Redistributing material supply chains for 3D printing

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3DP-RDM
3D printing-enabled re-distributed manufacturing

3DP-RDM Dissemination and Scoping Workshops,
13-14th January, 2016

DEPARTMENT OF ENGINEERING SCIENCE

SAID BUSINESS SCHOOL

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RESEARCH QUESTIONS

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Research questions

- Can materials supply be redistributed to bring materials production closer to primary goods production?

1. **Capacity:** What is the availability of waste materials including polymers, metals, ceramics, and biomaterials that could be 3D printing feedstock?

2. **Value:** What is the potential value of available waste materials if used for primary production?

3. **Information:** What is the potential for tracking and tracing material flow data?

4. **Technology:** What are the barriers for low batch production of 3D printing feedstock, such as materials separation and purity, pre-processing, and the design parameters of 3D printing hardware?

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APPROACH

Approach

- Literature review
- Scoping workshop
  - Review of materials
- Visits/interviews
  - From plastic bottle to printed product
  - Case study of waste stream in London
- Workshop
  - Stakeholder analysis of key barriers

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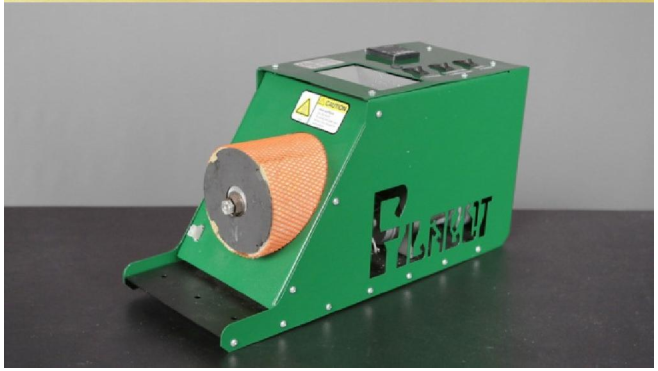
Literature review

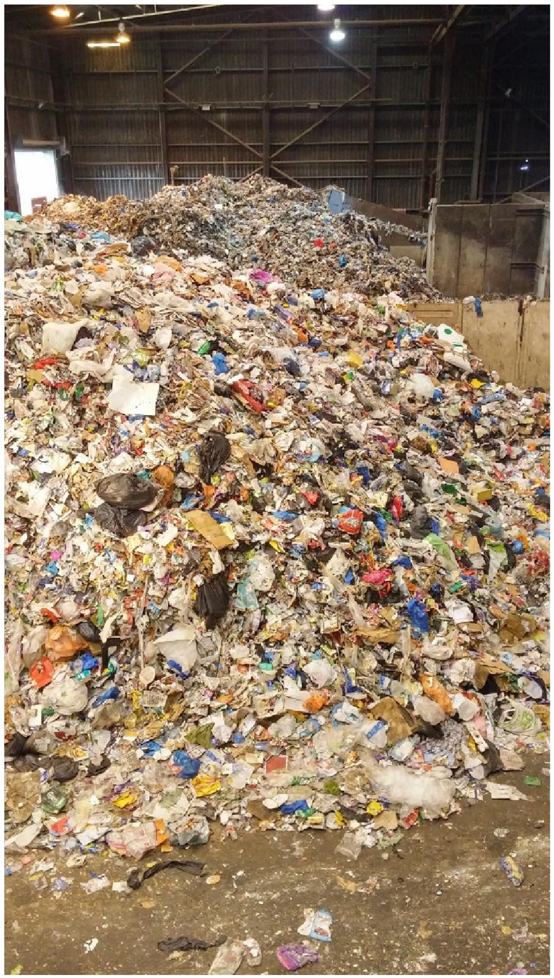
- AM tech/market
- Supply chains
- Waste materials
- Recycling of plastics for 3D printing

