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#59 | A rating system for building condition ranking

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Building Condition and Evaluation | 22 May 2014 | 10.45 – 12.15

Do people know everything about their asset?

CONSTRUCTED ASSET

GLOBAL SERVICE

BOUGHT WITH

MANAGED WITH

LACK OF INFORMATION

UNEFFECTIVE CONTROLS

POOR PERFORMANCES

UNEFFECTIVE MAINTENANCE

EXPENSIVE OPERATIONS

UNSAFE BUILDINGS

UNSATISFACTORY BUILDINGS

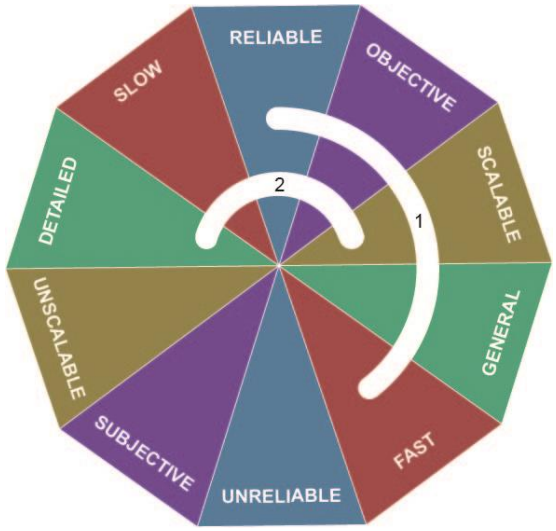
LOW YELD INVESTMENTS

OVERCOSTS

AVOIDED BY

BUILDING CONDITION ASSESSEMENT + RATING SYSTEM + MAINTENANCE OPERATIONS DATABASE

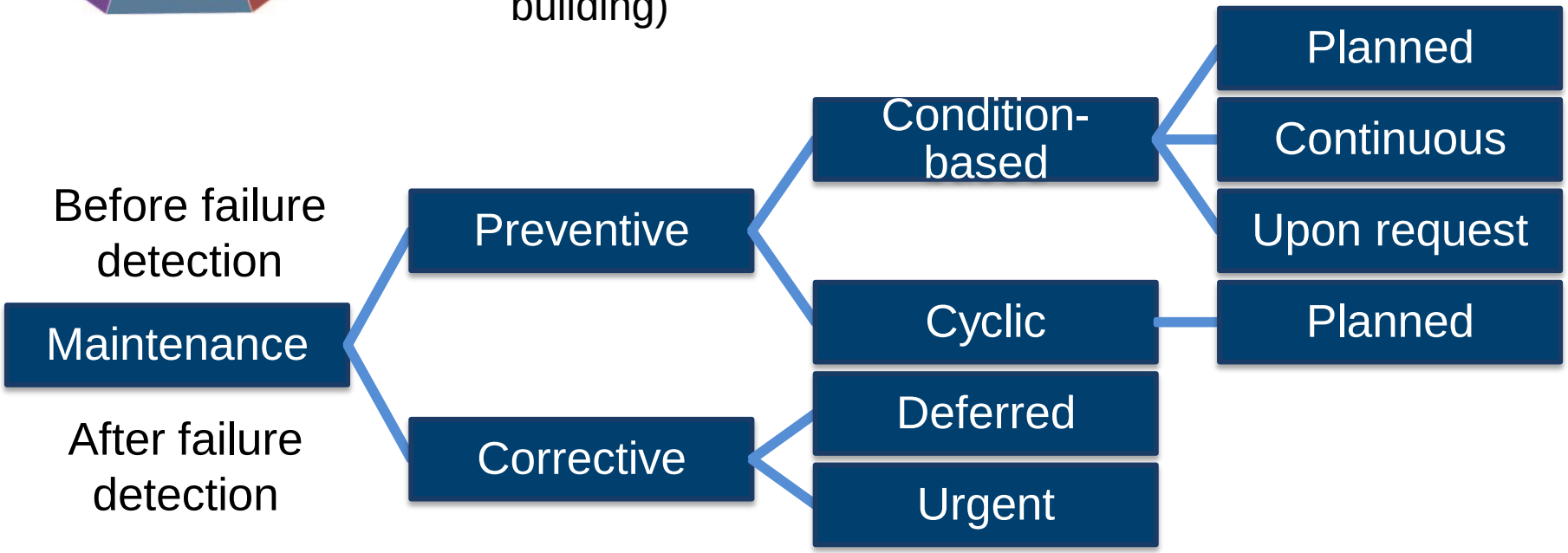
State of the art



Building Condition Assessment

1. quick and rough (e.g. for many buildings in an asset)
2. slow and detailed (e.g. more deteriorated components in a specific building)

