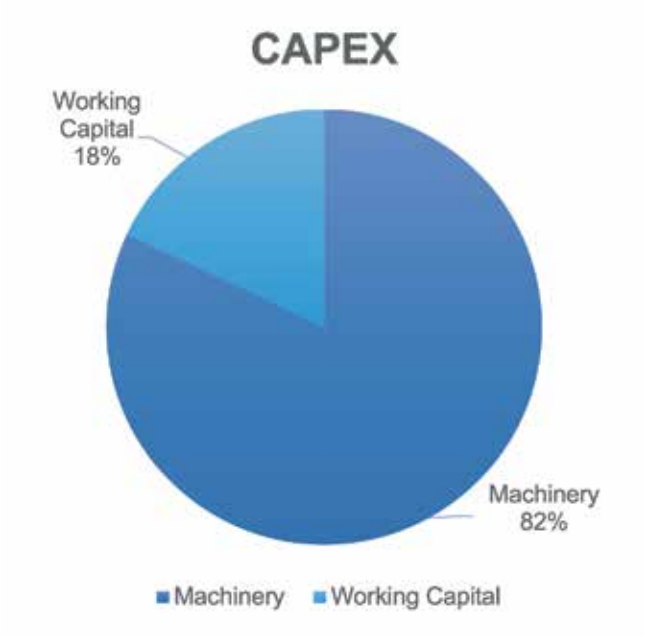
MARKET OUTLOOK

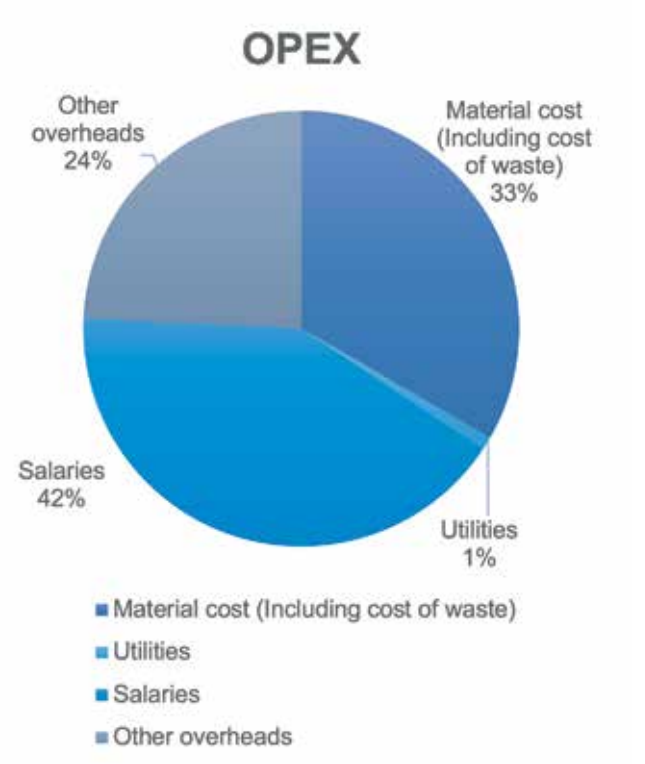
Production Capacity	600 ton / year
Available Supply	15 million ton / year
1st year production	300 ton / year
Local Market Size	5.3 million ton / year
Local Market Value	6.9 billion EGP / year
CAGR	5.3%

Financial features. This is one of the least capital-intensive opportunities in the present study. The initial investment is only about 681,000 EGP and the 1st year OPEX are relatively low compared to the CAPEX at 347,000 EGP. About 73% of the initial investment is in acquiring worms, which is considered to be a productive asset in the present business. The IRR is 45% and the profitability index is 4.9. The production cost of compost in the first year reaches 390 EGP/ ton and the product can be sold for 800 EGP/ ton. Out of the initial investment, 9% covers the cost of containers, in which the worms are kept as well as air-conditioning system to maintain temperatures at levels suitable for worms to feed and reproduce. Cost of acquiring waste is only 33% of the total OPEX, while salaries are at 42%, which is among the highest in the present study. This is due to the intensive labour requirements in following up on worms and ensuring the breeding containers are well protected and ventilated. In addition, labour works continuously on ensuring the worms are fed regardless of the absence of decrease in feedstock. When worms over reproduce they need to be separated into new containers. Collecting the compost can also be labour intensive. The payback period 3 years.

FINANCIAL OUTLOOK

CAPEX	681,000 EGP
1st year OPEX	347,000 EGP
IRR	45%
Profitability Index	4.93
Payback period	3 years
Net Present Value	2.6 million EGP
Production Cost Yr1	390 EGP / ton
Product Selling Price	800 EGP / ton





The main challenge. The main two challenges are to (1) ensure the breeding of worms does not over populate in the containers and (2) that the worms are maintained in a healthy condition. Moisture and temperature of breeding containers must be maintained in a healthy range. Protection from pests, such as flies, which may breed in the containers, ants, or rodents which might feed on worms is a must. Worms also may try to leave the container. Continuous follow up is crucial to mitigate the challenges above.

Business Opportunity Factsheet: Mixed agricultural waste to vermi-compost	
Market	
Final Product:	Low cost bio fertilizer
Required Inputs:	Bedding mixed with organic waste, specials species of worm (as a starter), Additives
Competing Products:	Fertilizers, aerobic compost from food scrap & agricultural waste
Process	
Type of Process:	Bio-digesting process
Technology:	Composting (using specific mix of species of worms)
Equipment & Material:	Plastic containers and or cement & brick containers
Human resources:	Labour –biochemists
Advantages and Risks	
Competitive Advantage:	Aerobic decomposition allows a control and tuning of the quality of the product, competitive edge in quality and pricing as compared to chemical fertilizers
Barriers to Entry:	Technical knowledge to be able to reach the mix of types of feedstock (type and ration of various feedstock) matched with proper mineral and micro-organism additive
Key Stakeholders:	Farmers, Agriculture Directorate, Research centres, accredited laboratories (public and private sector)
Special Regulations:	NA
Risks and Mitigation Measures:	Variation of weather conditions and type of feedstock could change the quality, the possibility of contamination due to variability of the process steps: continuous quality monitoring and control through laboratory testing, as well as simple testing on site and proper statistical selection for sampling. Seasonality of agricultural waste: (proper selection of type of feedstock in season as well as keeping a planned inventory) - Lack of awareness; marketing through samples, agriculture consultation and awareness raising of doses, benefits and uses
Economic Features	
Revenue Stream:	Sales of vermi-compost bins for houses/ touristic facilities and restaurants
CAPEX	681,000 EGP
OPEX	1st year 377,000 EPG
Geography	
Location of Supply:	All over Egypt
Preferred operation regions:	Nearly all over Egypt except for inside urban cities where no place for processing organic waste

AGRICULTURE WASTE TO FIBRE BEDDING

7.3.3 AGRICULTURE WASTE TO FIBRE BEDDING

Outlook on product and technology. Fibre bedding is very simple, yet a very important product for animal breeding. Fibre bedding is laid on the floor of any sheep, cattle or poultry farm in order to provide comfortable surface for animals and decrease contamination caused by waste. Fibre bedding is produced through crushing/shredding of agricultural waste or waste wood. The product is sold in packs by weight. The bedding has to be removed frequently depending on the accumulation of manure and litter. Hence, there is continuous demand on fibre bedding. The alternative to agricultural waste based fibre bedding is wood shavings. There is no clear specification/ standards for the product.

Access to supply. Most of agricultural waste types can be used as fibre bedding, yet corn and cotton stalks as well as rice straw are favourable to use. Waste wood can be shredded and used as well. In this sense the supply could be both, a mix of waste wood from commercial entities, factories, and workshops as well as agricultural waste. However, access to agricultural waste is easier and provides large supply quantities in proximity to farms. The access to supply has similar properties and features to the above opportunities of this section. However, since operations can be profitable at small amounts, there are less challenges with having to build a large network of collectors.

Market size and features. The general market features are those of the food sector. However, animal breeding market is growing faster than the food sector. Cattle heads have increased in Egypt with an average of about 4% since 2013 and poultry production is expected to increase at a rate of 8% until 2021. The market size of fibre bedding is about 1.3 billion EGP/ year and can absorb 2.25 million tons annually. It can be expected to grow at 6% by averaging the growth rates between cattle and poultry farms. It is a large market in volume, but not as much in value. Production can be profitable at about 600 tons/year and the target in the presented business model is 1200 tons/year. This is a market with extremely low barrier to entry and hence high competition is expected. It is one of the opportunities that can absorb hundreds, if not thousands, of micro firms, rather than allowing only few to grow. Growth will involve a very complex supply chain that is required to supply clients rapidly and continuously over large distances with the product.

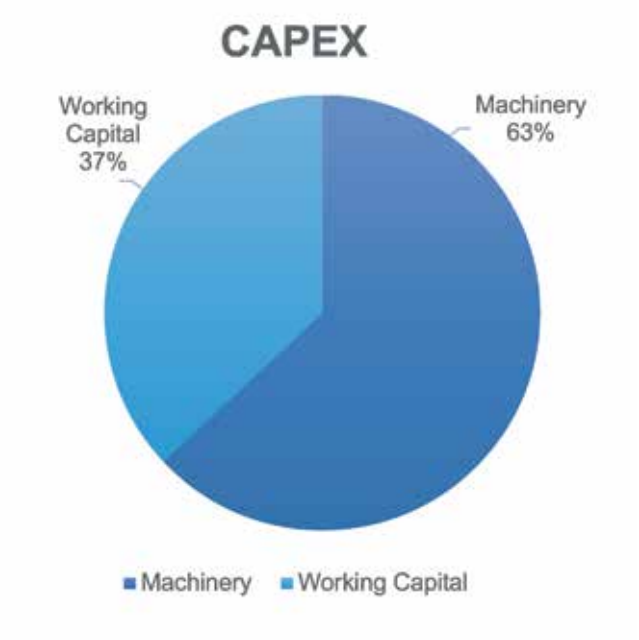
MARKET OUTLOOK

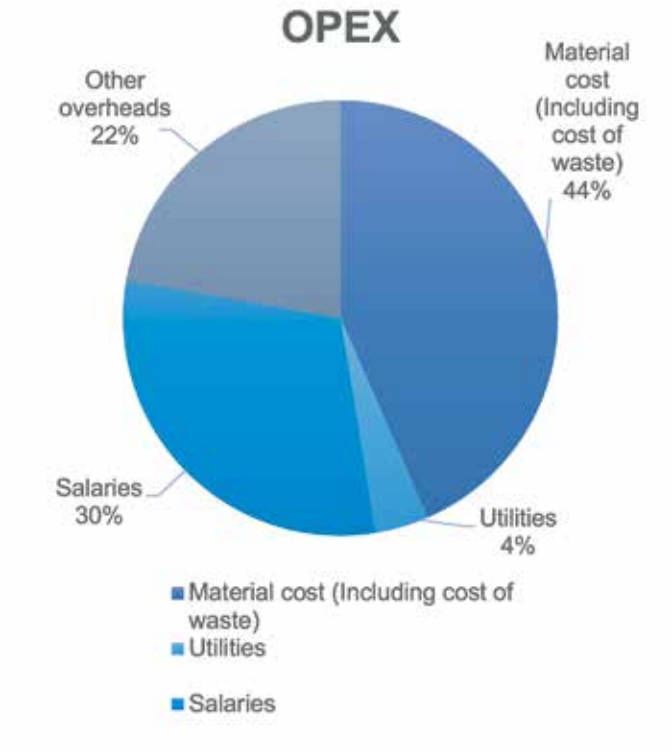
Production Capacity	1200 ton / year
Available Supply	15 million ton / year
1st year production	600 ton / year
Local Market Size	2.25 million ton / year
Local Market Value	1.3 billion EGP / year
CAGR	6%

Financial features. This is the opportunity with the lowest initial investment in this study. It simply requires the purchase of simple shredders, which absorb 63% of the investment. The remaining investment is used as working capital. The opportunity offers medium profitability when compared to those in the study. The IRR is at 42% and the profitability index 5.3. In comparison with the initial investment, the OPEX in this opportunity is high. Despite its simplicity, the opportunity offers good margins when operations are small scale. The ton can be produced at 245EGP and sold for 650EGP. Expanding operations at one point will raise costs with the increasing complexity of the supply chain. Hence, it is a business that is easier to replicate than grow. The payback period of the business is 3 years.

