Material passport

How make it real?

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Component **without** ID ⋙ **WASTE**

Component ID ⋙ **VALUE**

Why? **Who?** **How?**

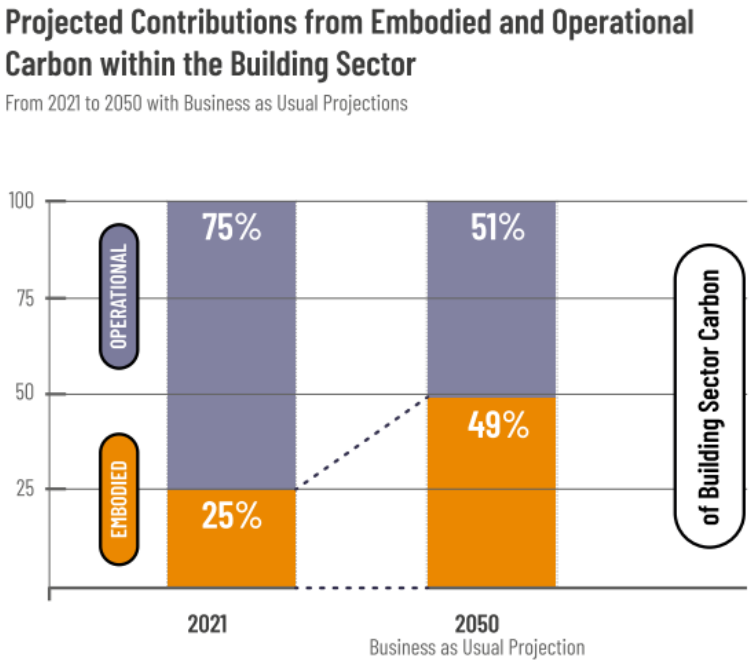
Why?

Current performance condition	Information for maintenance and repair	Clarity and authenticity of information
Increase competitiveness	Tracking	Industrial symbiosis
Partnership	Market differential	Design guidance

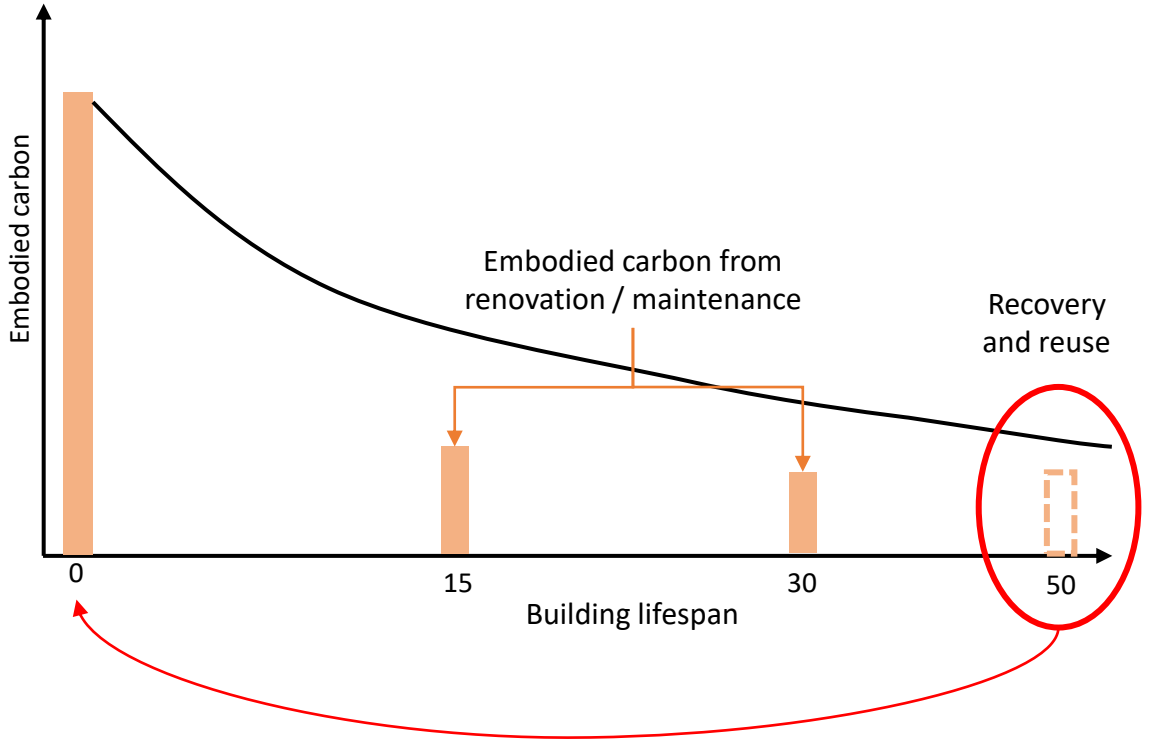
Environmental index!

- Resource efficiency
- Reuse and repurposing
- Recycling optimization
- Secondary materials market
- Eco-friendly material choices
- Carbon materials' impact
- Circular index
- Improved building durability

Why?



UNEP. (2023). *Building Materials and the Climate: constructing a new future*.



Why?