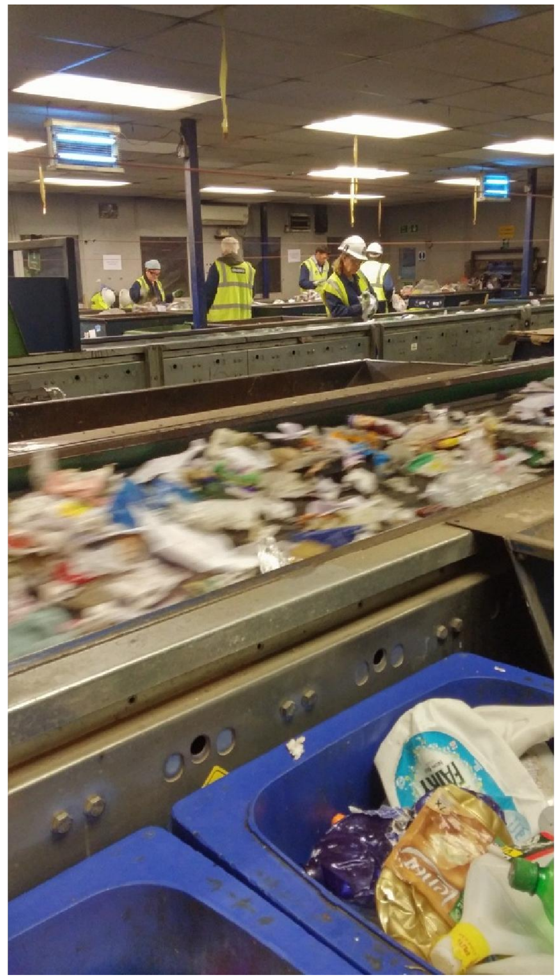


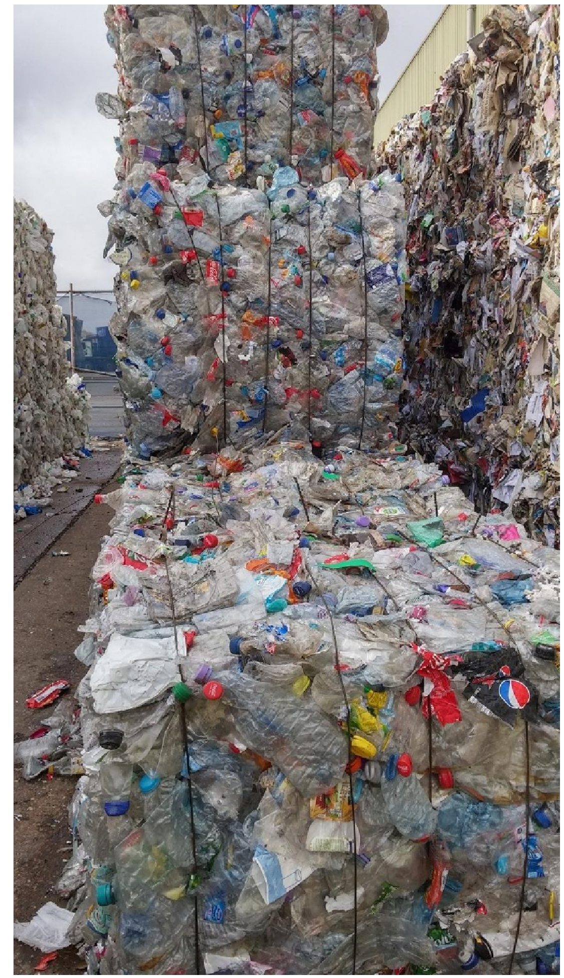
"Distributed recycling uses less embodied energy compared with a best-case scenario for centralised recycling"

Kreiger, M., et al., *Life cycle analysis of distributed recycling of post-consumer high density polyethylene for 3-D printing filament.* Journal of Cleaner Production, 2014. **70**: p. 90-96.