FINANCIAL OUTLOOK

CAPEX	309,000 EGP
1st year OPEX	311,000 EGP
IRR	43%
Profitability Index	5.24
Payback period	3 years
Net Present Value	1.3 million EGP
Production Cost Yr1	245 EGP / ton
Product Selling Price	650 EGP / ton

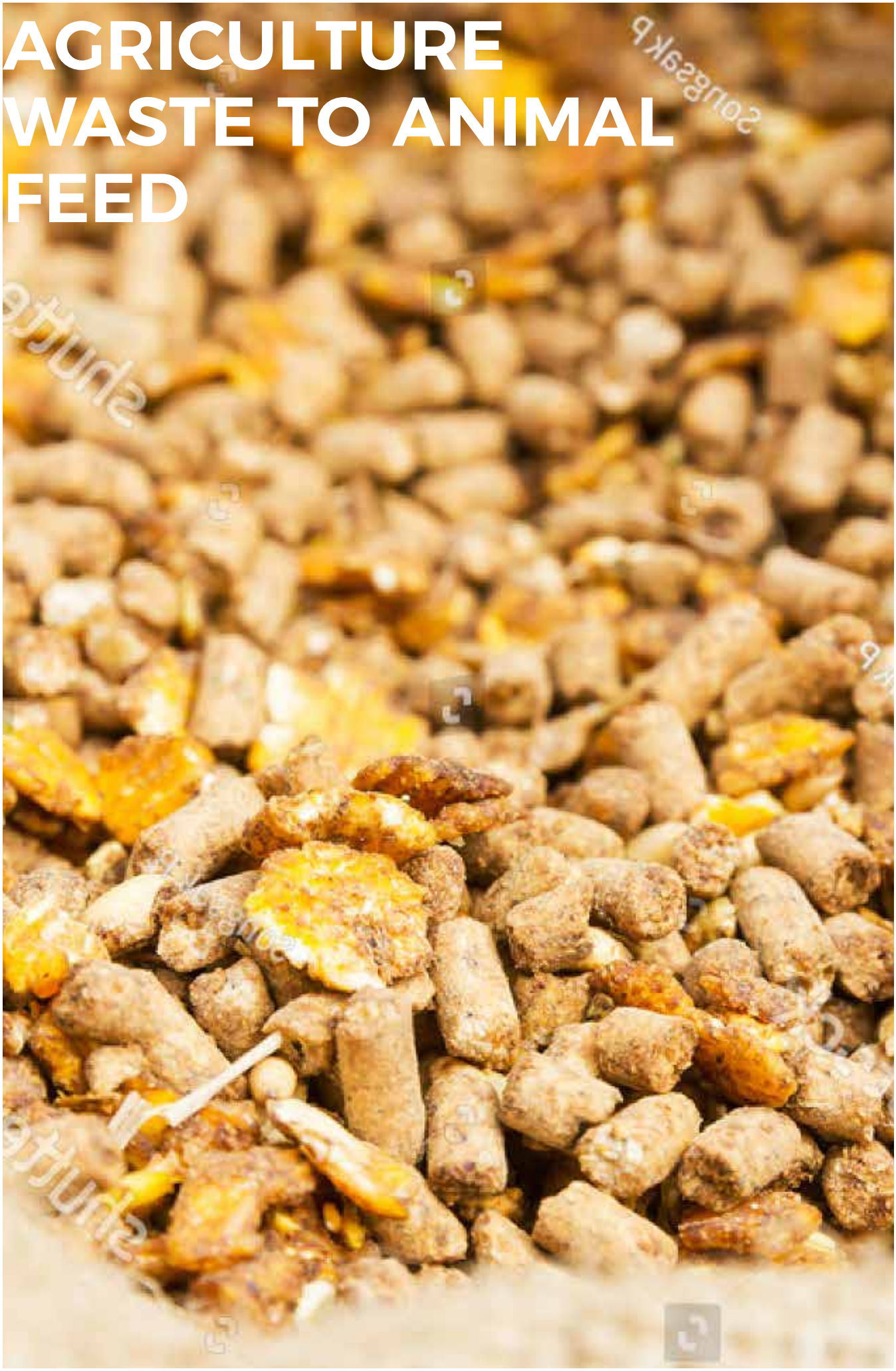




The main challenge. The main challenges are growth and volatility of the market, particular when targeting poultry farms. This is a business that is likely to be associated with other activities carried out by the firm rather than being the only focus.

Business Opportunity Factsheet: Agricultural waste to fibre bedding	
Market	
Final Product:	Fibre bedding for animal farms
Required Inputs:	Corn and cotton waste mainly
Competing Products:	Other bedding materials
Process	
Type of Process:	Mechanical
Technology:	Crushing of corn and cotton waste (eventually expanding into other sources of waste)
Equipment & Material:	Crusher, packaging, and tools/ equipment
Human resources:	Manual labour
Advantages and Risks	
Competitive Advantage:	High demand and ease to produce
Barriers to Entry:	Securing a continuous level of supply to satisfy high demand of farms
Key Stakeholders:	Local farmers to providing agricultural waste, poultry and cattle farmers as bedding consumers, local waste traders
Special Regulations:	NA
Risks and Mitigation Measures:	Seasonality of agricultural waste affects the supply levels, so it's important to have a diverse supply of waste in order to ensure consistency of quantity of end product Scattered sources of supply complicate logistics and increase overall costs of transportation, therefore optimizing the location of the processing facility is key
Economic Features	
Revenue Stream:	Selling bedding to breeders (chicken farms)
CAPEX	309,000 EGP
OPEX	1st year 311,000 EGP
Geography	
Location of Supply:	Supply is mostly in Delta region and Upper
Preferred operation regions:	Delta and Upper Egypt

AGRICULTURE WASTE TO ANIMAL FEED



7.3.4 AGRICULTURE WASTE TO ANIMAL FEED

Outlook on product and technology. Many types of agricultural waste can be used directly as animal feed without any treatment. Others can be shredded (e.g. sugar straw) or grounded (e.g. date pits). In this case, the market and nutritious value will be low. This opportunity targets high quality animal feed that is produced through anaerobic fermentation of agricultural waste. Additives could be included to complement the nutritious value. The feed is sold in standard plastic packs. The product can feed cattle and sheep. The value added in the fermentation process and additives can raise the price of the feed between 10 to 15 times the price of feed using agricultural waste directly without processing. The process of fermentation (i.e. decomposition of waste) is similar to that used in the compost opportunity. However, fermentation occurs in the absence of air. Hence, it is anaerobic rather than aerobic digestion. The technology proposed here is innovative and cuts down the cost of production. The agricultural waste is shredded and brick basins are built or holes dug into the ground. Plastic sheets are lined underneath the basins/holes that are filled with agricultural waste and additives. Some biological agents might be added to accelerate fermentation. Plastic sheets are folded and tightly zipped around the mix and left to ferment for approx. a month. The plastic wraps are sold as a whole and once opened need to be consumed within a few days. The produced animal feed cannot cover 100% of cattle dietary needs, but using it can reduce cost of animal breeding significantly.

Access to supply. In this opportunity, various types of waste streams can be utilized, such as corn stalk, sugar cane straw and stalk, etc. Access to supply is as discussed for the aerobic composting opportunity.

Market size and features. Animal breeding expenses are highly dependent on the cost of animal feed. In Egypt, small scale breeders and individuals carry out most of the cattle breeding for personal usage of less than 5 heads. There are few large scale breeders. However, both categories suffer from shortage of animal feed and its increasing prices. Agricultural waste cannot replace all fresh animal feed, but at least it can replace two categories of animal feed, (1) total digestible nutrients (TDN) and (2) dry matters. The gap in the Egyptian market between local production and demand is 2.3 million tons of TDN and 4.2 million tons of dry matters, which are covered by imports[69]. Egypt is a net importer of animal feed. Local agricultural waste based feed discussed above is likely to have a 30% cost advantage for the same quality compared to imported animal feed as well as fresh animal feed. In Egypt, the growth of cattle averages at 4% since 2013, despite the economic downturn. Available agricultural waste that can be used as animal feed is about 10 million tons/year and the market can absorb 6.7 Million tons/year. The opportunity is profitable at 1800 tons yearly production. This will capture less than 0.1% of the enormous market size.

MARKET OUTLOOK

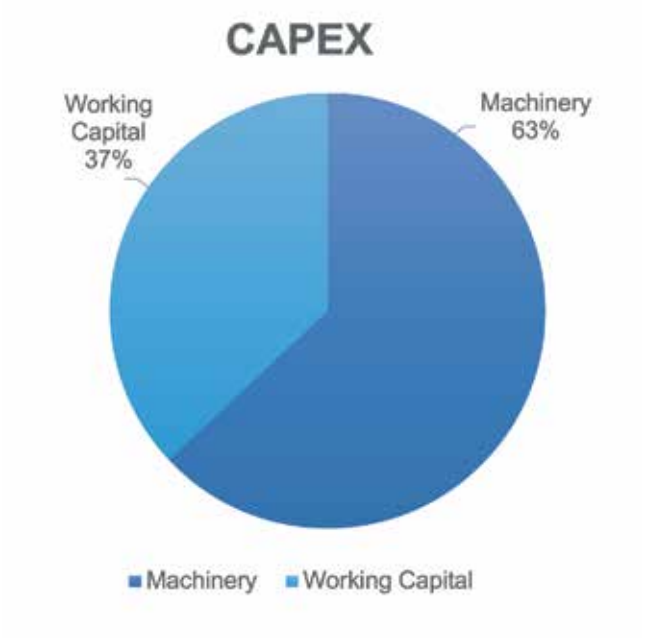
Production Capacity	2400 ton / year
Available Supply	10 million ton / year
1st year production	1800 ton / year
Local Market Size	15 million ton / year
Local Market Value	1.9 billion EGP / year
CAGR	6%

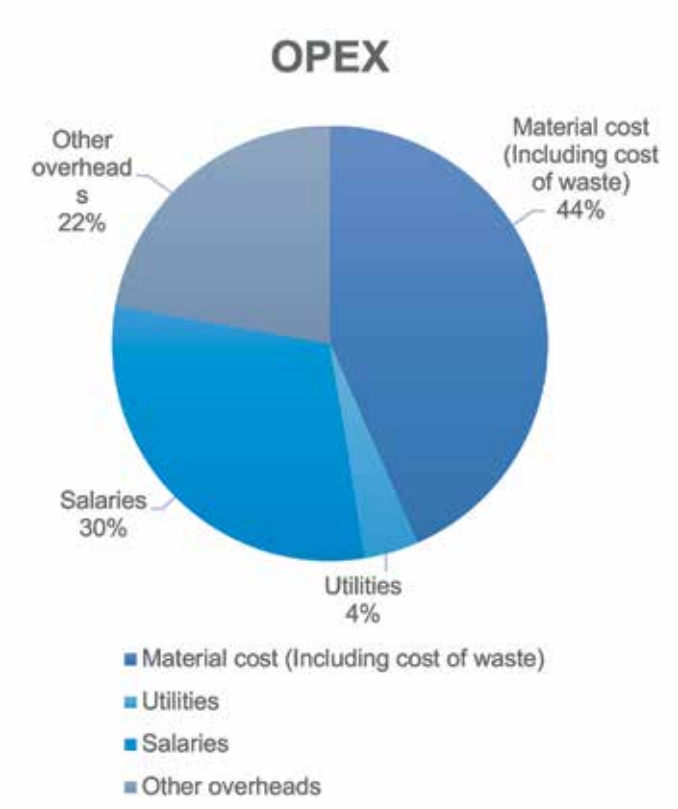
Financial features. Due to the business model and technology proposed, operations can be initiated with an investment of 1.1 million EGP. Starting with the lowest value added product, the IRR is 20.6% and profitability index at 2.4. Raising the product selling price to 1,200 EGP/ton from 900 increases the IRR and profitability. About 63% of the initial investments is used for machinery, while the rest is working capital. The OPEX is 1.3 million in the first year, which is higher than the CAPEX. In the first year, the product is produced at a cost of 615EGP/ton. This can decrease with increased production. The cost of acquiring the waste including transportation consumes 44% of the OPEX. Salaries account for 30% of the OPEX, since most of the activities are carried out manually. If shredders are rented, the CAPEX can be significantly reduced. Hence, this opportunity offers a chance to enter the market with minimal initial investment capital, once the know-how of the process is acquired. The payback period of the business is 4 years.