1. Reuse and repurposing products

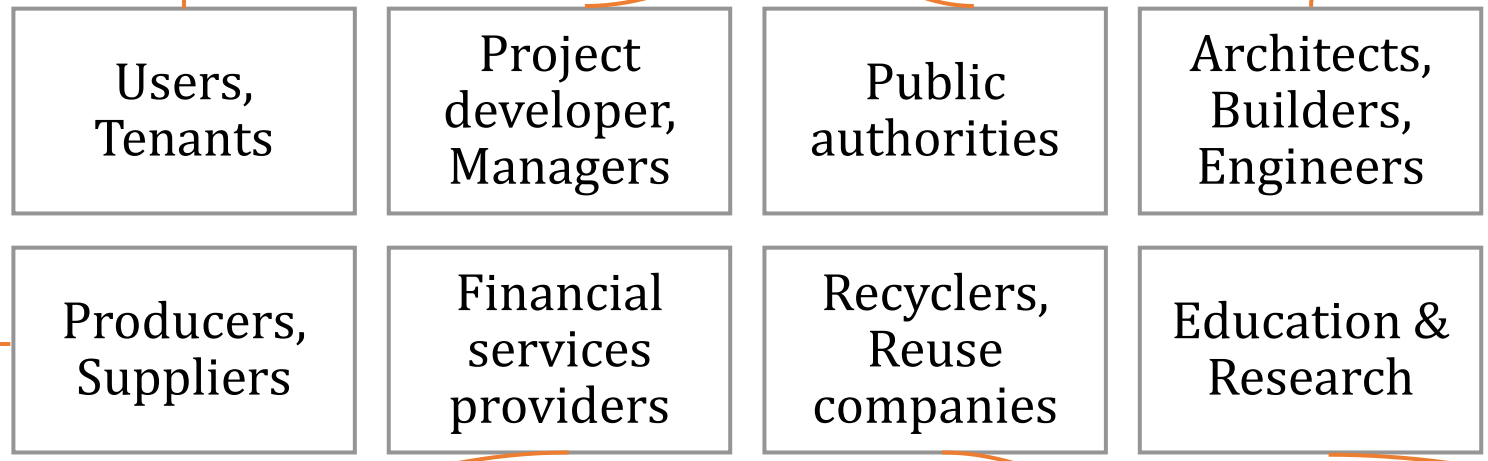
2. Reduce costs for the construction chain

Who?

Building general information
Product Safety, health
Operational aspects:
Maintenance, cleaning
Assembly, disassembly
Expected service life…

Building general information
Product general information
Building operational aspects
Building end-of-life aspects
Environmental performance

Building general information
Product general information
Product properties
Product Safety, health



Product properties
Dimensions, weight
Volume, quantity
Composition
Physical properties

Building general information
Building operational aspects

Recycling potential
Reuse potential
Disposal options
End-of-life economic value
Availability in future for reuse

Life cycle data management
Carbon impact

Data category	Digital technologies and human actors			Life cycle phase
	Data collection	Data integation	Data analysis	
A-Building General Information	Automated data retrieval from public records Employees of SHOs	Data harmonisation in the central data system, BIM, data lake or alternatively in an MP Platform Employees of SHOs and external stakeholderss	Big data analytics; machine learning	All life cycle phases *(ideally data should be collected in the design stage)*
B- Product General Information [Critical data gaps: B.12, B.14, B.17]	Automated data retrieval from third-party websites Project managers or maintenance managers of SHOs	Data harmonisation in the central data system, BIM, data lake or alternatively in an MP Platform Employees of SHOs and external stakeholderss	Web scraping; machine learning	All life cycle phases *(ideally data should be collected in the design stage)*
C- Product Properties [Critical data gaps: C.22, C.23, C.25, C.26]	Sensing and scanning technologies (e.g., Lidar systems) Site inspectors (e.g., pre-demolition auditors)	Data harmonisation in the central data system, BIM, data lake or alternatively in an MP Platform	Computer vision; machine learning Site inspectors and reuse experts (e.g., consultants)	Use and end-of-use phases *(ideally data should be collected in the design stage)*
D- Product Safety, Health & Env. Aspects [Critical data gaps: D.28, D.29, D.31, D.32]	Drones to capture building images; data retrieval from waste repositories, building registers, satellite images, etc. Safety inspectors and experts	Data harmonisation in the central data system, BIM, data lake or alternatively in an MP Platform	Computer vision; machine learning Safety inspectors and experts	Use and end-of-use phases *(ideally data should be collected in the design stage)*
E- Product Operational Aspects [Critical data gaps: E.44]	Drones to capture building images; data retrieval from satellite images, etc. Maintenance managers or contractors, inspectors or experts	Data harmonisation in the central data system, maintenance system, BIM, data lake or alternatively in an MP Platform Maintenance managers or contractors (to update data)	Computer vision; machine learning; augmented reality, virtual reality Inspectors or experts	Use phase *(ideally data should be collected in the design stage)*
F- Product End-of-Life Aspects [Critical data gaps: F.45, F.46, F.47, F.48, F.49, F.50]	Scanning technologies, drones to capture building images; data retrieval from satellite images, etc. Reuse companies, consultants or architects	Data harmonisation in the central data system, maintenance system, BIM, data lake or alternatively in an MP Platform	MP; computer vision; machine learning; simulations Reuse companies, consultants or architects	End-of-use phase *(data can be obtained during design and use stages)*

Çetin, S., Raghu, D., Honic, M., Straub, A., & Gruis, V. (2023). Data requirements and availabilities for material passports: A digitally enabled framework for improving the circularity of existing buildings. *Sustainable Production and Consumption*, *40*, 422–437.