- tailored on building function
- planned and not “fault-based”
- associated with a rating
- objective and reliable
- scalable

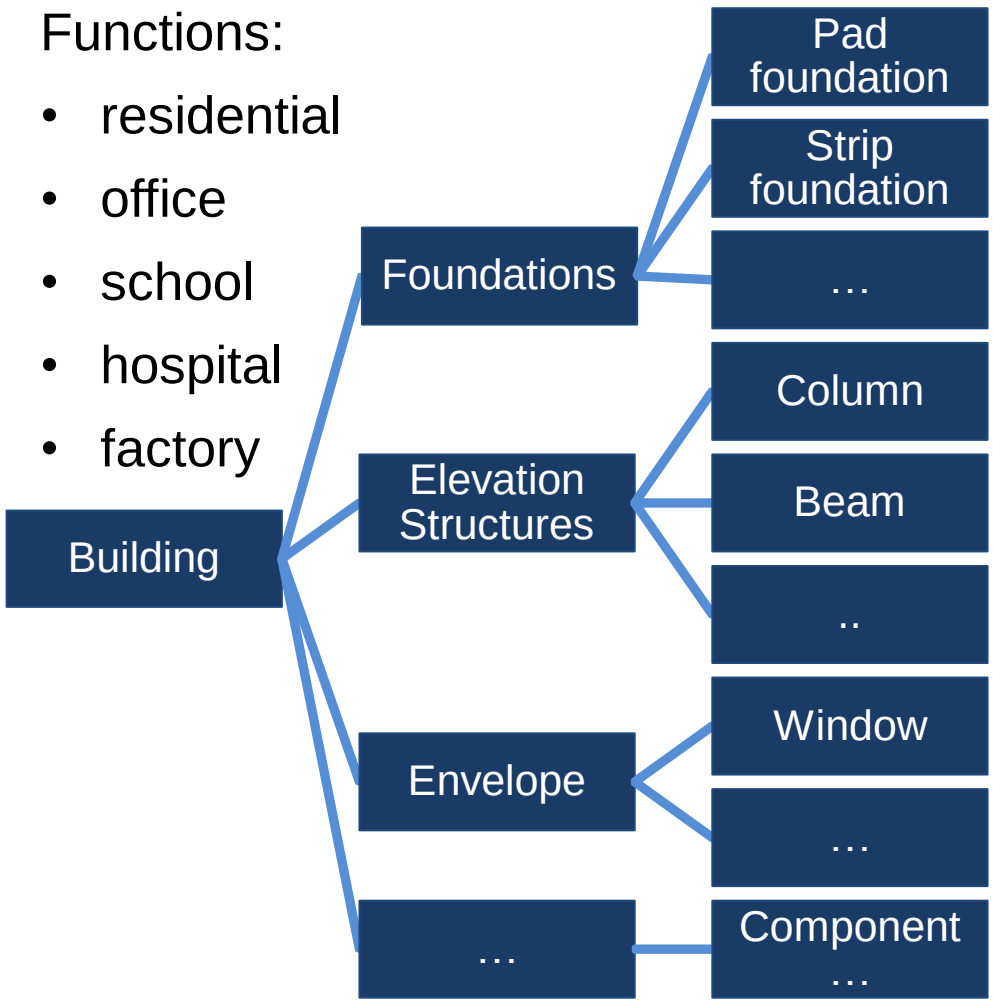


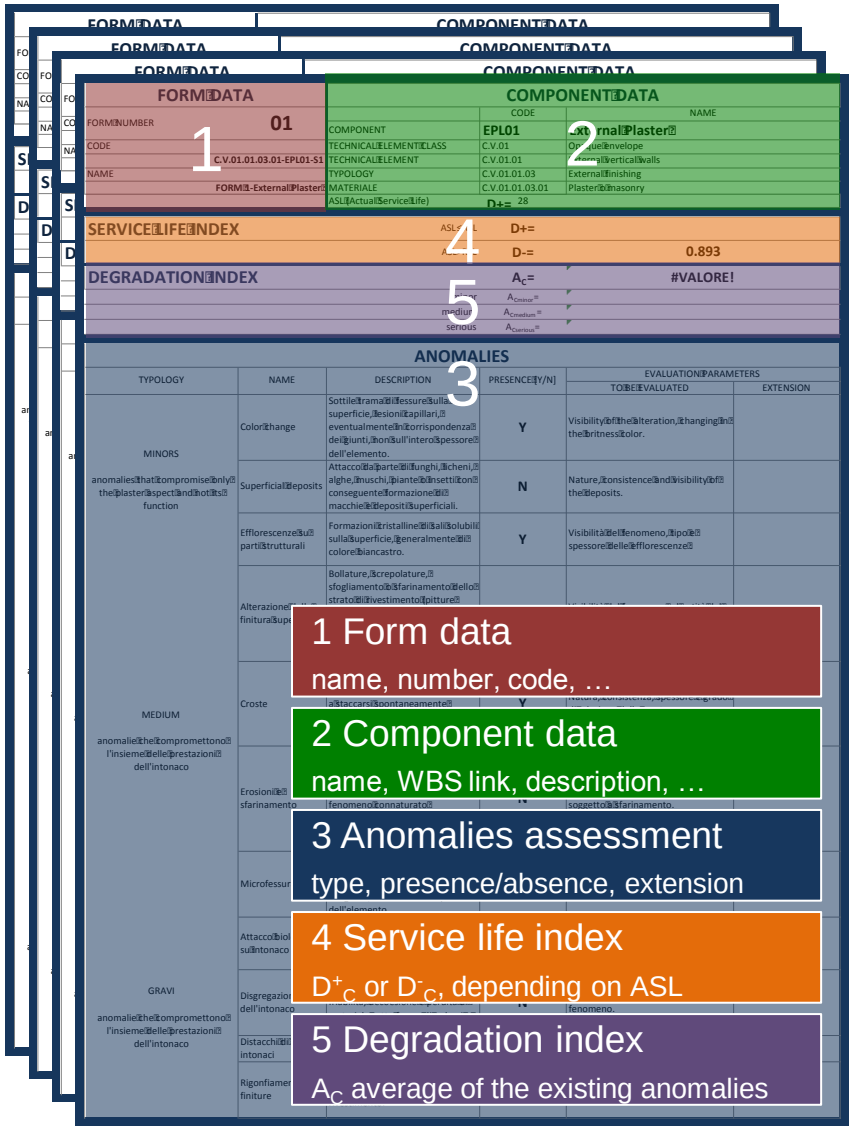
WBS and diagnostic forms

Technological units | Components

Functions:

- residential
- office
- school
- hospital
- factory





Building Condition Indexes

BUILDING CONDITION INDEX

TECHNICAL INDEX

- SERVICE LIFE INDEX (D^+, D^-)
- DEGRADATION INDEX (A)