FINANCIAL OUTLOOK

CAPEX	1.1 million EGP
1st year OPEX	1.3 million EGP
IRR	20.6%
Profitability Index	2.39
Payback period	4 years
Net Present Value	1.5 million EGP
Production Cost Yr1	615 EGP / ton
Product Selling Price	900 EGP / ton

[69] *Hamid M. Mousa, Rania M.Barghash, and Ahlam A. Hassan, "The Current Situaton of Th Animal Feed Gap in Egypt," 2011.*





The main challenge. The main challenge of this opportunity is to keep the product in good storage conditions, due to its sensitivity to weather and aeration conditions. Challenges also include maintaining strong quality control, as the feed can rot or fungus can grow in the case of imperfect wrapping processes. Further, effective technical support to the clients is required, as the animals might not be used to eating the new type of feed.

Business Opportunity Fact Sheet: Agricultural waste to animal feed	
Market	
Final Product:	Cattle and Sheep Fodder
Required Inputs:	Agricultural waste (e.g. sugarcane waste, second grade dates and rejected tomatoes)
Competing Products:	Pelleted feed, grains
Process	
Type of Process:	Mechanical process and anaerobic fermentation
Technology:	Shredding, grinding, fermentation build brick factories and cover in plastics, additives arrange in rows, seal in packs, close for longer time, open at once, agricultural waste should be fresh
Equipment & Material:	Shredder, Grinder, plastic covers
Human resources:	Labour – engineers – biochemists
Advantages and Risks	
Competitive Advantage:	High demand for animal feed, and Product has better quality than homemade feed with affordable prices
Barriers to Entry:	Finding the proper mix of feedstock
Key Stakeholders:	Farmers, Agriculture Directorate, Research centres, accredited laboratories (public and private sector)
Special Regulations:	NA
Risks and Mitigation Measures:	High probability of contamination (can be judged by smell and PH value) with large quantities due to lack of awareness, plastic scratched Mitigation measures are continuous monitoring, in case of batch spoilage batches can be changed into compost
Economic Features	
Revenue Stream:	Sale of animal feed to livestock production industry, farmers
CAPEX	1.1 million EGP
OPEX	1st year 1.3 million EGP
Geography	
Location of Supply:	Supply is mostly in Delta region and Upper
Preferred operation regions:	Delta and Upper Egypt

ORGANIC WASTE TO FISH AND POULTRY FEED

7.3.5 ORGANIC WASTE TO FISH AND POULTRY FEED

Outlook on product and technology. The product is similar to the previous opportunity as it is also used as fish or poultry feed. Unlike the rest of the opportunities in this section, this one utilizes organic MSW not agricultural waste. In this business opportunity, black soldier fly larvae are used to simply eat and digest organic waste. When the larvae grow they can be used as high protein feed in fisheries and poultry farms. Black Soldier Flies are bred in netted boxes. Eggs are transferred to hatcheries and the larvae are harvested into buckets where they can be fed with the organic waste. Once larvae reach the stage where they stop feeding, some can be sold as feed and others can be transferred to units where they can breed into flies. The percentages between breeding flies and sold larvae has to be delicately maintained. The technology is mostly manual and the knowhow can be acquired with time and training. The production cycle is short and should not exceed few days.

Access to supply. This opportunity is unique as it tackles one of the most environmentally challenging waste streams in Egypt, the organic fraction of MSW. As discussed above the stream usually accumulates in dumpsites, streets, and sometimes waterways and canals. In this opportunity, the organic waste is collected from dumpsites or purchased from waste collectors at extremely low prices. The startups and/or SMEs can establish contracts with compounds to collect the organic waste for a discounted fee by the startup or the SME. In the future, municipalities can deliver waste to production sites and pay for the service. The opportunity could also be combined with general waste collection services, where the MSW is handled as a whole. Recyclables are segregated and the organic fraction is fed to the larvae. Supply can be acquired for free as collectors can simply dispose it at the production site instead of dumping it in open areas. Extremely limited amounts of waste are needed to operate profitably and hence risks with acquiring supply are minimal. However, for this opportunity to grow into a large industry that absorbs all the amounts of waste available policy reform is needed and municipalities regulate the collection and disposal of the organic fraction of MSW.

Market size and features. In Egypt, both poultry and fishery industries are rapidly growing. Poultry production is expected to increase at about 8% annually. Egypt's annual consumption of poultry was 1.2 billion chicken[70]. Given that the breeding cycle for chicken takes 60 days on average and every chicken needs 3.5 kg of feed during its lifetime, thus approx. 4.2 million tons of poultry feed is consumed every year. Assuming that worms can replace only 10% of traditional poultry feed, poultry feed alone can consume 420 K tons of worms annually with a total value of 4.2 billion EGP[71].

Fisheries contribution in Egyptian annual production of fish is nearly 77%, which is equal to 1.1 million tons of fish[72]. The cost of feed per kg of fish equals 12 EGP[73-74]. Hence, the total value of fish feed annually equals to nearly 13 billion EGP. For every kg of fish, 1kg of feed is needed.

[70] *Yevgen Shatokhin, Mohammed El Gammal, and Dmitry Prikhodko, "Broiler Poultry Industry: Investment Challenges and Opportunities" (FAO, 2017).*
[71] *Prices were correlated based on current exchange rates (1 USD= 17.8 EGP)*
[72] *Ahmed Nabil Mohammed and Sahar F. Mehanna, "Fish Production in Egypt: Current Status and Future Perspective" (Conference on International Research on Food Security, Natural Resource Management and Rural Development organized by the University of Natural Resources and Life Science, Vienna, Austria, 2016).*
[73] *GAMAL EL-NAGGAR, AHMED NASR-ALLA, and KAREEM. R.O, "ECONOMIC ANALYSIS OF FISH FARMING IN BEHERA GOVERNORATE OF EGYPT," 2004.*
[74] *Prices were correlated based on current exchange rates (1 USD= 17.8 EGP)*

Assuming that worms can replace 10% of the annual consumed fish feed, then the market size were to amount to 110 K tons, which is equal to 1.1 billion EGP. The business can operate profitably at an extremely low production rate compared to previous opportunities and available supply. The opportunity focuses on a production capacity of 72 tons/year and first year production of 36 tons/year. This decreases the stress and risks associated with acquiring waste. For the same nutritious value, the larvae will have a competitive price advantage of about 30% compared to traditional alternatives. However, this product is quite new to the Egyptian market and even internationally only became established recently. Initially there might be resistance to switch to the new product in the market, particularly given the stigma associated with waste based products. This should be overcome through product, demonstrations and after sales technical support. The resistance will be less in fisheries, as a worm-based diet is more common and local fisheries already utilize a multitude of organic waste based feed. However, licensing would take time and a supportive policy framework to fully unleash the potential of this opportunity as well as biological treatment of waste at large is required.

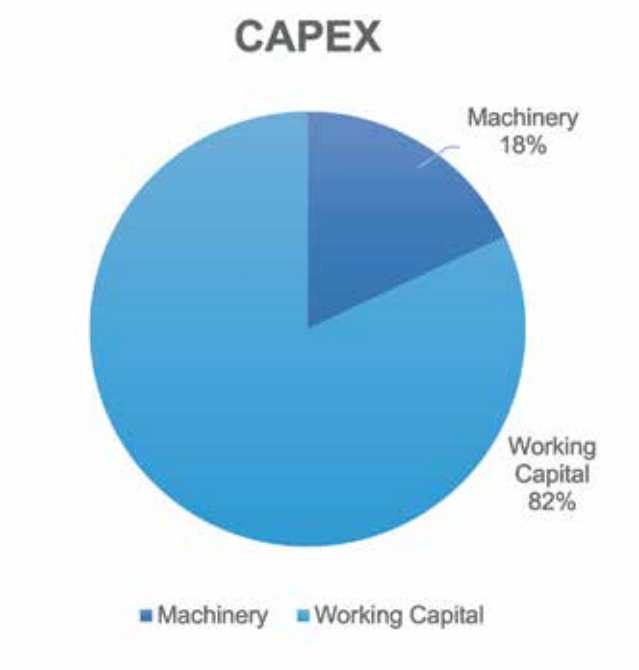
MARKET OUTLOOK

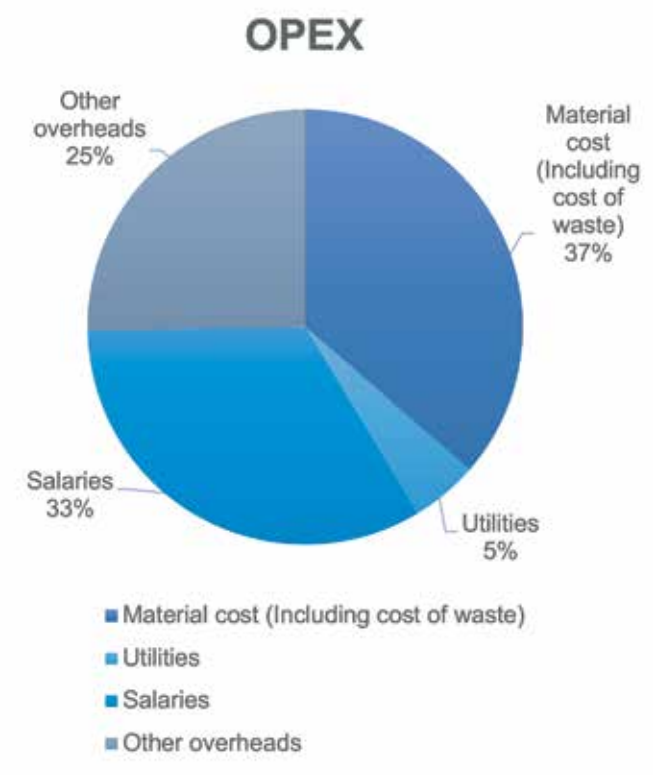
Production Capacity	72 ton / year
Available Supply	1.2 million ton / year
1st year production	36 ton / year
Local Market Size	5.3 million ton / year
Local Market Value	5.5 billion EGP / year

Financial features. A profitable business can be set up with an initial investment of just 163,000 EGP. This is the lowest investment needed in the present study. About 18% is used in setting up the infrastructure, in which the flies can breed and the larvae can feed (i.e. hatcheries, feeding containers). The rest of the investment goes into working capital. The IRR is about 30% and the profitability index about 4.7. The business is OPEX intensive. The first production year requires 377,000 EGP, which is higher than the initial investment required. The contribution of the cost of waste including transportation to the OPEX is at 37%, which is among the lowest in the present study. In general, this reflects working with waste that is usually perceived of low value with few productive uses. The salaries have a high share of the OPEX at about 33%, since the business relies heavily on manual labour. The business has rapid cash conversion cycles. In the first year, the product can be produced for 4,290 EGP/ton and sold for 10,000 EGP/ton, which provides the business with comfortable margins. The payback period of the business is 4 years.

FINANCIAL OUTLOOK

CAPEX	163,000 EGP
1st year OPEX	377,000 EGP
IRR	29.7%
Profitability Index	4.69
Payback period	22 months
Net Present Value	601,000 EGP
Production Cost Yr1	4,290 EGP / ton
Product Selling Price	10,000 EGP / ton





The main challenge. The main challenge in this opportunity is maintaining good level of hygiene. Organic waste can easily rot and lead to serious diseases between workers if they do not follow strict health measures, especially since multiple activities are done manually. There must be a strict health and safety code of conduct implemented, followed by continuous trainings for workers. Furthermore, regular monitoring of flies and larvae status is required. Growing the business needs long term contracts with municipalities of private sector waste suppliers. Another challenge is the potential resistance of clients towards using a new product.