How?

Key components

- Product performance
- Product Composition
- Product Location
- Maintenance and Care
- Reuse and Recycling Potential
- Environmental Impact
- Legal and Safety Information

Model developed

1. General data
2. Material health
3. Sustainability
4. Design and production
5. Use and operate phase
6. Disassembly guide
7. Recycling and reuse potentials
8. History
9. Other information

Material Passport proposed

Product name	Product tracking code: Manufacturer:	Last updaten: yy/mm/dd	Material Passport 01 (number)

1 General data

Product/commercial name
Manufacturer's name/details
Composition/materials
Product properties (physical, chemical, biological)
Product picture/product main function
Use recommendation/restrictions
Performance characteristics
Technical data (strain/weight)
Temporal inf. (manufacturing date, expected lifetime)

2 Material health (safe data sheets)

Security information (warnings/recommendations)
Material composition (toxicity, additives)
Risk identification/fire protection
Handling and storage instructions
Product certifications and labels
Legislation and policy

3 Sustainability

Environmental declaration
Life cycle assessment (LCA)
LCA boundaries and methodology
Material criticality
Renewable/non-renewable, treated/untreated
LCA results and interpretaction

4 Design and production

Manufacturing process and techniques
Installation and handling instructions
Certifications (energy labeling, material testing)
Digitisation (BIM)
Traceability (RFID tags, barcodes)
Logistics (packaging, supply chain managements, transportation requirements)

5 Use and operate phase

Positioning and location in the building
Cleaning and maintenance instructions
Connections details and requirements
Warranties and expected use times
Monitoring and consuption (energy, water, outside influences)

6 Disassembly guide

Disassembly instructions (removal/replacement of pieces)
Packaging/storage requirements
Transportation instructions

7 Recycling and re-use potentials

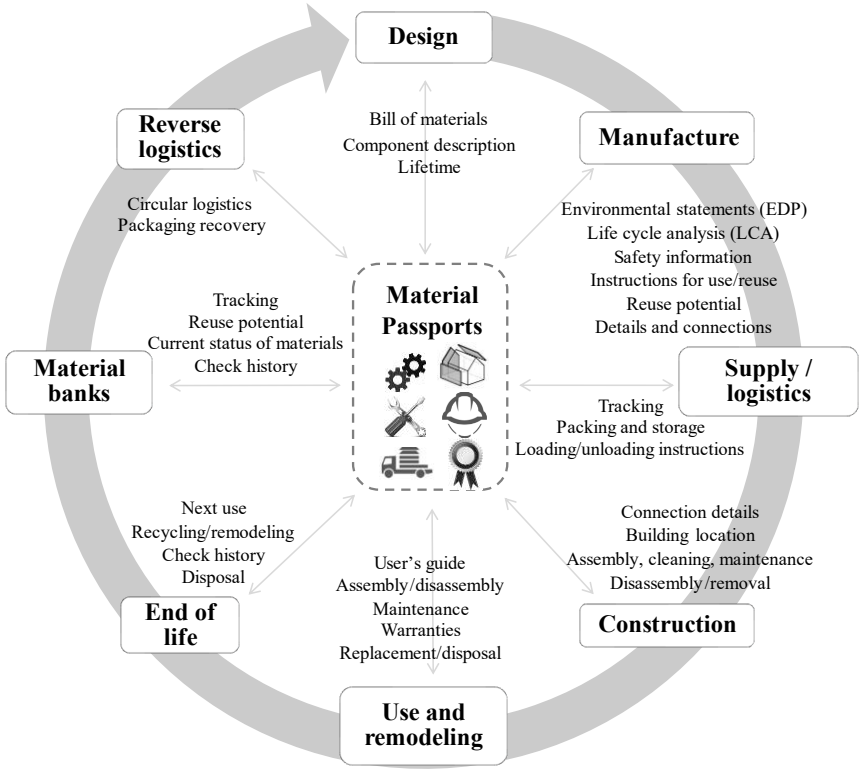
End-of-life considerations (reuse/recycling/remodeling)
Disposal options/decomposability

8 History

Use period
Verifications made during use
Latest uses/operations
Updates during operations

9 Other information

References used/standards consulted
Complementary material



Munaro, M. R., & Tavares, S. F. (2021). Materials passport's review: challenges and opportunities toward a circular economy building sector. *Built Environment Project and Asset Management*. https://doi.org/10.1108/BEPAM-02-2020-0027

What about the name?