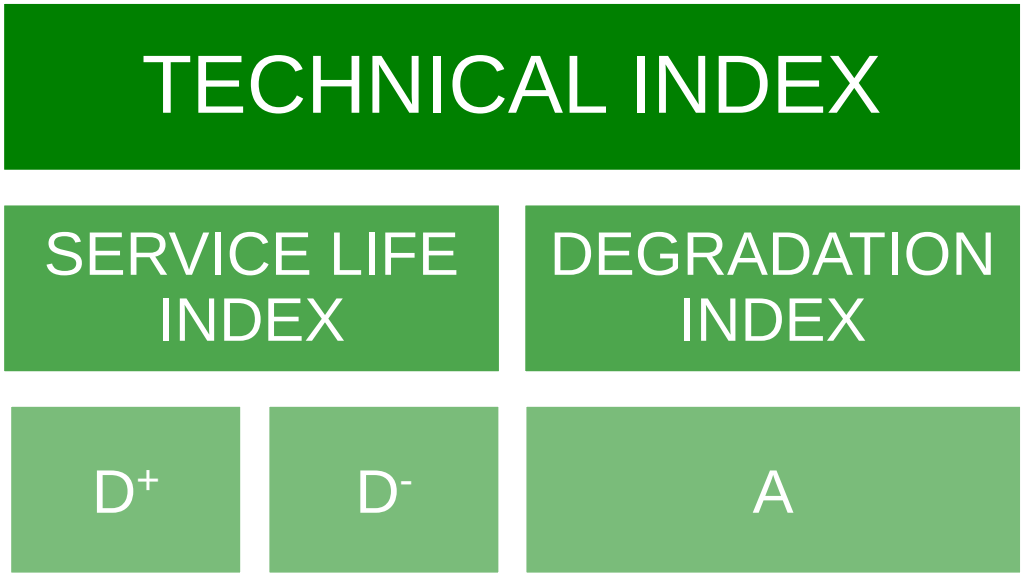
DOCUMENTS INDEX

MAINTENANCE OPERATIONS

- URGENT
- DEFERRED

DOCUMENTS UPDATE

Technical Index



Service Life index: ratio between ASL and RSL (D^+ and D^-)

Degradation index: ratio between anomalies found and possible (A)

Database with:

- **18** technological units
- **>400** components (organised in a **WBS**)
- **431** anomalies (low, medium, serious)
- ~12 anomalies for each component
- **RSL** associated to each component (from literature)

Technical Index

COMPONENTS	Ext. plaster	Windows	Heating sys.	Paint
	Flooring	Lift	Balconies	…

D+ D- A

$$D_C^+ = \frac{RSL - ASL}{RSL} \; if \; ASL \leq RSL \quad or \quad D_C^- = 1 - \frac{ASL - RSL}{ASL} \; if \; ASl > RSL$$

Simple mean

$$\left.\begin{aligned} A_L &= \frac{\sum_{i=1}^{L} P_{L,i} * E_i}{L} \\ A_M &= \frac{\sum_{j=1}^{M} P_{M,j} * E_j}{M} \\ A_S &= \frac{\sum_{k=1}^{S} P_{S,k} * E_k}{S} \end{aligned}\right\} A_C = \frac{A_L * W_L + A_M * W_M + A_S * W_S}{(W_L + W_M + W_S)}$$

TECHNOLOGICAL UNITS	Elevation structures	Opaque envelope	Transparent envelope	…

Weighted mean

$$D_{Bld}^+ = \frac{\sum_{k=1}^{o} D_{TU,k}^+ * W_k^{E/C}}{\sum_{k=1}^{o} W_k^{E/C}} \qquad D_{Bld}^- = \frac{\sum_{k=1}^{o} D_{TU,k}^+ * W_k^{E/C}}{\sum_{k=1}^{o} W_k^{E/C}}$$

BUILDING

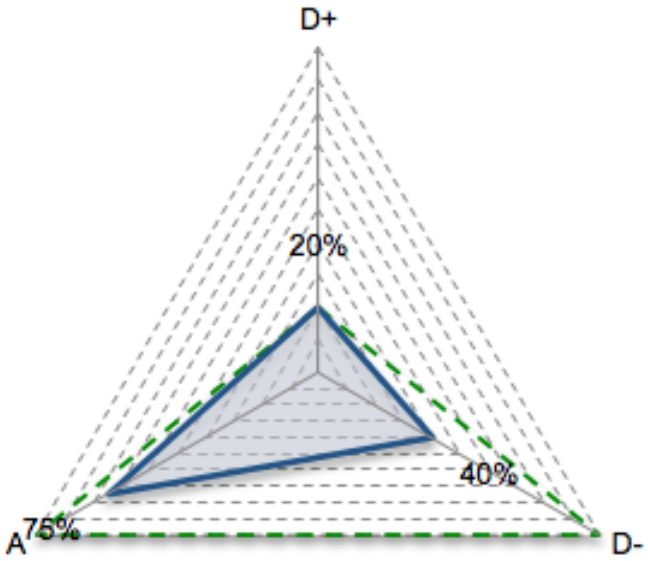
$$A_{Bld} = \frac{\sum_{k=1}^{o} A_{TU,k} * W_k^{E/C}}{\sum_{k=1}^{o} W_k^{E/C}}$$