Business Opportunity Factsheet: Organic waste to fish and poultry feed	
Market	
Final Product:	Worms that can be eaten by fishes and poultry
Required Inputs:	Organic waste in general (food waste in specific) from households, touristic facilities, and restaurants and Black Soldier Fly Larvae
Competing Products:	Pelleted fish food, pelleted poultry food, corn
Process	
Type of Process:	Bio-digestion of organic waste
Technology:	Organic waste processing with Black Soldier Fly Larvae
Equipment & Material:	Worms hatcheries, Grub tubs and collection buckets
Human resources:	Manual labour, technical specialist
Advantages and Risks	
Competitive Advantage:	High protein content; easily scalable (modular)
Barriers to Entry:	High competition from large private and public animal feed industries
Key Stakeholders:	Farmers, agriculture directorate, research centres, traders, extension services
Special Regulations:	NA
Risks and Mitigation Measures:	Lack of market awareness and quality control Mitigation measures are using promotional tools and co-selling/branding and hiring technical experts
Economic Features	
Revenue Stream:	Sales of worms
CAPEX	163,000 EGP
OPEX	1st year 377,000 EGP
Geography	
Location of Supply:	Across Egypt
Preferred operation regions:	Nearly all over Egypt except for inside urban cities where no place for processing organic waste

7.4 OUTLOOK ON FINANCIALS OF BUSINESS OPPORTUNITIES.

The selected opportunities vary in initial investments. Hence, they can attract various types of entrepreneurs and investors (Figure 46). In general, this market has the lowest initial investment requirement. Technologies are simple and less dependent on complex machinery when comparing to the previous markets. The true productive asset in these markets is the biological agent that carries the digestion process itself (except for fibre bedding where the process is mechanical). In general, biological technologies are less capital intensive than mechanical, thermal, or chemical technologies. The production capacity, which is required to operate profitably, is also limited compared to previous markets. It varies from few tons per month to few hundred tons per month. It is possible to start with as little as 6 tons/month to a maximum of 400 tons/month, as targeted in the present studies. Even less capital-intensive models than those presented above can be developed for these models.

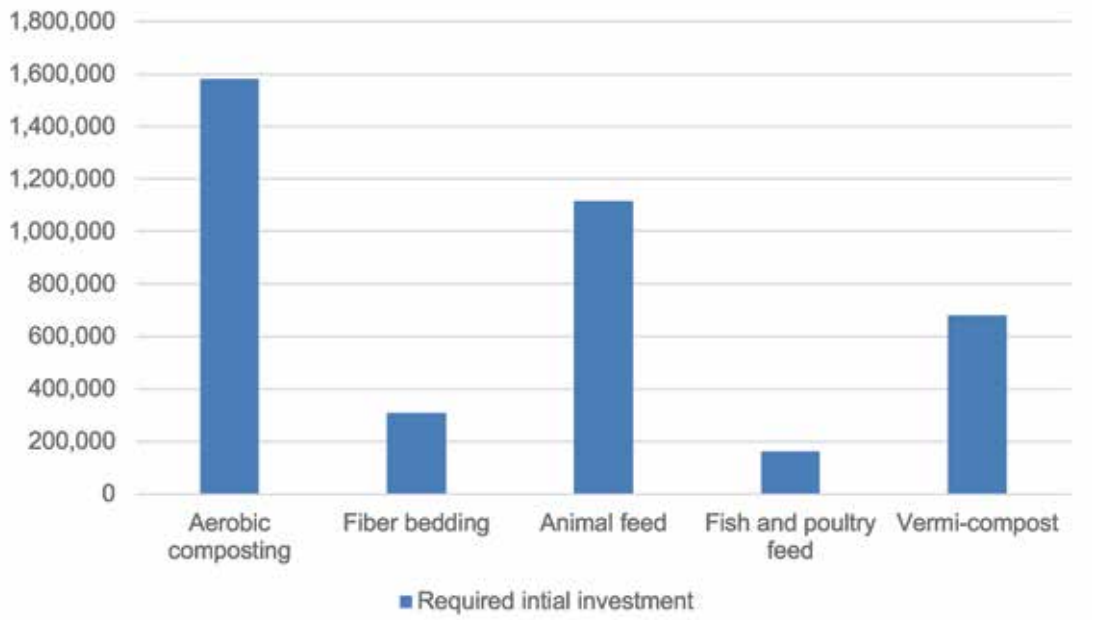


Figure 46: Required initial investment for top ranked business opportunities in the agricultural market

In terms of profitability, the models presented have a low IRR compared to those in the present study, ranging from 20% to 45%, given the most opportunities are in the medium range of 40% to 70% (Figure 47). However, in most opportunities the product quality can be increased with experience and without further asset investments. This would push profitability to the higher range exhibited in this study. The exception being the fibre bedding business, where there is limited room for improvement.

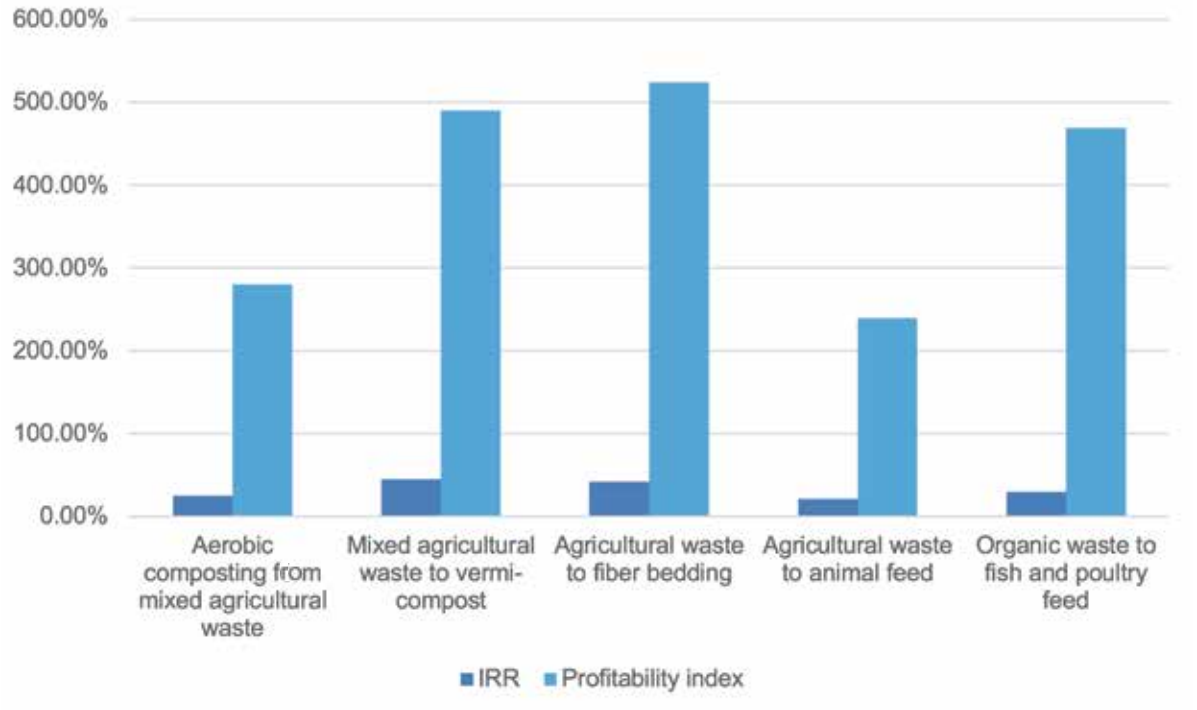


Figure47: Internal rate of return and profitability index for top ranked business opportunities in the agricultural market

7.5 SOCIO-ECONOMIC AND ENVIRONMENTAL IMPACT

Economic impact. Four of the five markets identified in the present section operate using agricultural waste. Each of the four can create the following economic impact in terms of market value:

24 billion EGP in compost
6.9 billion EGP in vermi-compost
1.3 billion EGP in fibre bedding
5.8 billon EGP in animal feed

However, there is an overlap between the waste absorbed in each opportunity. Hence, the total economic impact is 9.5 billion EGP/year. The fish and poultry feed market operate on organic MSW. The market can absorb 3 million tons of organic waste and hence the economic impact is 5.3 billion EGP/year.

The agricultural sector waste markets can collectively contribute to the economy with 13.8 billion EGP annually. There is an indirect positive economic impact to the present market. The opportunities above provide the agricultural sector with inputs to the production process, which are at least 30% less expensive than its alternatives. This can increase margins for the agricultural sector, which is under high pressure. The waste based products also increase the sustainability of the agricultural sector as well as its resilience. All this contributes to Egypt's food security. In most cases, the products do not replace imported goods, hence its direct impact on Egypt's trade balance is limited.

Social impact. The aerobic composting business opportunity creates 4-6 direct and about 150 indirect job opportunities in transportation and waste collection. In order to cover the market needs, about 4000-5000 direct and 150,000 indirect job opportunities will be created. For the vermi-composting opportunity, 4-6 direct and about 20 indirect job opportunities are created. In order to cover the market needs, about 6400-9600 direct and 240,000 indirect jobs can be created. The fibre bedding business opportunity creates 4-5 direct and about 40 indirect job opportunities in transportation and waste collection. In order to cover the market needs, about 4000-5000 direct and 150,000 indirect jobs will be created. The fish and poultry feed business create 4-6 direct and about 6 indirect job opportunities in transportation and waste collection. In order to cover the market needs, about 6400-9600 direct and 6400 indirect jobs would be created. Finally, the animal feed business opportunity creates 4-5 direct and about 80 indirect job opportunities in transportation and waste collection. In order to cover the market needs, about 4000-5000 direct and 80,000 indirect job opportunities would be created.

The markets mentioned above are among the most job intensive ones. The impact on indirect job creation mostly in collecting waste is also high compared to other markets. About 21,000 direct job and 500,000 indirect job opportunities can be created in the markets above. The reason for the high job creation is the large market sizes. In addition, production is labour intensive. The majority of direct and indirect job opportunities do not require skilled/educated labour and can be easily learnt. In addition, at least 25% of the job opportunities are suitable for female employment.

Environmental impact. The opportunities working in agricultural waste can help divert the stream from open burning, which is common practice in Egypt, to productive

uses. The key four opportunities can absorb the following amounts of waste:

- Large scale, high quality compost can absorb 5.3 million tons/year of agricultural waste;
- Vermi-compost can absorb also 5.3 million tons/year of agricultural waste (same supply base as the above);
- fibre bedding can absorb 2.25 million tons/year;
- Animal feed can absorb 10 million tons/year.

The pool of agricultural waste used for compost and animal feed is likely to be the same. Hence, the opportunities working on agricultural waste streams can absorb collectively 15 million tons annually. About 100%[75] of the waste is currently openly burnt, with only a small percentage used for low value-added activities.

Based on the fifth opportunity of fish and poultry feed, the environmental and health impact are significant, as they make use of the most problematic waste stream in Egypt, the organic fraction of MSW. This stream either disposed at dumpsites and waterways or is used as animal feed in a setting below accepted standards. The opportunity can absorb 1.2 million tons of organic MSW out of 5.3 million. Thus, solving 20% of the most problematic waste. A market advantage of the organic fraction of the MSW is its yearlong availability.

For markets to absorb more municipal organic waste, the production of compost and animal feed should be encouraged. As well as policy and regulatory interventions are needed. Access to supply and better management of organic MSW is necessary. Segregation at homes might be a solution. The animal feed and compost markets are able to use more municipal organic waste than currently being absorbed. There are two main barriers facing the utilization of municipal organic waste in those two products, (1) legal and (2) quality barriers. Laws and regulations prohibit the use of organic waste as animal feed. Thus far, it is only used informally. The quality of compost produced from organic waste is considered low by the market and hence its price is 10th of that from agricultural waste. This is mainly due to its level of contamination. Without segregation at source, it remains difficult to leverage municipal organic waste effectively in composting. The only existing large scale utilization of municipal organic waste in composting takes place at recycling factories, which rarely make a profit on compost. Perhaps, encouraging businesses that help the few homeowners to produce compost at home, through for instance "bokashi", a company offering home-based composting tools, or other type of processes, is a start. Another route for productive uses, which can absorb the organic fractions of MSW, is dry fermentation for the production of electricity and compost. Yet, without feed in tariffs, businesses in the sector are not viable.