Materials Recovery Facility

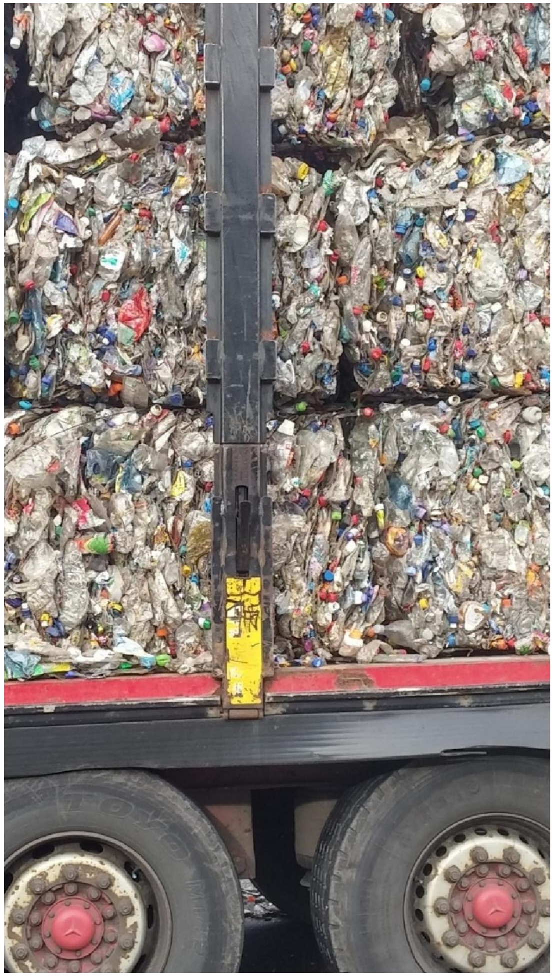


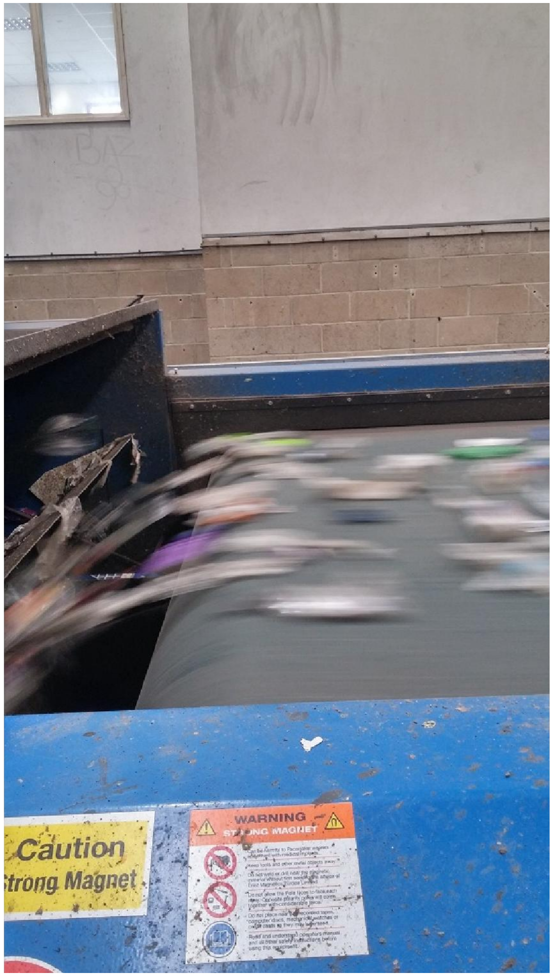




Shanks East London

Ecotech London Ltd.