Digital Product Passports (European Commission, 2022)
Digital Building Logbooks (European Commission, 2020)
Building Materials Passports (Caldas et al., 2022)
Data Templates (Mêda et al., 2021)
Product Circularity Data Sheets (Mulhall et al., 2022)
Material Passports (Heinrich and Lang, 2019)
Digital Product Passports (Jansen et al., 2022)
Digital Battery Passports (Berger et al., 2022)
Circular Material Passports (Goswein et al., 2022)
Waste material passport (Wu et al., 2023)
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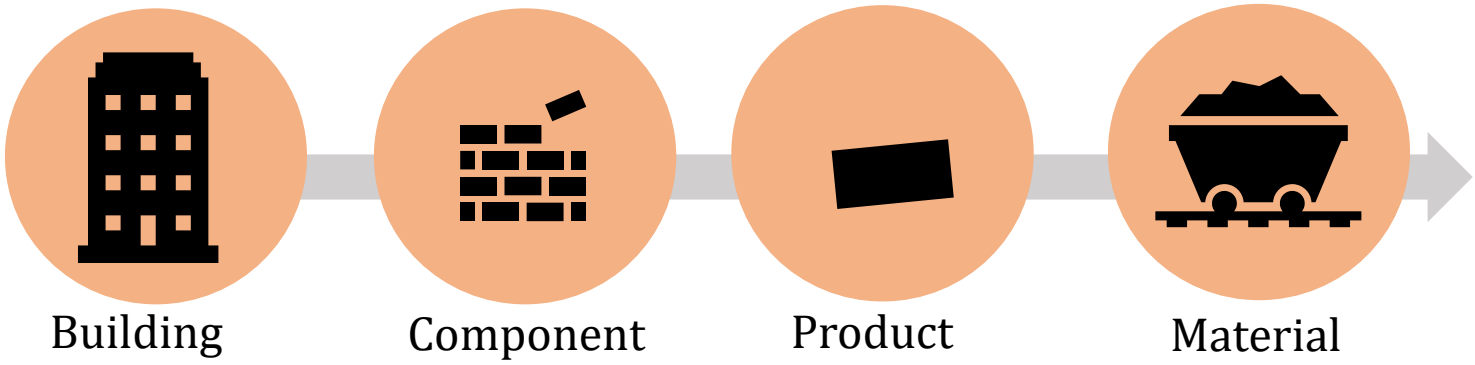
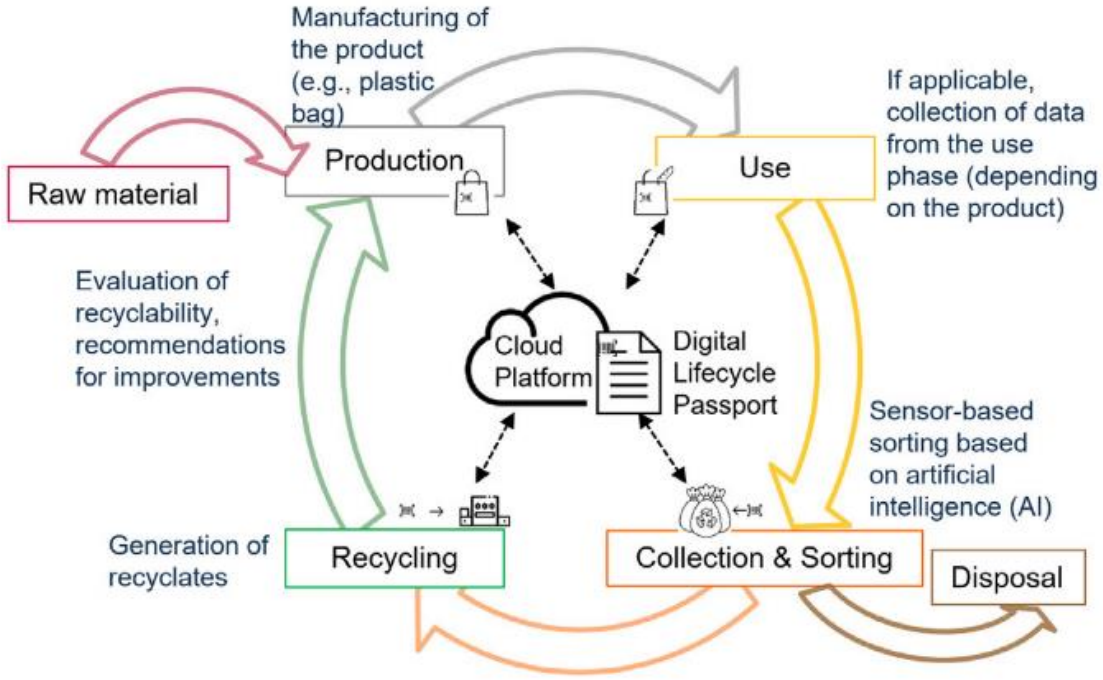


Building Passport?
Product Passport?
Material Passport?
Building Materials Passports?

What about the storage?

1. Digital database or software
2. BIM
3. Cloud-based
4. Physical files or documentation
5. QR codes or Barcodes
6. Blockchain

What about the storage?