Tailored on function

Technical Index

TECHNOLOGICAL UNIT				WEIGHTS	WEIGHTED INDEXES			ANOMALIES
#	CODE	NAME	# FORMS [-]		D^+	D^-	A	# A
01	S.F	Foundations						0 on 0
02	S.C	Retains structures						0 on 0
03	S.E	Elevation struvtures						0 on 0
04	C.V.O	Opaque envelope	5	20.41%	2.72%	13.27%	19.14%	22 on 90
05	C.V.T	Transparent envelope	8	12.12%	1.26%	6.06%	9.34%	44 on 105
06	C.O.I	Slab on ground	1	3.83%	0.00%	1.92%	3.52%	3 on 13
07	C.OSA	Slab on open spaces						0 on 0
08	C.S	Roof						0 on 0
09	PI.V	Invernal vertical partition	5	22.49%	0.00%	13.87%	17.97%	26 on 52
10	PI.O	Invernal horizontal partition	4	16.89%	0.00%	11.96%	16.47%	9 on 66
11	PE.V	External vertical partition	1	2.18%	0.00%	1.99%	1.77%	7 on 20
12	PE.O	External horizontal partition	2	4.77%	0.00%	2.18%	2.55%	17 on 27
13	IFS.IC	HVAC						0 on 0
14	IFS.IDS	Water and sanitary plant						0 on 0
15	IFS.E	Electric plant	4	13.58%	10.41%	13.58%	13.49%	3 on 22
16	IFS.SL	Sewer plant						0 on 0
17	IFS.TR	Lift plant	2	3.73%	0.00%	2.49%	3.45%	2 on 12
18	IFS.A	Fire plant						0 on 0
		TOTAL	32	100.00%	**14.39%**	**67.32%**	**87.70%**	**133 on 407**

Technical Index	63.17%



- **blue line**: current building condition.
- **green dashed line**: optimal building condition.

D^+ is equal in both cases because the building physiologically gets older, but this is not a failure.

$$I_{Tech} = \frac{Area_{Building}}{Area_{Optimal}} \ [\%]$$

- **133** on 407 possible **anomalies** detected
- **24** components with **ASL ≥ RSL**
- **8** components with **ASL < RSL**

Documents Index

DOCUMENTS INDEX

It is the weighted ratio between available and required documents.

- A – Construction
- B – Fire safety
- C – Structures
- D – Plants
- E – Safety and O&M
- F – Urban planning
- G – Land register
- H – As built
- I – Origin and rights

- it relies on a list of documents required by Italian laws
- documents are grouped in 9 families (A to I) using a Documents Breakdown Structure
- each family has an importance weight (calculated with AHP technique)

It allows identification of documents:

- missing
- out of date
- non-compliant

Documents Index

SINGLE DOCUMENT	NECESSITY [Y/N]	X	IMPORTANCE [1→4]	X	QUANTITY (if required)	X	PRESENCE [Y/N]

Ratio between present and required documents for each family

DOCUMENTS FAMILIES	A construction	B fire safety	C structures	…

Weighted sum of required documents families indexes

BUILDING DOCUMENTS

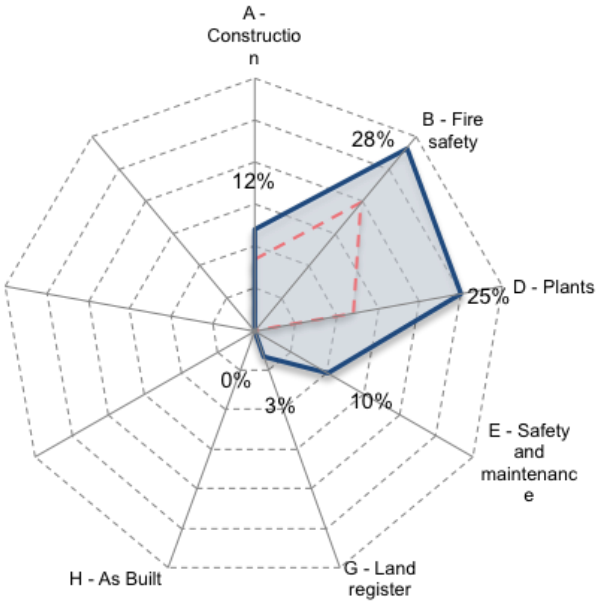
$$I_{family} = S_{family} * W_{family} \ [\%]$$