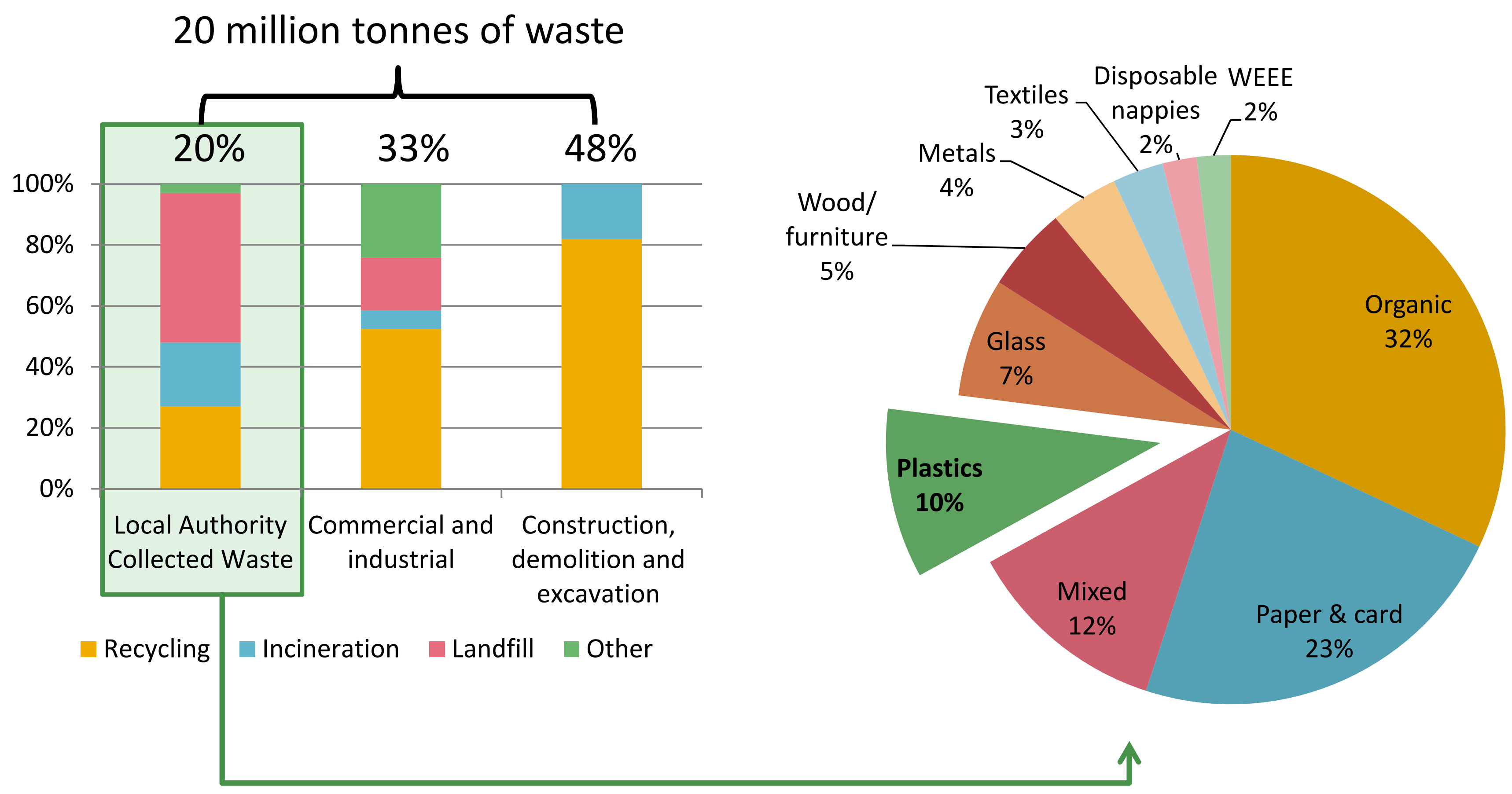




Turning PET bottles to flakes. Yield is in the range of 45-75%, mostly 50-60%.