Plociennik, C., Pourjafarian, M., Nazeri, A., Windholz, W., Knetsch, S., Rickert, J., Ciroth, A., Precci Lopes, A. D. C., Hagedorn, T., Vogelgesang, M., Benner, W., Gassmann, A., Bergweiler, S., Ruskowski, M., Schebek, L., & Weidenkaff, A. (2022). Towards a Digital Lifecycle Passport for the Circular Economy. *Procedia CIRP*, *105*, 122–127.

MADASTER

Madaster: the cadastre for materials and products

What about the storage?

Digitizing material passport for sustainable construction projects using BIM

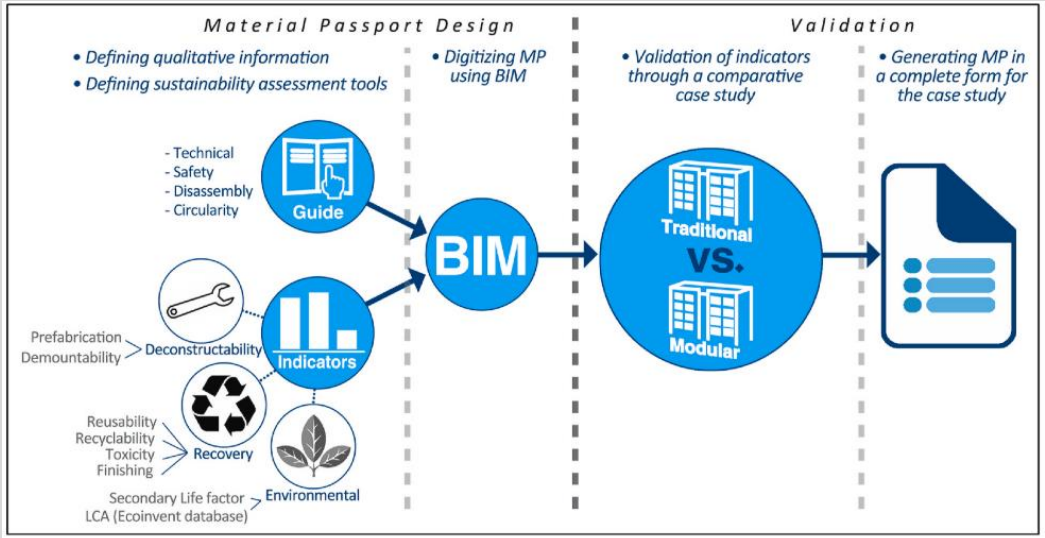
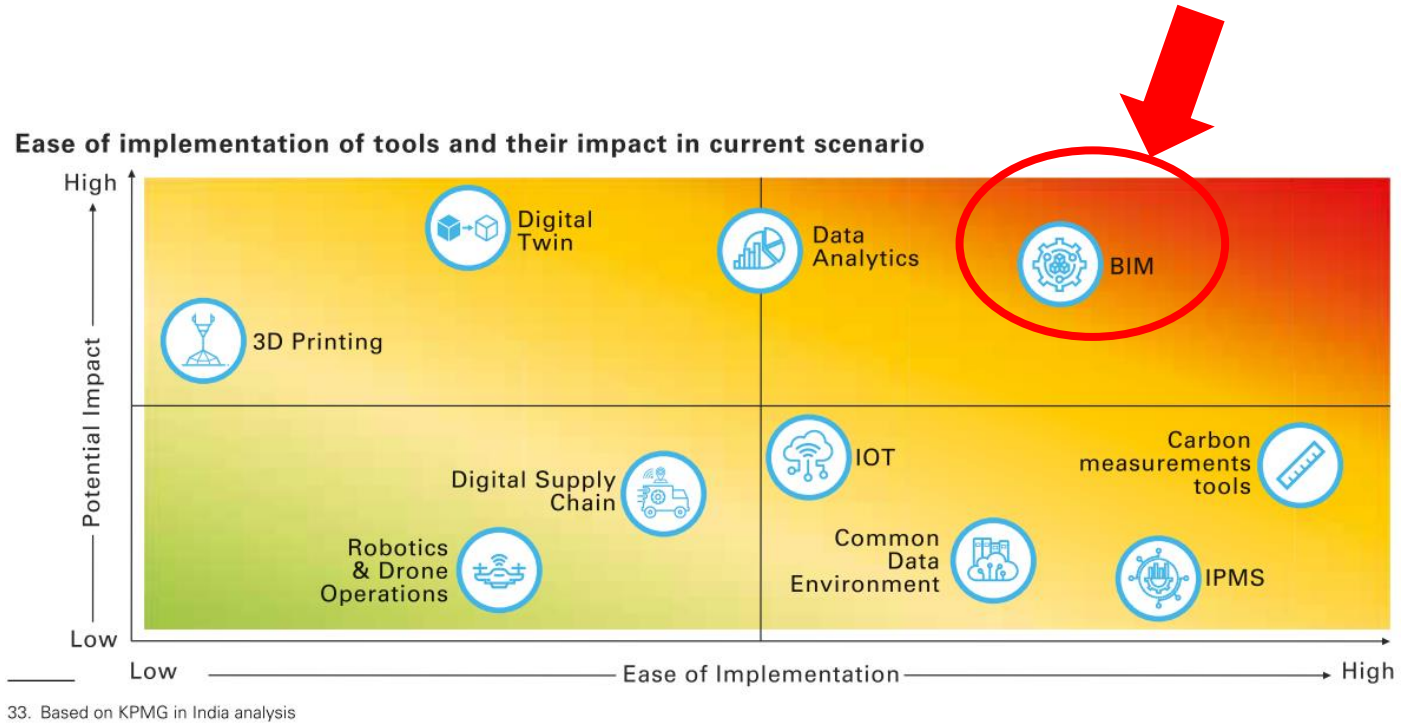


Fig. 1. Proposed framework of developing a digital material Passport.