$$I_{Doc} = \sum_{i=1}^{N} I_{family,i} \ [\%]$$

Documents Index

DOCS FAMILY	WEIGHT	FAMILIY SCORE [%]	WEIGHTED SCORE [%]
A - Construction ✓	11.97%	100.00%	11.97%
B - Fire safety ✓	28.26%	100.00%	28.26%
C- Structures ✓			
D - Plants ✓	25.05%	100.00%	25.05%
E - Safety and maintenance ✓	10.19%	100.00%	10.19%
F- Urban planning ✓			
G - Land register ✓	3.27%	100.00%	3.27%
H - As built ✓	18.22%	0.00%	0.00%
I - Origins and rights ✓	3.05%	0.00%	0.00%

78.74%



- **blue line**: current documents available.
- **red dashed line**: level 1 documents – required by laws.
- an high rating does not mean a sufficient documents situation: each single family must be above sufficiency.
- some family may not be present because not relevant for the specific building.
- weights automatically calibrated on analysed docs families
- green/red check for mandatory documents

Building Condition Index

BUILDING CONDITION INDEX

Building index 71%

average of previous indexes,
if both present.

red: average of the below limits
yellow: average of the below limits

Technical index 63.17%

There are 38 serious anomalies on 32 diagnostic forms

red: "bad" condition
yellow: "normal" condition

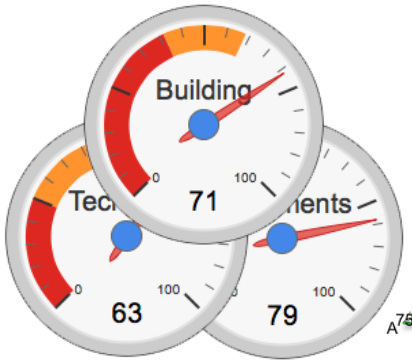
Documents index 78.74%

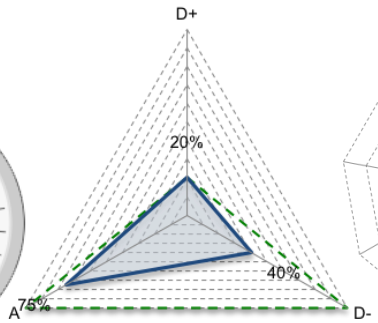
Mandatory documents are all present

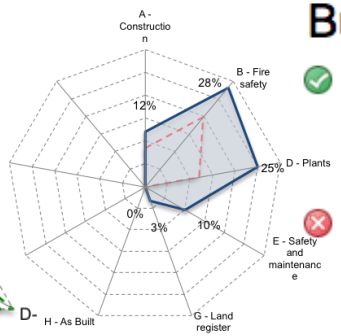
red: mandatory documents
yellow: zero

Building Condition Index

SYNTHETIC VIEW







Building index 71%

Documents index 78.74%

Mandatory documents are all present

Technical index 63.17%

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DETAILED VIEW

TECHNOLOGICAL UNIT #	CODE	NAME	# FORMS [-]	WEIGHTS	WEIGHTED INDEXES D+	D-	A	ANOMALIES # A
01	S.F	Foundations						0 on 0
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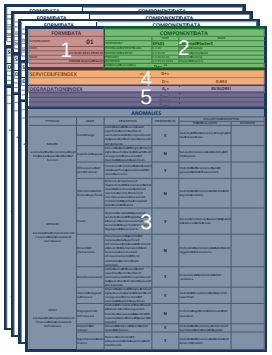
COMPONENT DATABASE