LONDON CASE STUDY

London’s waste in numbers

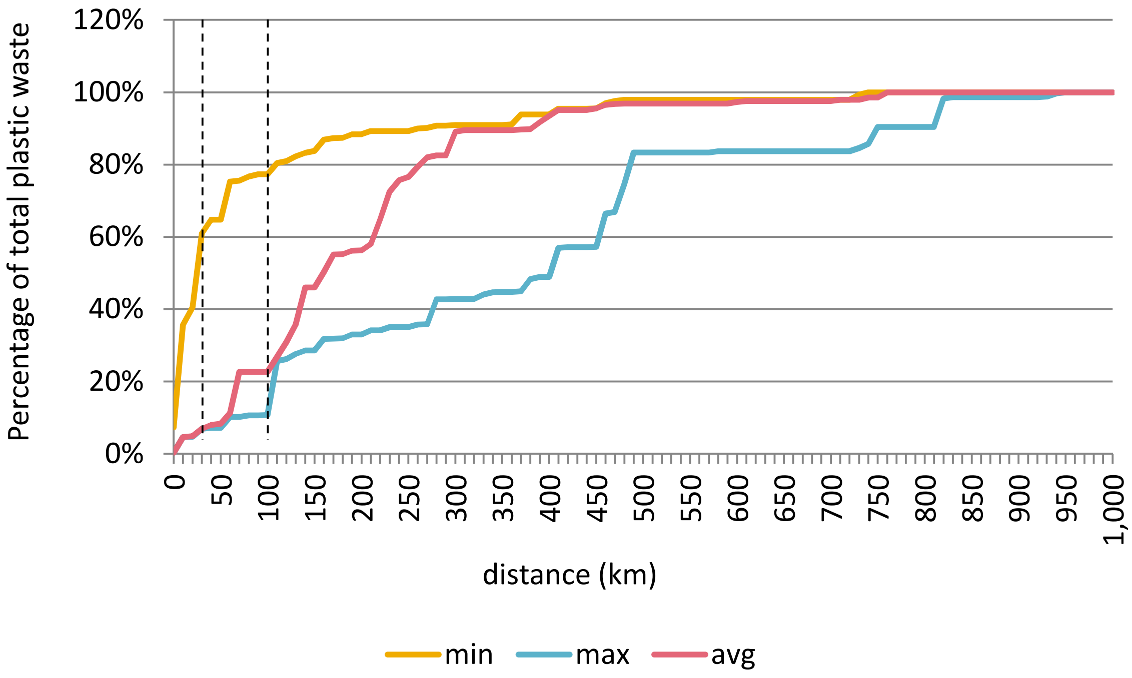


Data from 2008

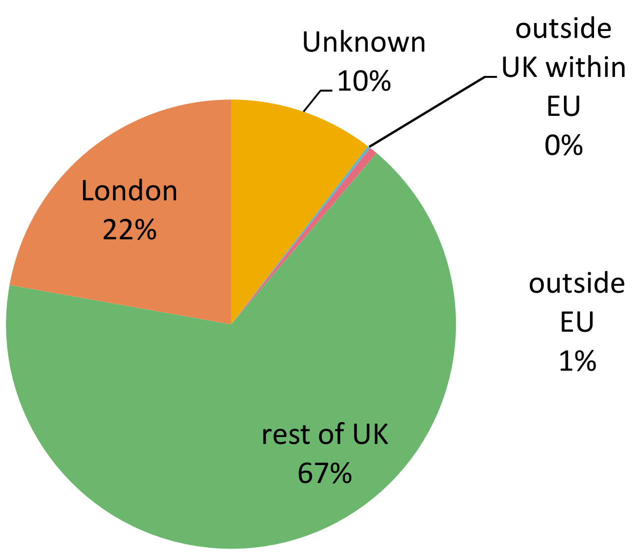
Data from 2010

Distance from sorting to recycling centres

London's plastic waste collected by local authorities for recycling, 2014



First destinations



Source: WasteDataFlow

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The potential of redistributed manufacturing for London

- A total of 4 million tonnes* of waste per year
- Of this waste, 200,000 tonnes are PET plastics
- Of this PET waste, 75% can be recycled to flakes
- This gives a theoretical potential of 150,000 tonnes of 3DP products made locally
- Potential reduction in landfill by 8%**

*** 889 thousand tonnes landfill in London in year 2013/14; assuming 50% of PET bottles currently recycled in London*

- Economic and ecological impacts
  - novel business models, reduced carbon footprint

*LACW = Local Authority Collected Waste

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WORKSHOP


Partners
FAB LAB
OAXACA
ab3D
AFRICAN
BORN 3D PRINTING
STICLab
THE HOUSE OF INNOVATION
techfortrade
Relieving Poverty, Encouraging Innovation

Presentations

techfortrade
Relieving Poverty, Encouraging Innovation

Experience with local 3D printers and collection of waste as 3DP feedstock in developing countries.

ECOTECH
LONDON LIMITED

London based company which recycles 1 million PET bottles a day into PET flakes.

OBJECT FORM

Company which produces filaments from various waste streams.

Stakeholder analysis

- Technology from “PET bottle to 3D-printed product” is available today
- What are the key barriers?
  - Economic
  - Technological
  - Regulatory
  - Social
  - Organisational