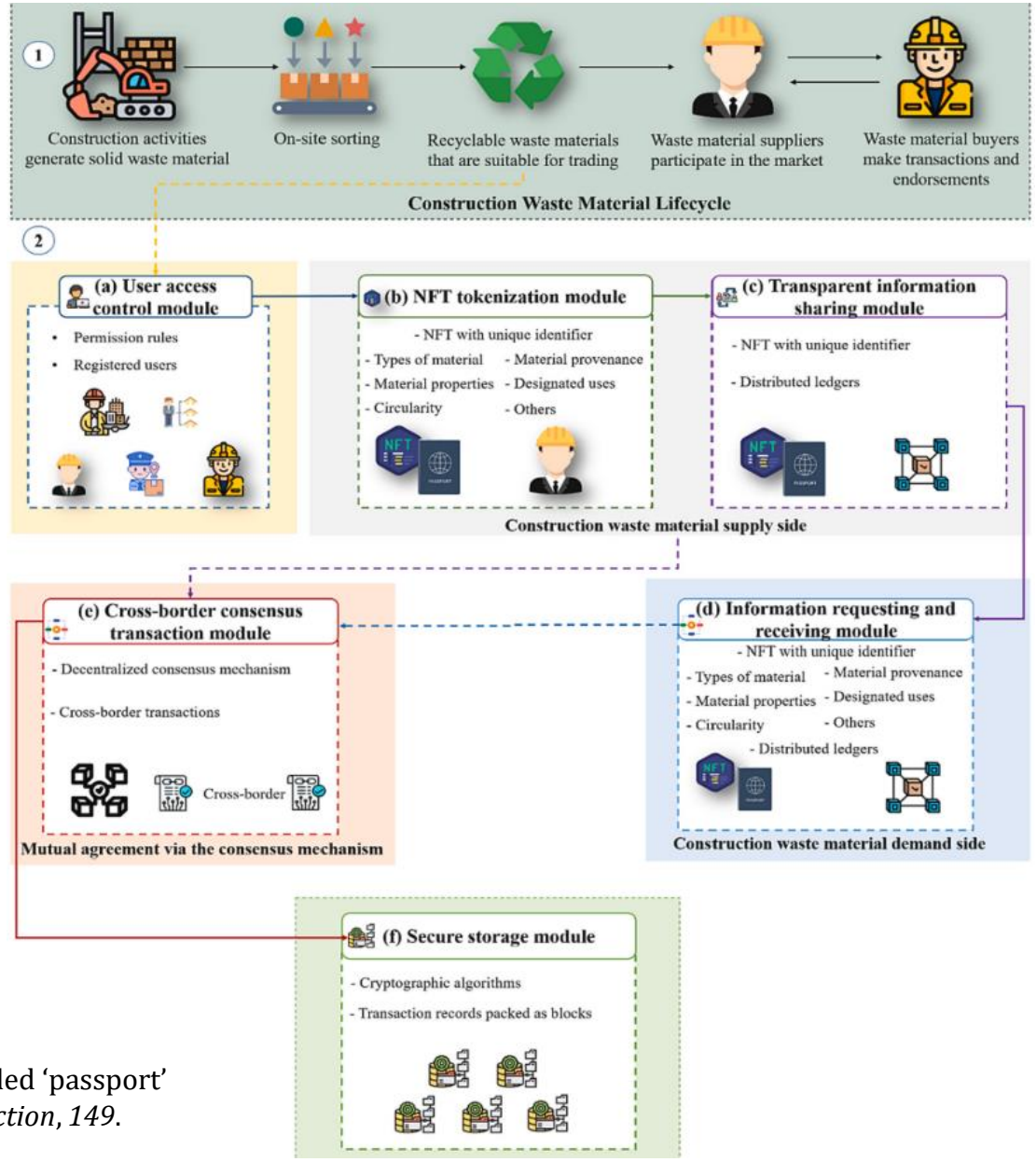
Atta, I., Bakhoum, E. S., & Marzouk, M. M. (2021). Digitizing material passport for sustainable construction projects using BIM. *Journal of Building Engineering*, *43*.



33. Based on KPMG in India analysis

KPMG. (2023). *Embodied carbon management for global infrastructure.*

A blockchain non-fungible token-enabled ‘passport’ for construction waste material cross-jurisdictional trading



Wu, L., Lu, W., Peng, Z., & Webster, C. (2023). A blockchain non-fungible token-enabled ‘passport’ for construction waste material cross-jurisdictional trading. *Automation in Construction*, *149*.

What about the storage?