[75] *At least 50% of agricultural waste is burnt (Total annual generated quantities are 30 million tons) and accordingly we are covering 100% of burnt quantities.*

SECTION 8

SUPPORTING PRODUCTS AND SERVICES

8.1 OVERVIEW OF THE MARKET

Supporting Waste Recycling Markets. The present market is unique since it addresses supporting activities to all previous markets. It does not focus on recycling or producing waste based products. It focuses on products and services that empower the value chains. The mapping of activities in the present study led to identifying an opportunity in collection that can fill a market gap as well as an opportunity, which focuses on the production of equipment and machinery used in recycling. Despite not directly using waste into productive activities, the two opportunities will reflect in a healthy manner on recycling businesses in general. A more effective collection system would provide recyclers with a steady stream of feedstock, particularly for waste streams of low perceived values. The local production of machinery reduces the CAPEX of startups and SMEs. Locally manufactured machinery provides a wider range of production capacities, which reflect positively on collectors, pre-processing businesses, and recycling startups and SMEs. The two opportunities address essential problems that were identified by interviewed companies and experts.

Towards a more effective collection service. This opportunity can address two gaps in the market. One is the informality of activities in collection and the second is the low effectiveness of collection services in rural areas. Operating informally means having less access to capital for growth. Further, it means that startups and SMEs purchasing waste from informal collectors will have difficulties reflecting the financial position accurately to lenders and investors. An effective and formal collection service will not only allow collectors to grow, but also boost the growth of startups and SMEs through improved access to supply. The part related to opening a route to formalization is primarily a policy issue, which many countries have faced. However, meanwhile, there are also opportunities in establishing collection services that are professional and effective in rural areas. Unlike in large cities, in some rural areas the informal sector currently has less interest to collect the waste, due to the limited amounts of recyclables and fragmentation of waste generation. It is in these areas where the opportunity is for formal collection activities to develop.

Increasing access to machinery. There are machines, which are widely needed in all the markets above and are becoming increasingly expensive to import. These include shredders, crushers and pressing machines. Designing and building such machinery falls within the engineering industry sector where Egypt has the skills and experience. There is a gap in the market of machines with small/medium production capacities (ton per hour or less). This makes it difficult for startups and SMEs to start their operations. It also makes collection, of e.g. agricultural waste, less effective, where having the capacity to process waste on site decreases the volume of material to be transported. Furthermore, there is a class of industrial clients who are increasingly interested in pre-processing waste before disposal to ensure it is not misused. This includes shredding defective products or packing units to avoid its reuse informally, which might hurt the original brand. Below is a brief discussion on the increasingly important business opportunities such as:

- Collection of MSW in rural areas and small cities
- Recycling machines design and manufacturing

8.2 IDENTIFIED BUSINESS OPPORTUNITIES IN SUPPORTING PRODUCTS AND SERVICES

In this market, the nature of the discussion is different from that in the previous sections. First of all, the supply is quite different and so are the clients. The clients in collection are the households and/or municipalities. Collection businesses could be carried out by a cooperative or an NGO. The client of the design and manufacturing of machinery are the recycling firms themselves. The supply in collection is the waste at households and in machine production is metals, components and motors, etc. Unlike the previous sections, there is no discussion regarding potential amounts of waste being recycled, since it is not the objective of the businesses. However, these businesses will indirectly increase the amount of waste recycled.

COLLECTION OF MSW IN RURAL AREAS AND SMALL CITIES

8.2.1 COLLECTION OF MSW IN RURAL AREAS AND SMALL CITIES

Outlook on service and technology. Wherever informal activities in collection already exist, support in formalization is advised instead of establishing new formal businesses to compete with existing activities. This has been the strategy of the Ministry of Environment and it should be continued. Formalization is a slow process and requires a comprehensive policy package. The focus in this business opportunity is on areas where informal sector is inactive. In certain areas (rural and small urban centres), the collection service provided by municipalities can fall short of aspirations of citizens. In addition, the amounts of recyclables are limited to attract effective private sector collectors. Collectors' main revenue streams are from selling segregated waste. The collectors in urban centres are used to operating on large amounts of waste in limited areas and mostly finance their operations from revenues of selling recyclables, which are collected at a low cost and sizable amounts. The business model in the present opportunity is different. It focuses on financing the operations from collection fees and selling pre-sorted RDF to RDF firms, it also focuses on pre-processing activities which raise the value of low amounts of sold recyclables. In various governorates (e.g. Luxor and Menya), cooperatives and NGOs have proven that citizens are willing to pay higher collection fees an for effective collection service. This has been proven in various surveys and pilot projects. These models can be expanded with the concept that private sector collectors would cover regions of 10,000 residents (few small villages or one or two medium ones). This would be accompanied by establishing sorting facilities with the purpose of producing RDF, which can be sold to RDF firms. In that case, the collector is a subcontractor for the RDF firms. In addition, due to the low amounts of recyclables simple pre-processing must be carried out to raise the value. This including pressing paper and cardboard, cans, and later shred plastics into flakes. Pressing can be done using a single machine. Transportation could be done by tractors, tricycles, or small trucks. The organic waste which will be the majority should be composted or eventually treated using the bio-digestion technologies explained above.

Access to supply. Access to supply in that case is facilitated by coordination with municipalities as well as potentially local NGOs. In addition, direct engagement of residents is crucial. It might be the case that the waste disposed by residents is currently sorted by pickers who directly collect the recyclables. It is also common that residents sell few recyclables and hence the business has to be prepared to operate on low amounts of recyclables and RDF.

Market size and features. The number of citizens in rural areas without adequate collection services is difficult to estimate. However, the amount of waste could be estimated to 6 million tons/year. The amount of MSW that can be collected through the model presented is about 90,000 tons/ year. The market is shaped by the mistrust of citizens in the current collection services offered and their frustration of lower living standards due to the waste accumulation. Hence, the business must convince citizens that the service will be effective and is worth its fee. This should be coupled by timely service and professional staffing. The collection fee could be 4-10 EGP/month per household of max. 5 citizens. The sub markets also providing revenue stream include RDF, which would be about 10% of the waste amounts collected. Other revenue streams will include selling glass directly, and compressed paper and cardboard, cans, and plastics. The amount of waste targeted is about 90,000 tons annually per business.

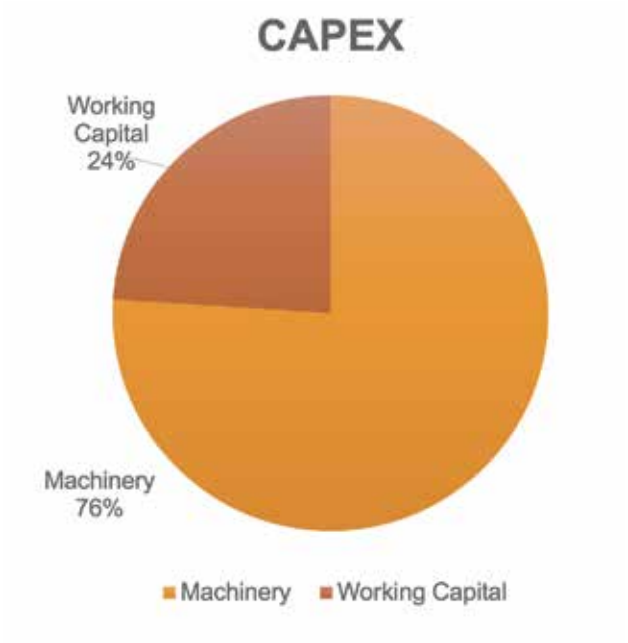
MARKET OUTLOOK

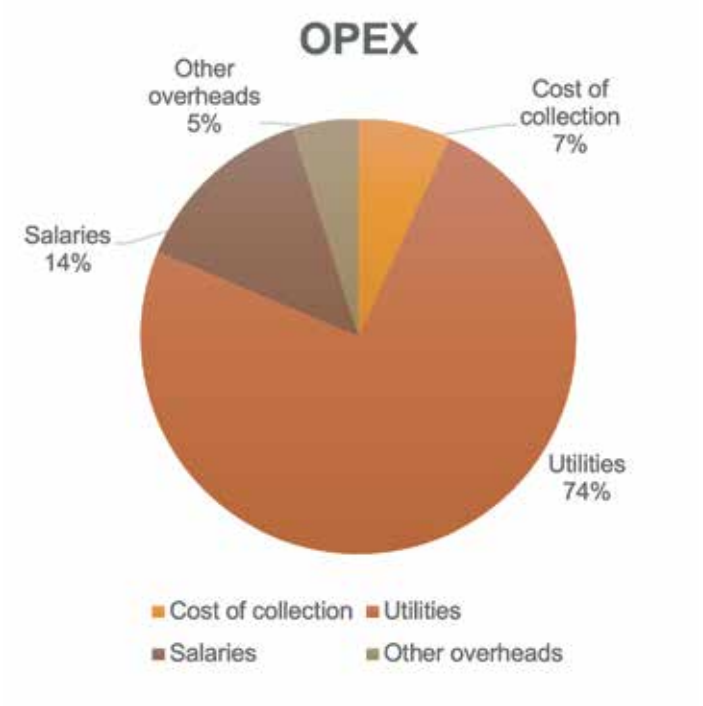
Production Capacity	90,000 ton / year
Available Supply	6 million ton / year
1st year production	45,000 ton / year
Local Market Size	6 million ton / year
Local Market Value for service	210 million EGP / year
Local Market value for selling waste	720 million EGP

Financial features. The initial investment required is 5.5 million EGP. This mostly goes into transportation vehicles, pressing machines and a sorting line. These are the typical machinery, which can be produced locally. Machinery and vehicles represent 76% of initial investments. Vehicles alone are about 55% of initial investment. It is easy to finance vehicles through loans. Thus, acquiring investment for this opportunity is easier than other opportunities. The OPEX of the first year exceeds the initial investment at a total of 6 million EGP. This is one of the businesses of the highest OPEX compared to initial investments. Yet, most of the OPEX goes into fuel for transportation vehicles maintenance as well as electricity to operate machinery either through the grid or through diesel generators. If set out properly, this can be a lucrative business. The IRRs is 30% and the profitability index is 3.04. This remains at the lower side of IRR in the present study. Yet, it is also a service and risks are limited. The calculated IRR only consider sales from recovered waste as RDF, however, if service fees are added, recyclables are sold and recycling of organic matter is included the returns will be significantly higher. The payback period of the business is 4 years.

FINANCIAL OUTLOOK

CAPEX	5.5 million EGP
1st year OPEX	6 million EGP
IRR	30%
Profitability Index	3.04
Payback period:	3.04
Net Present Value	11.2 million EGP