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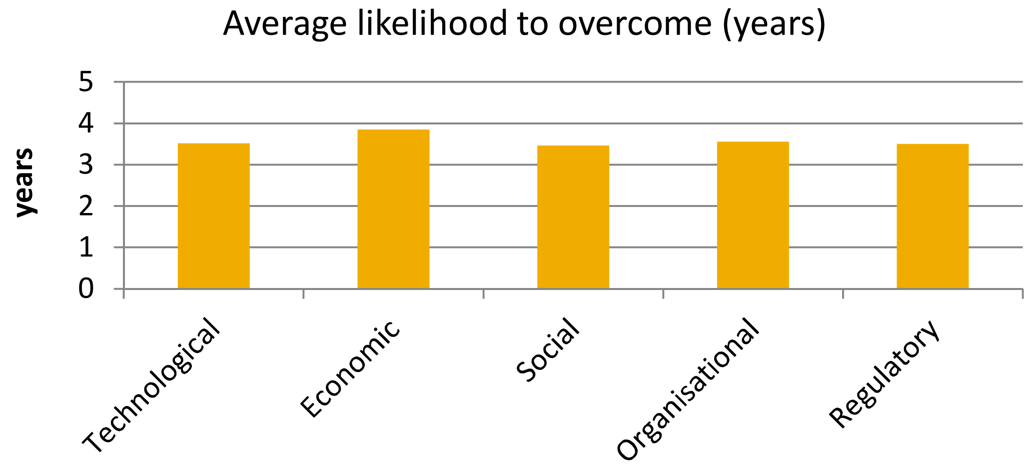
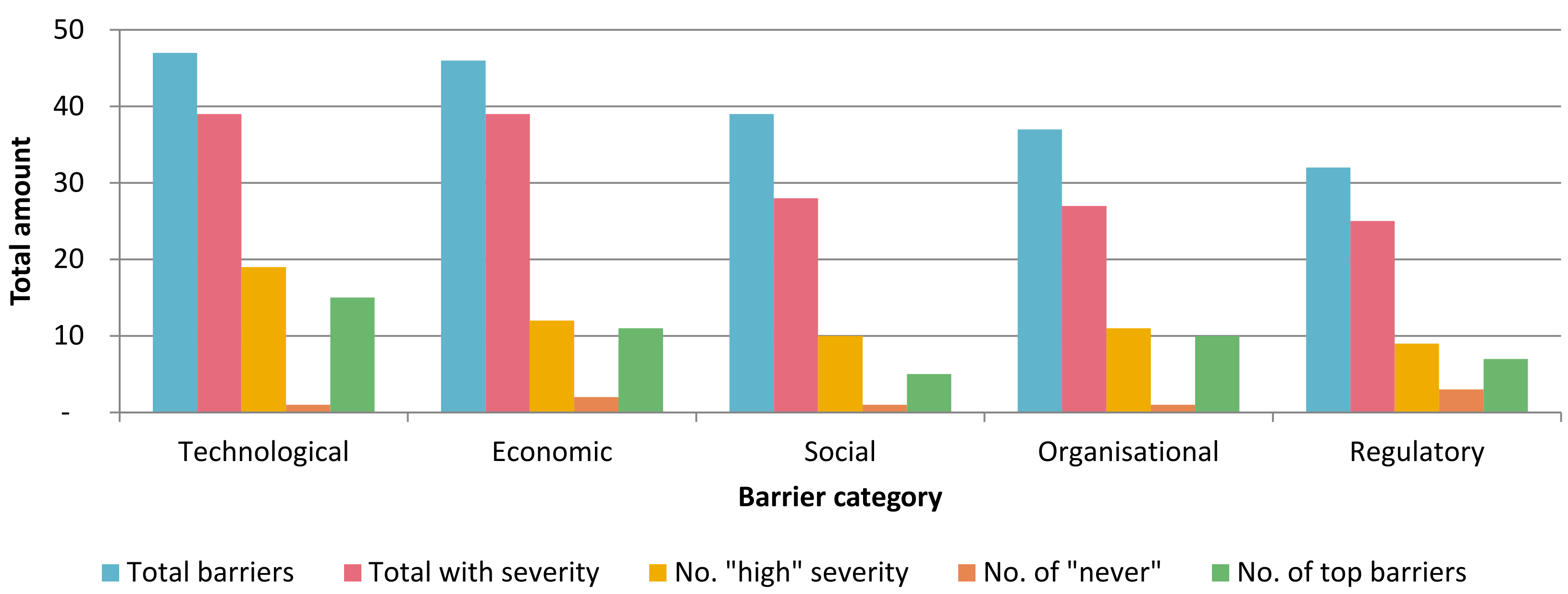
Findings from stakeholder analysis

Category	No. of surveys
Design	3
Engineering	9
Business	6
Industry	3
Unknown	3
Total	**24**