1. Digital database or software
2. BIM
3. Cloud-based
4. Physical files or documentation
5. QR codes or Barcodes
6. Blockchain

OpenAI

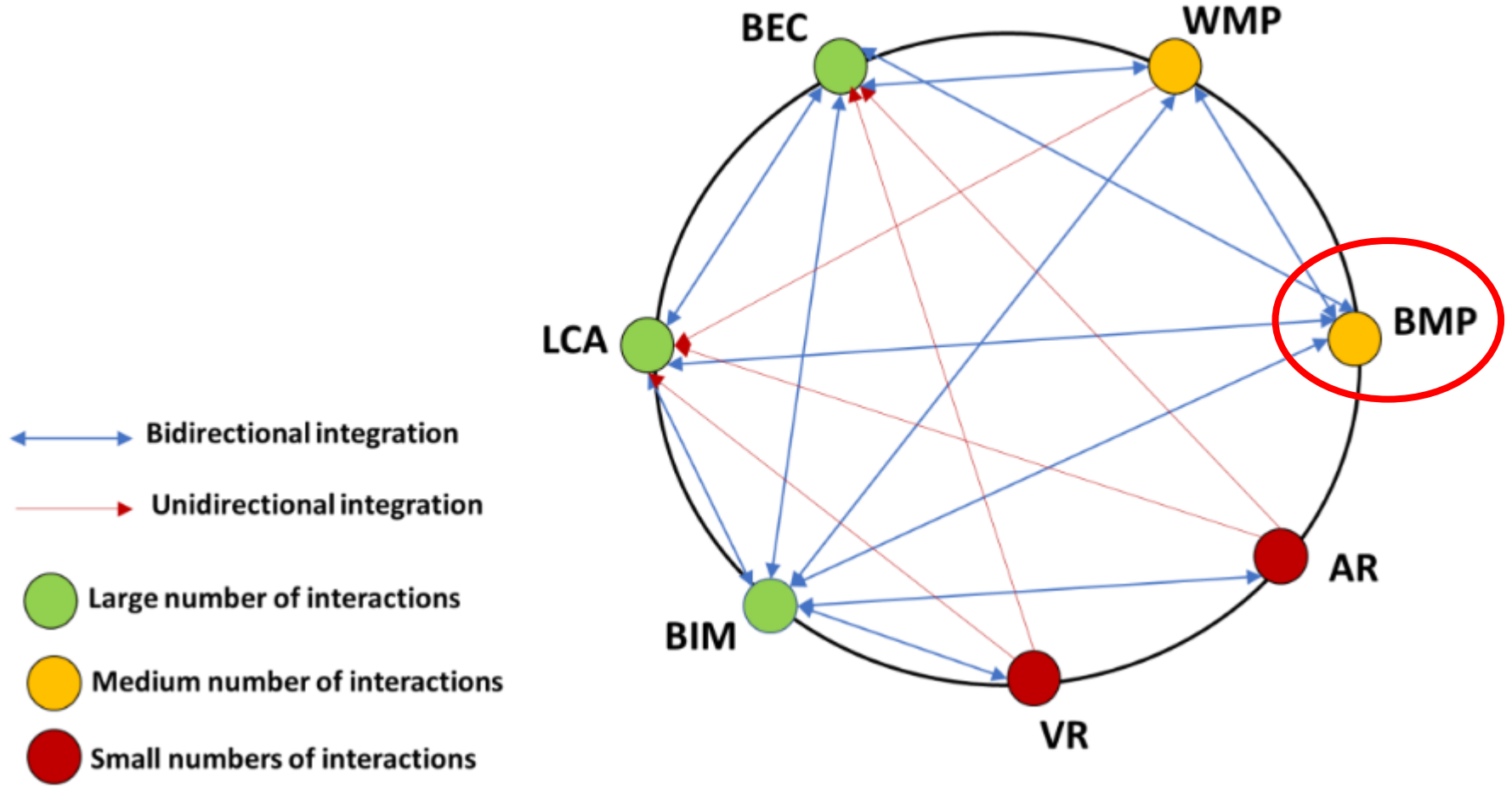
What are the main features that material passport storage technology needs to have?

1. Data Organization and Structure
2. Accessibility and Security
3. User-Friendly Interface
4. Integration with Other Systems
5. Scalability
6. Data Versioning and History
7. Search and Retrieval Tools
8. Visualization and Reporting
9. Audit Trail and Compliance
10. Mobile Accessibility
11. Data Export and Sharing
12. Data Validation and Quality Assurance
13. Lifecycle Management
14. Compliance with Standards
15. Regular Updates and Support
16. User Training and Support Resources
17. Scalability and Future-Proofing