- for different stakeholders and purposes
- incremental system
- to be used both for quick and detailed surveys
- good starting point for maintenance management and energy refurbishment

Corrective maintenance

COMPONENTS ANOMALIES				
	Ext. plaster	Windows	Heating sys.	…
	cracks	broken glass	water leakage	…
	missing parts	dust	…	…

+ schedule + description

MAINTENANCE OPERATIONS	External plaster			
	cracks	missing parts	Dust	…
URGENT	restoration	partial replacement	cleaning	…
DEFERRED	partial replacement	complete replacement	…	…

- directly connected with components anomalies
- can be grouped together (opportunity maintenance)
- divided in macro-categories (restoration, cleaning, replacement, …)
- best interventions to be done must be selected by the user
- associated with a schedule (short-medium-long term) and a description

Urgent maintenance operations

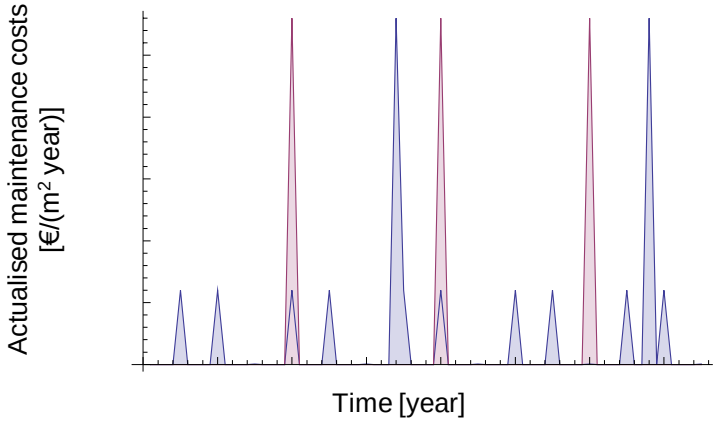
ANOMALY	OPERATION	SCHEDULE	DESCRIPTION
Finishing degradation	Restoration	long-term	Repainting and/or replacing hardware parts
Superficial deposits	Cleaning	long-term	Use of specific instruments and products
Hardware degradation	Restoration	middle-term	To be fixed, oiled and tuned
Gasket degradation	Partial replacement	middle-term	Disassembly and replacement
Biological attack	Restoration	short-term	Biological colony removal
Missing parts	Partial replacement	short-term	Disassembly and replacement

Extract of maintenance operations for a **wooden window**

Possibility to combine with other operations to be done on the main façade

Further developments

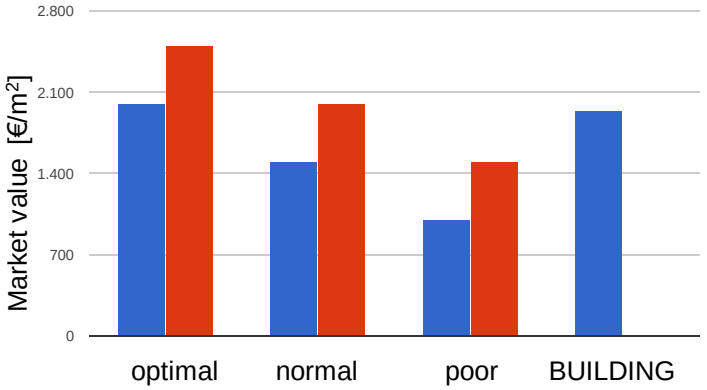
- complete maintenance profile for each component
- Life Cycle Cost for components maintenance profiles



External plaster LCC comparison

- planned maintenance (blue)
- corrective maintenance (red)

- Building Condition Indexes as an instrument to find the asset true market value



Evaluation of:

- asset market value
- maintenance cost to restore market value

Conclusions

The system helps in filling the lack of information for a constructed asset:

- it gives the **current building situation** (documents and degradation)
- It helps in the definition of **maintenance operations** to be done
- it is **incremental**
- it is **objective** and building **function** tailored
- it can be used both during **refurbishment** and **handover**
- its **reliability** has been tested with several case studies (made by different people's categories)
- it can be connected to a **quantity survey** and to **BIM** technologies