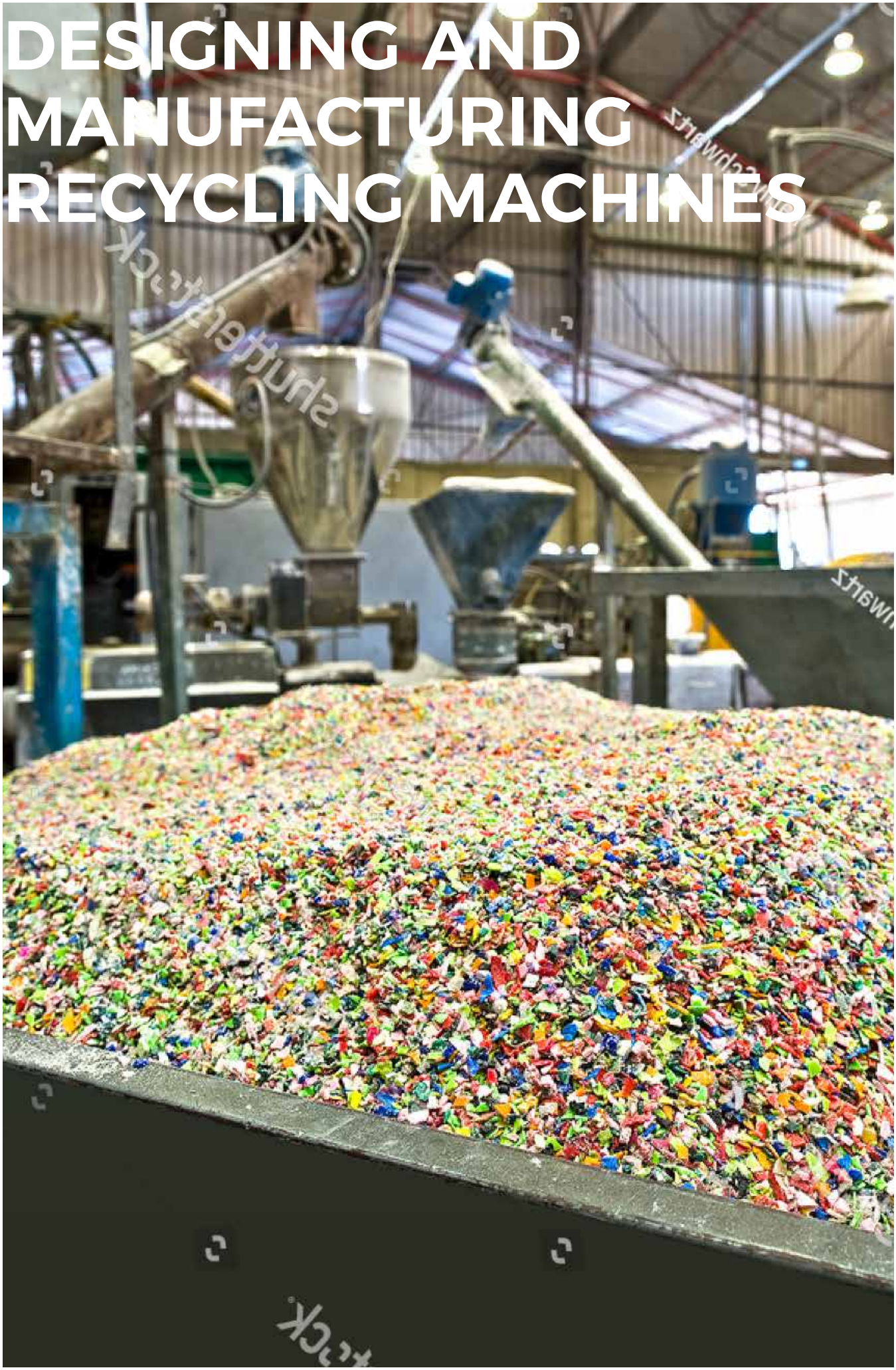




The main challenge. The main challenge in this business include maintaining timely service, which encourages citizens to continue paying for service fees. In addition, other challenges include being able to gauge the number of citizens in certain geographic area as well as the amounts of recyclables to be recovered. This reflects strongly on the financials of the business. The data in the this study can help meeting these challenges. Training of employees and strong public awareness raising regarding the importance of paying higher fees for the service mitigates challenges. In some areas, it was possible to start segregation at homes, which reflects well on business financials.

Business Opportunity Factsheet: Collection of MSW in rural areas and small cities	
Market	
Final Product:	Collection of MSW from households and commercial facilities, selling sorted MSW to waste management companies
Required Inputs:	Waste from households, offices, universities, and schools (MSW mainly)
Competing Products:	Collectors and informal sector
Process	
Type of Process:	Manual labour, mechanical Process
Technology:	Manual technology mainly: mapping, communication, collection and pre-processing (possible)
Equipment & Material:	Trucks, sorting conveyor
Human resources:	Labour and drivers
Advantages and Risks	
Competitive Advantage:	Controlling beginning of the value chain therefore control price
Barriers to Entry:	Informal waste collectors, households, municipalities
Key Stakeholders:	Informal waste collectors, Households, municipalities
Special Regulations:	License from EEAA, license from municipality and license for cars from Ministry of Interior
Risks and Mitigation Measures:	Competition with informal sector valuable recyclables and collection fees Mitigation measures are 1) Designing financial and business model to make profit without bin based on valuable recyclables 2) work in governorates and neighbourhoods where there is a gap in collection service providing
Economic Features	
Revenue Stream:	Sale of waste to different entities down the value chain (incl, startups)
CAPEX	5.5 million EGP
OPEX	1st year 6 million EGP
Geography	
Location of Supply:	All over Egypt
Preferred operation regions:	All over Egypt

DESIGNING AND MANUFACTURING RECYCLING MACHINES



8.2.2 DESIGNING AND MANUFACTURING RECYCLING MACHINES

Outlook on product and technology. This business opportunity focuses on designing and manufacturing custom made recycling machines. Sales of machines is the main revenue stream. Most common machinery include sorting lines, shredders of plastic and agricultural waste, pressing machines which can work with plastics, cans, as well as paper and cardboard. Pelleting machines are also starting to be in high demand. The used technology is basic machining and forming processes for which Egypt have the experienced and skilled workers. The process also involves design. Main inputs include motors, gears, belts, as well as other components needed in the production of machinery. Automation of machines will be of value added. This requires a highly skilled labor force as well as designers. Supply in this case is the components, metal sheet and rods, motors and whatever is needed for the production process.

Market size and features. The market size is difficult to assess. However, a very rough estimate is 3,200 systems per year, which is based on the number of needed machines that should be manufactured to satisfy the demand for RDF and aerobic compost, given the average price per machine of 200,000 EGP. Accordingly, the local market value would be between 620-640 million EGP/ year. One of the benefits of this market is the possibility to operate profitably with a production volume of as little as 5 machines per year. If overheads are kept low, the revenue from selling few machines can cover operations. The targeted production is 60 systems per year which covers an extremely slime slice of the market of less than 2%. The market is rapidly growing with the increasing rate of waste in Egypt but also with the higher demand on local produced equipment over imports after the floatation.

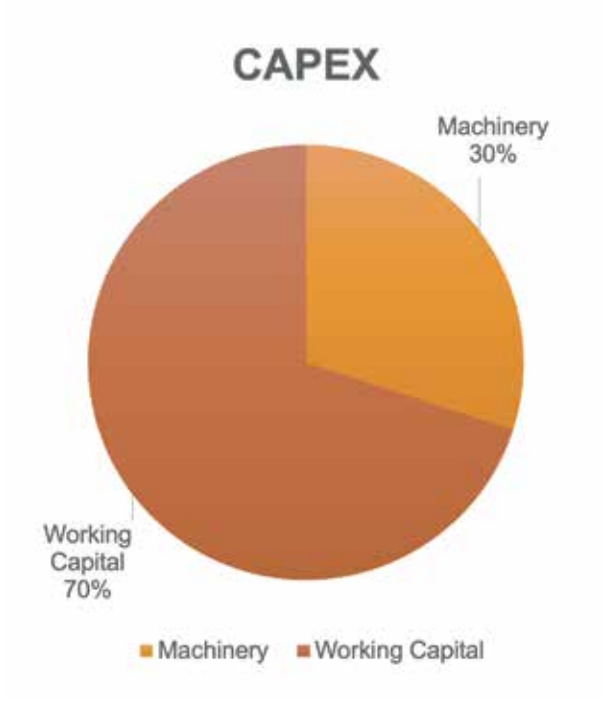
MARKET OUTLOOK

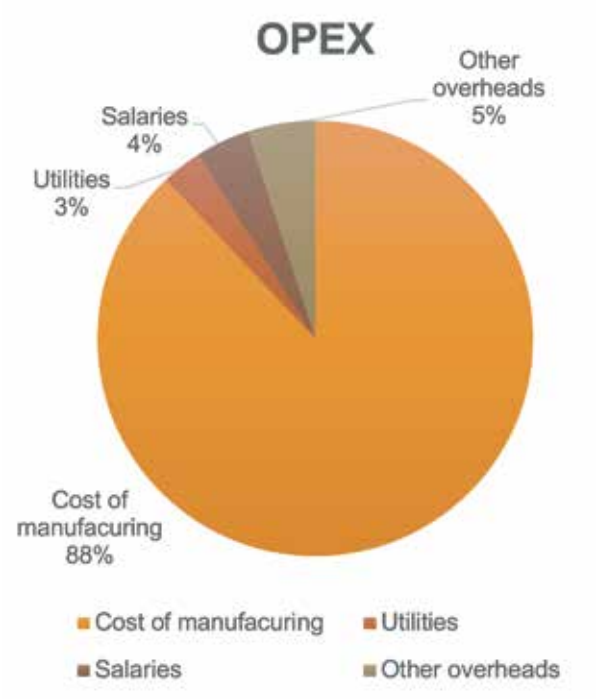
Production Capacity	60 system / year
Available Supply	Available components
1st year production	30 system / year
Local Market Size	3,200 system / year
Local Market Value	60 Billion EGP / year

Financial features. This business can be started with a little initial investment that can finance the production of the required units for clients if machining is to be outsourced. The business model on which the pre-feasibility was based on assumes establishing a medium size workshop with a production capacity of 60 units per year. This requires certain equipment and tools. The IRR is 28% and a profitability index of 3.4. It is difficult to standardize this opportunity, since it ultimately hinges on the type of machines produced and their capacity. The initial investment would be 2.5 million EGP. Only 30% of initial investment is for production equipment and tools while the rest is working capital to finance product material and components. The first year OPEX is extremely high compared to the CAPEX (similar to the previous opportunity). This is due to the high value of inputs to the product process, which constitutes 88% of OPEX. This opportunity has the lowest overheads amongst the opportunities analysed in the present study.

FINANCIAL OUTLOOK

CAPEX:	2.5 million EGP
1st year OPEX:	5.3 million EGP
IRR:	28%
Profitability Index:	3.39
Payback period:	3.5 years
Net Present Value:	6 million EGP
Production Cost Yr1:	155,000 EGP / ton
Product Selling Price:	200,000 EGP / ton





The main challenge. The main challenges in this business opportunity are market needs identification and customer outreach. This is a business that requires effective and advanced marketing channels, since the client segment operating in the recycling market is slim. Thus, finalizing contracts with customers can be challenging. Possible mitigation measures are to complement the business with trading machinery or utilization of used machinery. Providing a machine renting service and outsource some processes could allow starting and running the business with a much lower CAPEX and OPEX than the determined above.

Business Opportunity Factsheet: Designing and manufacturing of recycling machines	
Market	
Final Product:	Recycling machinery (e.g. shredder)
Required Inputs:	Material and component suppliers
Competing Products:	Imported machinery
Process	
Type of Process:	Mechanical processing (Forming, machining and assembly)
Technology:	Machining and assembling
Equipment & Material:	Tools, welding and turning machines
Human resources:	Manual and technical labour
Advantages and Risks	
Competitive Advantage:	Provide lower cost customer-specific machinery
Barriers to Entry:	High technical knowledge is required
Key Stakeholders:	Suppliers of components, material, and local workshops to outsource some of the activities
Special Regulations:	NA
Risks and Mitigation Measures:	Difficulty in finalizing sales deals and slow start for the business; complement business with trading in machinery or utilization of used machinery or machine renting and sharing - Cash flow in financing building machines; start with few units per month
Economic Features	
Revenue Stream:	Sales of Machines and tools to waste management companies
CAPEX	2.5 million EGP
OPEX	1st year 5.3 million EGP
Geography	
Location of Supply:	Across Egypt
Preferred operation regions:	Across Egypt

8.3 OUTLOOK ON FINANCIALS OF BUSINESS OPPORTUNITIES

The opportunities discussed in this section are within the medium range of investment (1-5 million EGP is taken as the medium range) with 5.5 million for MSW collection and 2.5 million for design and manufacturing of recycling machines (Figure 48). The main advantage of both businesses is that the risk is limited since most of capital in the collection market goes to vehicles and pre-processing equipment all of which has a high re-sale value. Vehicles are easy to finance through banks and leasing firms. The design and manufacturing opportunity can start at a much lower capital if machining is outsourced.