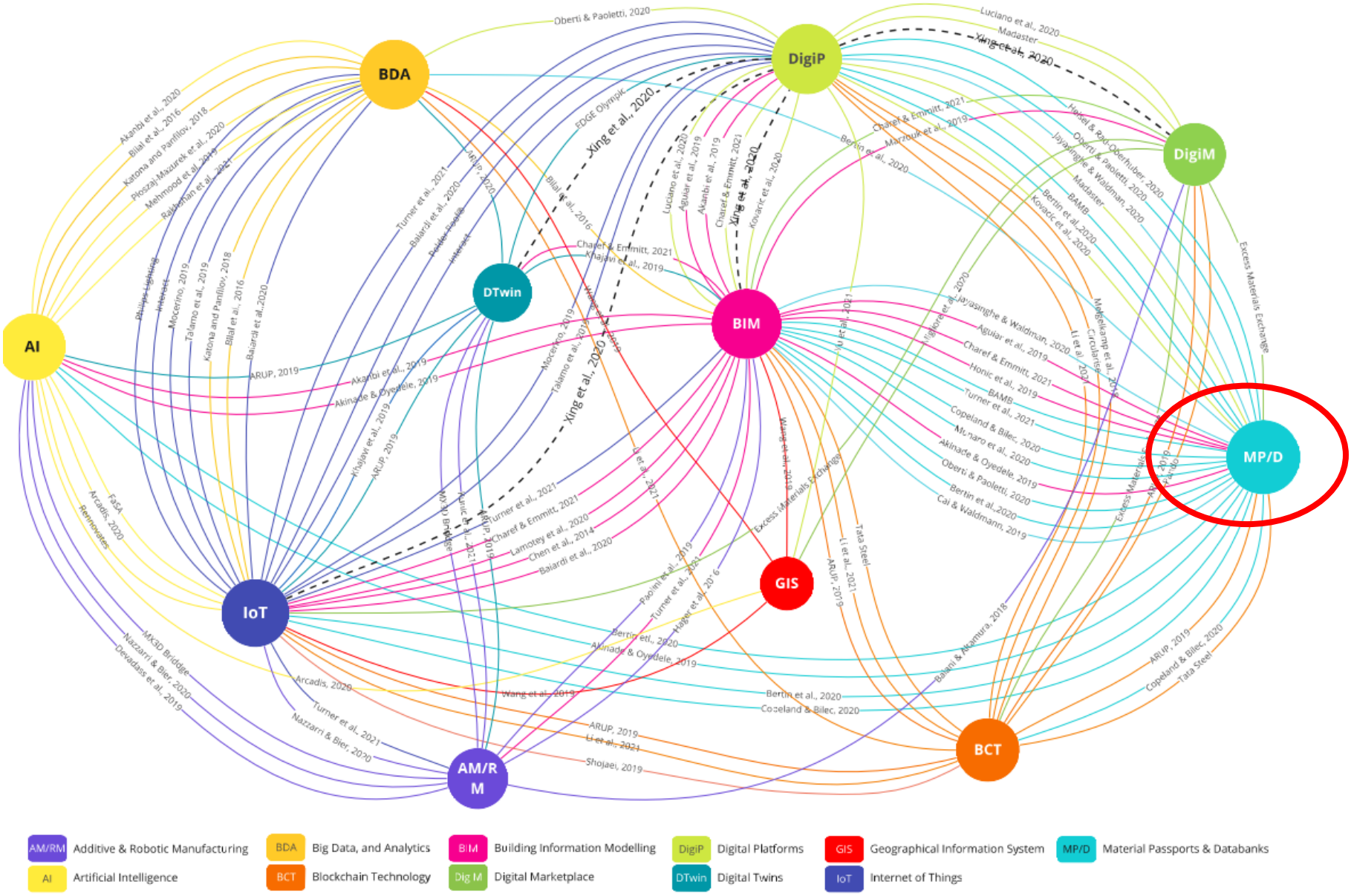
What about the storage?

Technologies	Easy to access	Update	Security	Data export and sharing	Lifecycle management	Integration	History
Digital database or software	✓	✓	✗	✓	?	✗	✓
BIM	?	✓	?	✓	?	?	✓
Cloud-based	✓	✓	?	✓	?	?	✓
Physical files or documentation	✗	✗	✗	✗	✗	✗	✗
QR codes	?	?	✓	?	?		?
Blockchain	?	?	✓	?	?	✗	✓

Tendencies – connections between technologies



Caldas, L. R., Silva, M. V., Silva, V. P., Carvalho, M. T. M., & Filho, R. D. T. (2022). How Different Tools Contribute to Climate Change Mitigation in a Circular Building Environment?—A Systematic Literature Review. *Sustainability (Switzerland)*, *14*(7).



Çetin, S., de Wolf, C., & Bocken, N. (2021). Circular digital built environment: An emerging framework. *Sustainability (Switzerland)*, *13*(11).

How make it real?

MPs vary in terminology, content, scale, technology use, and maturity level and overlook users' data needs.

- Simple
- Free
- Easy to access
- Updatable
- Consistent
- Compatible
- Reliable
- Comprehensible…

…throughout the life cycle of the material/product?

Private initiatives?

or

Public initiatives?

Design → Manufacture → Supply → Construction → Use and remodeling → End of life → Material bank → Reuse

PUBLIC POLICIES!

- **Property registration**
- **National repository**
- **Secondary material markets**
- **New jobs**
- **New business models**

Pathway

The inclusion of a MP in a property registration process depends on the specific regulations and requirements of the jurisdiction:

1.Check Local Regulations
2.Engage with Stakeholders
3.Promote Awareness
4.Collaborate with Experts
5.Pilot Projects

Thank you!

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