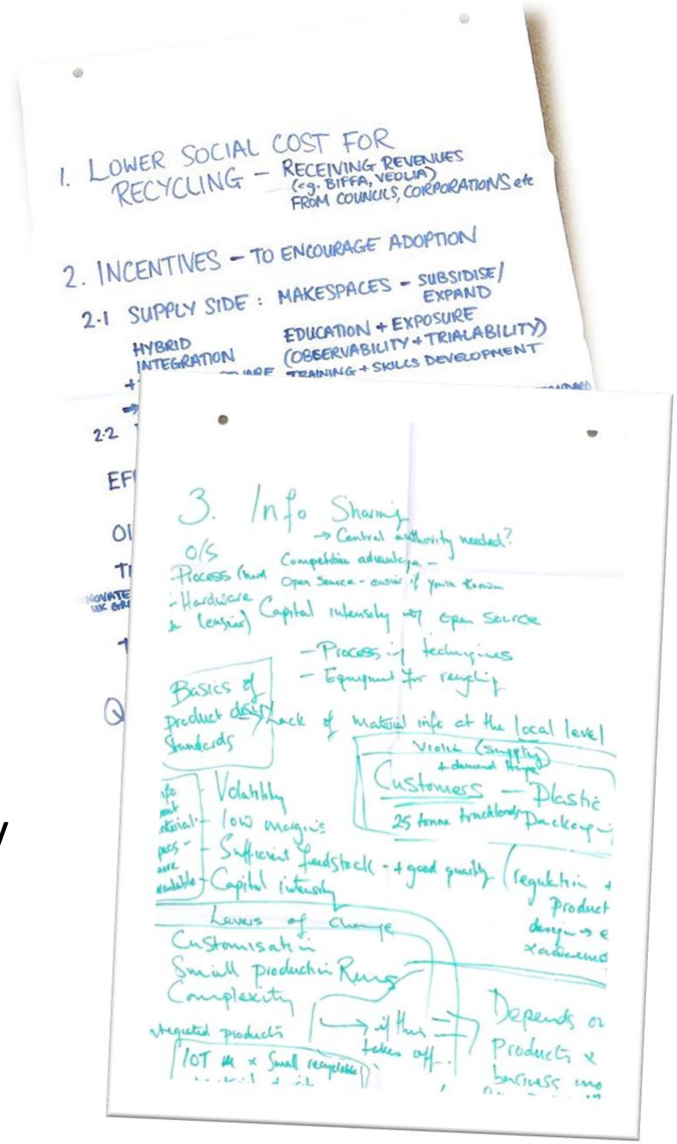


Main barriers identified in stakeholder analysis

Barrier theme	No. of barriers	No. of top barriers
• **Current technology limitations (e.g. quality and cost of 3DP products)**	**33**	**9**
• **Standards & testing, also related to trust and health & safety of products and processes**	**25**	**6**
• **Limited (cost/efficiency/availability) small scale recycling/production systems**	**21**	**7**
• Behaviour/knowledge/trust/education/R&D regarding recycling and value of materials	18	3
• Knowledge and skills regarding 3D printing	17	3
• Cost of recycling, inefficient sorting & collection of waste	15	3
• Laws enforcing/rewarding recycling	15	3
• Economies of scale	14	3
• Local limitations (skills, materials, money, legislation)	12	2
• Economic drivers, focusing on low cost/high profit only	11	1
• Innovative business models (circular economy, scale up)	11	5
• Commodity market (price of virgin materials, price fluctuations, exports/imports)	11	4
• Lack of collaboration in value chain	7	2
• Legislation recycling/reuse	6	1
• Lack of monitoring data material recycling supply chain	6	2
• IP regulations limiting knowledge sharing / innovation	5	1
• Innovative materials	4	2
• Understanding of distributed manufacturing systems	3	0

Ideas about how to overcome the barriers

- Open-source knowledge sharing
  - (1) processes, (2) hardware and (3) material specs
  - The digital file of a 3D model could offer ways to include information about material recycling
- There are constraints of the economies of scale, so the different players in the wider eco system should be taken into account.
- Small amounts of materials which may exist in a given locality (e.g. precious metals) can become more valuable.
- Align the incentives: remove waste –> get money
- There may be a mismatch among the actual levels of centralisation (recycling vs. use).
- A device to ensure filament is up to standards



CONCLUSIONS

Conclusions

Recycled plastic filament is already commercially available, however key barriers for using local materials in redistributed AM remain:

- Lack of standards & testing procedures
- Low (functional) value of 3D printed products
- Skills required
- Economies of scale
- Low price of virgin plastic

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Thank you for your attention

Questions?