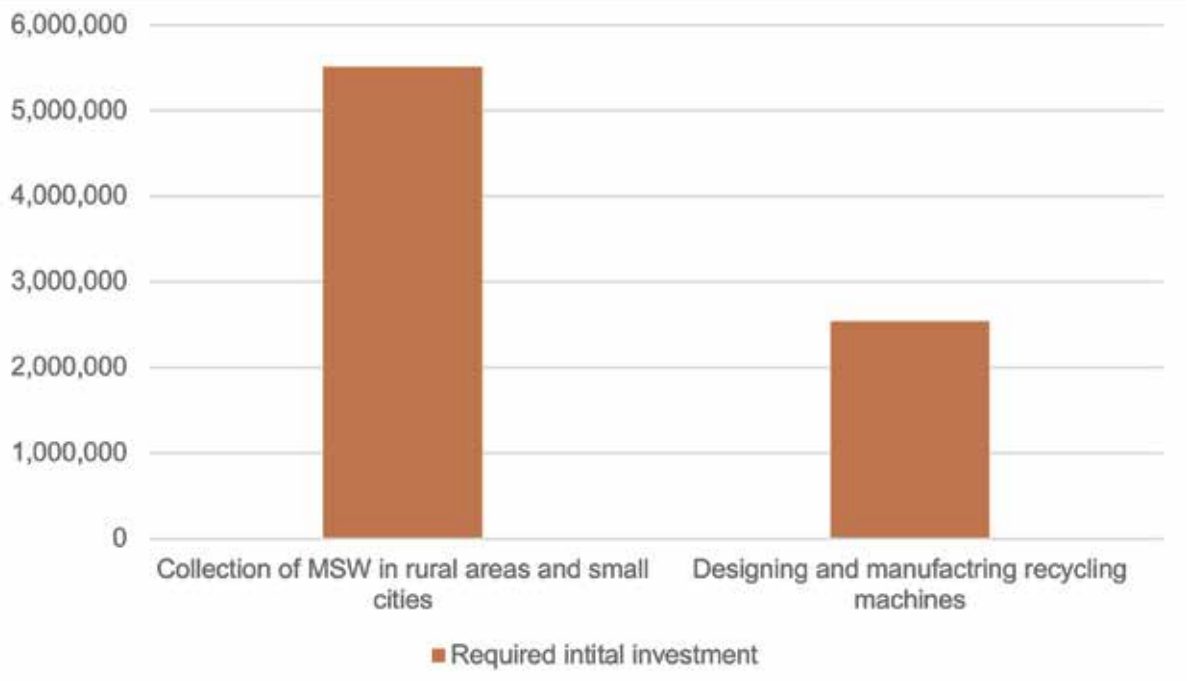


Figure 48: Required initial investment for top ranked business opportunities in services for waste market

The IRR of both opportunities is ranked low compared to the identified opportunities in the present study. Both business models have an IRR of less than 30%. The profitability index is also relatively low at less than 3.4. However, profitability can be boosted by moving to designing advanced machinery and adding recycling of organic fraction in collection/ including collection fees. The businesses are crucial for other waste management businesses to grow.

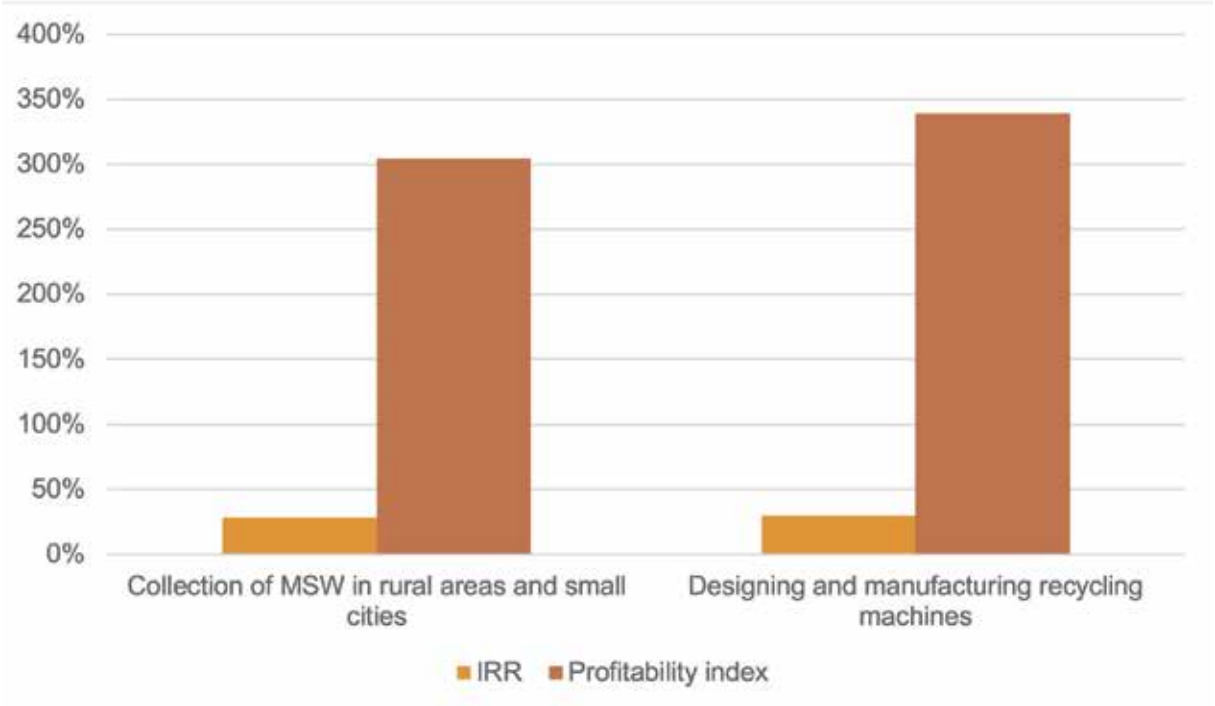


Figure 49: Internal rate of return and profitability index for top ranked opportunities in services for waste market

8.4 SOCIO-ECONOMIC AND ENVIRONMENTAL IMPACT

Economic impact. For the collection of MSW business opportunity, given that the total amounts of generated MSW annually are about 21M tons, and small letter at discussion with experts indicate that there is about 6 million tons of MSW, which are unaddressed by collection services currently. This can generate about 720 million EGP annually from waste sales and about 210 million EGP annually of collection fees. An estimate of about 3,200 machines annually would put the economic impact of the design and manufacturing of recycling machines at 640 million EGP. The market sizes above are based on expert opinion and rapid assessments. However, in both opportunities it is difficult to estimate the market size and economic impact accurately. In collection, the market size is dependent on amount of waste, which can be addressed in the collection market. These are highly geography specific. For machinery, the economic impact and market size are dependent on variations of machinery needed, their capacity and the demand on recycling activities in general. Yet, the assumptions above allow the synthesis of a key conclusion. The economic impact of the collection service can reach 735 million EGP per year and of the design and manufacturing of the recycling machinery can reach 623 million EGP per year. This gives a collective market value and addition to the economy of about 1.4 billion EGP per year. This is timid compared to the economic impact of the markets discussed above. However, the indirect economic impact of advancing these supporting products and services must not be underestimated. As discussed above, these products and services will help empower recycling businesses and grow them significantly. Having access to local machinery with low to medium moderate production rate (less than 1 ton per hour) will help recycling businesses to flourish as well as collectors to operate more efficiently. Capturing MSW through a formal and effective collection service will also indirectly help recycling businesses to grow through easier and increased access to supply, waste. In addition, formal collection services help their clients (recycling businesses) account for their expenditures in a formal and accurate way. This formal accounting indirectly increases access to finance and improves cash flow of recyclers.

To complement the assumptions above, various market scenarios are presented in Table 8. Every scenario is described and their market size estimated. The feasibility study and market estimation disregard the maintenance of existing machines as potential revenues stream.

Table 8: Economic impact scenarios for recycling machines design and manfacturing opportunity

	Scenario one	Scenario two	Scenario three
Description	Opportunity only addresses RDF production from the 'collection of MSW business opportunity'	Oppprtunity addresses RDF production from the 'collection of MSW business opportunity' and compost from 'aerobic compost production from agricultural waste business opportunity[76]'	Opportunity addresses RDF production from the 'collection of MSW business opportunity', compost from 'aerobic compost production from agricultural waste business opportunity' and RDF production from other formal and informal sources[77]
Amounts of waste that should be utilized annually (tons)	1 million tons	8 million	10.5 million
Number of machines / systems needed to recycle amount of waste (units)[78]	400	3200	4200
Value generated annually (EGP)	80 million	640 million	840 million

Social impact. The collection of MSW business opportunity create 15-20 direct jobs and about 50 indirect jobs opportunities in manufacturing of tools and equipment used in cleaning and collection. In order to cover the market needs about 15,000-16,000 direct and 40,000 indirect jobs can be created.

For the designing recycling machinery and manufacturing business opportunity, 4-6 direct jobs and about 20 indirect jobs can be created. In order to cover the market needs, as in scenario two[79] of the economic pillar, about 53 business with the same size as proposed in the feasibility study should be implemented. As a result, about 210-320 direct and 1,000 indirect job opportunities are created. Again this is a timid number, however, indirect impact of other businesses can lead to higher job creation.

The supporting services and products market can create about 16,000 direct jobs and 41,000 indirect jobs. At least 25% of job opportunities can be suitable for female employment.

Environmental impact. The environmental impact of designing and manufacturing of recycling machinery are not discussed, as it is mostly indirect and will rely on compounded assumptions. For MSW, it is estimated that annually 6 million tons can be covered by formal and financially viable businesses. This represents 0.067% of Egypt's waste and about 30% of MSW. Despite the number being small compared to the annual 90 million tons of waste produced in Egypt, these 6 million tons are from waste streams that are likely to end up in dumpsites and waterways. Hence, the environmental impact of capturing these 6 million tons is significant.

[76] Assuming 7 million tons of agricultural waste will be utilized for compost manufacturing.
[77] Assumed to be 2.5 million ton annually
[78] With the assumed capacity
[79] Average scenario

SECTION 9

CONCLUSION AND THE WAY FORWARD

9.1 IN BRIEF

This section provides a reflection on the previous ones and discusses the way forward henceforth. The "19 Business Opportunities: Economic Business Models in Egypt's Recycling Sector for Startups and SMEs" study identified 19 key business opportunities that are expected to create profits for startups, SMEs, and investors, but would also have an economic, environmental and social return to Egypt. These impacts were quantified in the study through an in-depth analysis of the potential job creation and total value added for the economy, based on how waste can be transformed to products. In addition, the amounts of waste, which can be absorbed in each market were also quantified. The table below provides a few highlights on the return for the economy, the environment, and the society when the market opportunities are captured.

Total economic potential: Value added to Egypt's GDP 62.8 billion EGP

Amounts of waste absorbed: The waste amounts that can be absorbed through the identified business models serving the local markets amount to 14.9 million tons annually

- ✓ 13 million tons of agricultural waste
- ✓ 88.000 tons of e-waste
- ✓ 840.000 tons of glass waste (4% of annual generated MSW and 100% of glass waste)
- ✓ 560.000 tons of waste tires (100% of annual generated waste tires)
- ✓ 372.000 tons of organic waste from MSW (3% of annual generated organic waste)
- ✓ 30.000 tons of citrus peels waste from agro-industrial waste streams

Total job creation potential: 850.000 jobs of which 60.000 direct job opportunities and 790.000 indirect job opportunities.

The different business opportunities offer diverse investment sizes and returns. Some of the opportunities offer high growth chances and can accommodate for large scale players in the future, such as rubber products from waste tires and MDF from agricultural waste, whereas other opportunities offer chances to multiple micro-firms, which can collectively address the market, such as the dismantling of e-waste and rubber powder from waste tires. Figure 50 depicts the range of initial investment required across the business opportunities, demonstrating the diversity of opportunities in terms of capital requirements in the waste sector in Egypt.

Figure 51 displays the IRRs of the different business opportunities. Some businesses offer an extremely high IRR in return for higher risks, whereas others have a lower IRR and are rather risk averse business opportunities. The variations of initial investment required and IRR are shown in Figure 51 below.

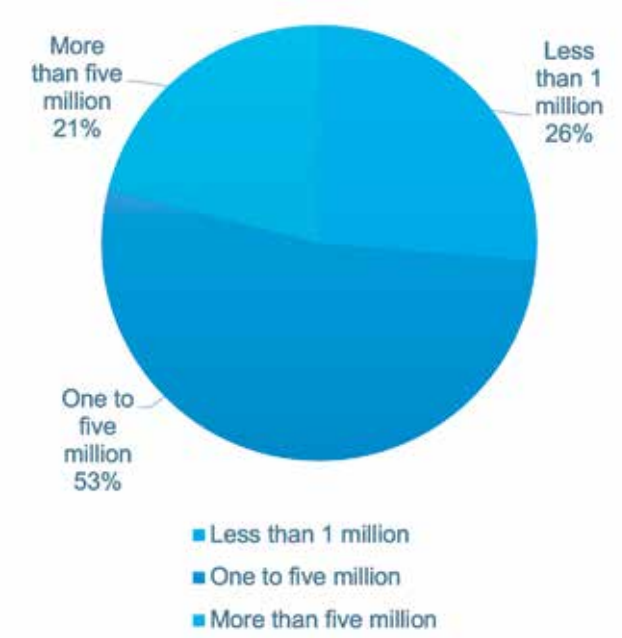


Figure 50: Percentage of opportunities in each range of initial investments

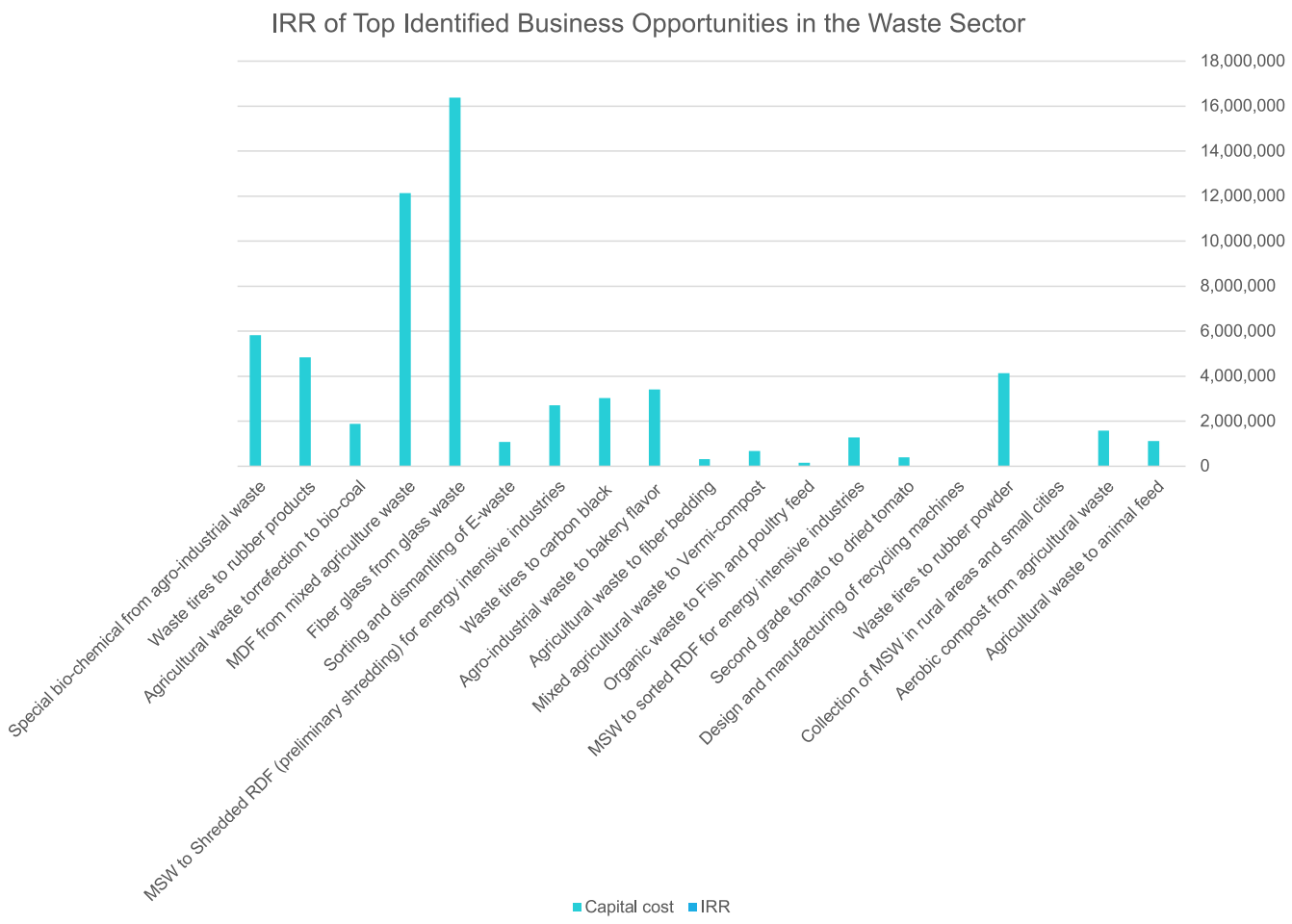


Figure51: IRR - capital cost of the 19 identified business Opportunities in the Waste Sector

9.2 INTEGRATION OF DEBT FINANCE

In the pre-feasibility analysis, the capital structure was assumed to be 100% equity financed. Equity finance requires startups and SMEs to raise the investment through personal funding or external investors in return for shares in the business. This cash requirement represents a key barrier to entry for various firms and limits opportunities to those who can mobilize investment. However, having a mix of equity and debt finance can decrease this barrier of entry for startups and SMEs. In particular, special SME debt finance of soft loans with lower interest rates and at times a grace period could support business growth and profitability for many startups and SMEs. For banks and lending institutions, financing machinery is more favourable than financing working capital, as the machinery often serves as collateral. When startups and SMEs have access to low interest rate loans, such as the initiative of the Central Bank of Egypt offering a soft loan for SMEs with an interest rate of just 5%, to finance machinery and deploy their equity investment in working capital, higher profitability is expected. Below is a comparison between 100% equity finance versus a mix of debt and equity finance for two selected business opportunities. Two opportunities with different levels of asset intensive investments were selected. MDF is a business opportunity with higher asset intensity due to the required machineries to produce the MDF panels, whereas dismantling e-waste is a rather limited asset intensive business model.

9.2 INTEGRATION OF DEBT FINANCE

MDF from agricultural waste

Capital Structure:	100% equity	vs.	33% equity + 66% debt
IRR%	77%		97%
Discounted payback	2.91 years		1.36 years

- Assuming loan at 5% (repaid in 3 years) to finance machinery
- IRR increases and discounted payback decreases significantly due to loan financing most of the the initial investment
- Financing a large part of initial investment with low interest loan improves the business case

Sorting and dismantling of e-waste

Capital Structure:	100% equity	vs.	90% equity + 10% debt
IRR%	63%		69.5%
Discounted payback	1.3 years		1.3 years

- Assuming loan at 5% (repaid in 3 years) to finance machinery
- IRR increases slightly and discounted payback period remains almost the same since percentage of debt finance is small compared to total investment
- Financing a small part of initial investment with low interest loan improves the business case only minimal

Lending institutions often find it challenging to finance early stage firms as well as businesses and equipment that are not common. This is perceived as a high-risk decision. First of all, startups and SMEs are advised to approach lending institutions after raising a complementary amount of equity finance to raise their credibility and decrease perceived risk to lenders. Equity should be used to finance working capital and debt should be focused on fixed assets. The information in the present study as well as pre-feasibility analysis can help banks to assess the business risk. Risk is mitigated partially by knowledge, part of which is provided in the present work. Other elements, which can facilitate debt finance in the sector, are related to policy interventions. For instance, certain equipment could be guaranteed by the public sector to lenders. Long-term contracts and purchase orders secured with creditable clients can help banks assess the risk. Startups and SMEs selling to industrial facilities would be able to provide such documentation to banks, which increases the change of acquiring loans successfully. Most of the businesses presented here would be able to bear the burden of debt easily since the margins are quite high. In addition, in case business does not operate as expected it is easier to recover investments by resale of inventory of waste and liquidate assets since resale of most machinery in the present study is easy.

9.3 UNLOCKING BUSINESS POTENTIAL THROUGH POLICY INTERVENTION – THE IMPACT STARTUPS AND SMES HAVE ON EGYPT'S WASTE SECTOR

The economic study demonstrates how market opportunities based on waste management can create profits of startups, SMEs, and investors as well as economic returns for the nation, while diverting waste to environmentally friendly productive channels. Throughout the study, few potentially lucrative markets were identified that can only be unlocked through policy interventions. These include opportunities for instance in markets based on construction waste and waste oils management. Other supportive policy interventions that potentially increase the effectiveness of the markets are concerning access to waste through further inclusion of the informal sector and policies enhancing access to finance through available and accessible data and market knowledge. The policies build upon experts' opinions, market surveys and international experience. The policy recommendations were also categorized based on ease of implementation as well as impact. These policies were developed in coordination with the key owner of the waste management sector in Egypt, The Ministry of Environment. It is aspired that these policies will open further markets while boosting the current ones.

9.4 STARTUPS, SMES, AND INVESTORS

The startups, SMEs and investors can benefit from this report in many ways. Access to information is mentioned as the second most crucial challenge for businesses in waste management. In fact, that is true for many sectors in Egypt. The present study provides information, which may be directly used by startups. More importantly, the study provides an analysis of where the opportunity lies. This analysis is typically what is carried out by large scale investors and major businesses, while deciding upon investment routes. Here, the cost of market research has been covered by the authors of the study and it is hoped to decrease time to rolling out businesses for startups and SMEs. Ultimately, startups and SMEs have to revise the conclusion in the present study and might develop hybrids of the business opportunities. They, need to perfect the technology and elaborate upon the technical requirements of each business. They may find opportunities outside those identified. However, in that case, the market features, information, and knowledge in this study is transferrable. Multitude of products serve the identified markets and the features of such markets remain the same. The concepts used in analysis of the markets and opportunities are generic and needs to be applied to all other markets which the startups and SMEs target. Investors, particularly early stage VCs and business angels will find a solution to a main dilemma they face in the waste management sector. The dilemma lies in the difficulty to assess potential of the waste management businesses, despite knowing the high potential of the sector. This is due to difficulties in determining supply availability and pricing. Also due to the difficulty in determining technology details and viabilities. Most of such information can be found in the present report. Not all the business opportunities presented have a high growth potential as discussed in the study. Yet, while these might not be what growth entrepreneurs and angel investors are looking for, they can be the less risky choice of small business owners and self-employment seeking entrepreneurs.

9.5 DISCLAIMERS

The ***"19 Business Opportunities: Economic Business Models in Egypt's Recycling Sector for Startups and SMEs"*** study was based on secondary research, of both local and international sources, as well as primarily research based on 58 interviews and expert discussions. The survey population was composed of 33 waste companies and/or traders, 15 respondents from the financial sector, both bankers and angel investors, as well as 10 representatives of public agencies and NGOs. Further, the study analyses are based on the current policy framework. Changes to policies might open further markets and create further and more profitable opportunities than the ones identified. The financial details should only be used for screening opportunities and comparing profitability. They should not be used to plan investments by any means. Numbers may vary with time and should be adapted to the individual circumstances and thus verified by startups, SMEs, and investors. For the market to be able to absorb all amounts of waste detailed value chain analyses must be carried out and support in the value chain gap might need to be developed. Hence, there could be more profitable opportunities that were not captures in the present study. Opportunities involving large investments of above 16 million EGP were not considered in the present work, as only opportunities that can be pursued by startups and SMEs were considered. In addition, opportunities, which will only capture limited amounts of waste, were not highlighted.

9.6 THE WAY FORWARD

Startups deciding to venture in the identified opportunities are likely to face more success than the average business in waste management. Startups can grow rapidly, particularly the early entries. However, for each market identified here to grow collectively, such that most of the waste is absorbed and the highest value added is captured, a lot needs to be done. Value chain analysis is needed to identify the weak links and needed supporting businesses. For instance, when it comes to waste tire recycling value chain, analysis needs to indicate the sub markets breakdown, which is the best between potential markets energy as pyrolysis oil, energy as solid fuel in shredded manner, steel, powdered tires, and rubber products as well as their breakdown. Further large scale recycling activities must be determined to act as industry leader and principle firms. Interactions between entities operating in the sector needs to be strengthened so that they may operate in a cluster form. Policies need to fill in the gaps, comprehensive finance schemes should be developed, and awareness around the businesses should be wide spread. All the above can become be transformed into a road map which addresses targeting higher value added products as well as educational and skills development aspects. This can help transform the businesses opportunities into a full industry.

However, what the study has demonstrated, is the market potential for various waste streams. It has carefully analysed where the market can solve waste problem, following a fact-driven approach. It demonstrates that seeing the waste management problem through a market lens can lead to different conclusions, compared to a supply side perspective. Startups in the sector have achieved impressive success and growth as indicated in the sample of this study and with the help of this study, further success is hoped for.




www.nswmp.net
egyptnswmp




European Commission

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Department of Economic Affairs, Education and Research EAER
State Secretariat for Economic Affairs SECO

german cooperation
DEUTSCHE ZUSAMMENARBEIT

Implemented by:

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

KFW

NSWMP
national solid waste management program
البرنامج الوطني لإدارة المخلفات الصلبة

WMRA
Waste Management Regulatory Authority

Ministry of Environment