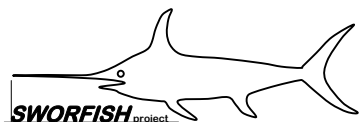


Bio-based building materials: aesthetical service life and customer's environmental conciseness

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COST FP1407 1st meeting, 25-26/08/2015, Koper



BI⁴ever



bio-based building materials: a dream

the ultimate (bio-) residence is:

- **zero energy** consumption in construction, use and demolition
- extremely **high insulation**
- **ecological footprint = 0**
- **easy** to erect
- entirely part of the **natural cycle**
- **no waste** of materials in construction and demolition
- **100% recyclable**
- ...

advantages of building with bio-based materials:

- locally available resources
- easy to make
- flexible in use
- competitive pricing
- great freedom in design

Selection criteria for sustainable (bio-) building materials

Green Features		
Manufacturing Process (MP)	Building Operations (BO)	Waste Mgmt. (WM)
Waste Reduction (WR)	Energy Efficiency (EE)	Biodegradable (B)
Pollution Prevention (P2)	Water Treatment & Conservation (WTC)	Recyclable (R)
Recycled (RC)	Nontoxic (NT)	Reusable (RU)
Embodied Energy Reduction (EER)	Renewable Energy Source (RES)	Others (O)
Natural Materials (NM)	Longer Life (LL)	

Source: Jong-Jin Kim, Brenda Rigdon "Sustainable Architecture Module: Qualities, Use, and Examples of Sustainable Building Materials"

some initial remarks...

Wood is an amazing material, but:

- **wood products may lose visual appeal** (due to staining, oxidation, and discoloration, weathering, etc.) leading to a perceived need for replacement
- + even if in most cases the wooden products are far from the **functional failure**

Marketing should be not only a sale (old sense - “telling and selling”) - but nowadays also a tool for satisfying customer needs:

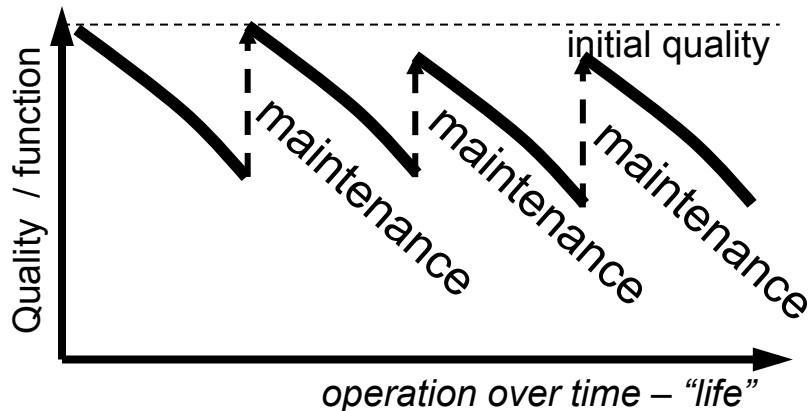
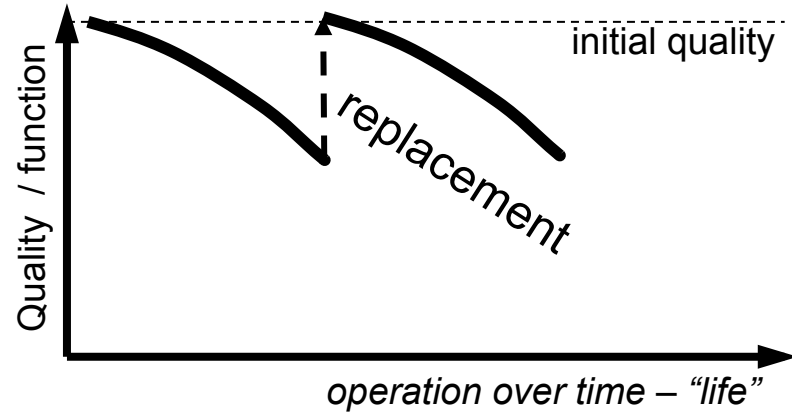
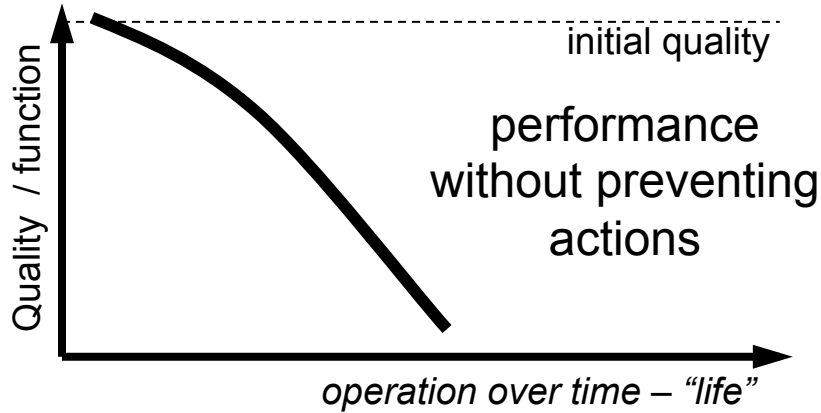
- consumers usually **face a broad array of products and services** that might satisfy a given need
- consumers make **buying choices based on their perceptions of the value** that various products and services deliver
- **customer satisfaction** is the extent to which a product’s perceived performance matches a buyer’s expectations
- **quality** has a direct impact on product or service performance. Thus, it is closely linked to customer value and satisfaction.
- quality can be defined as “**freedom from defects**”

Using **locally produced building (bio-) materials** shortens transport distances:

- + **reducing air pollution** produced by vehicles
- + in general, **local materials are better suited** to climatic conditions
- + purchases of local materials support **area economies**

Question: are customers really aware of all the above???

scenarios of the “service life”



Question: What is really best???

The goal(s)...

- to investigate the influence of **material costs** and **customer environmental awareness** on the choice of bio-materials used for building applications
- to develop a simple **software tool** for “assessing user preferences”
- to investigate what is an **acceptance limit for surface weathering** in various groups of respondents (perception/tolerance of imperfection)
- to identify **causes for change of the customer choices** after providing additional information regarding bio-material:
 - economic
 - environmental

The test

- **Simple approach:**
 - read the question (in native language)
 - look at set of images
 - decide & click
- **Seven questions** in total (only 2 presented here)
- Focus (of this selected questions) on **wooden facades exposed to weathering:**
 - various bio-materials
 - natural weathering for 3 years, south exposition, no protection from rain
- Data analysis related to **age, gender, nationality, education & expertise in wood**

- average **time needed for answer** all questions in the test: ~226 seconds
- dedicated **software tool** has been developed in LabView 2013
- only **one portable computer** has been used for visualization of the sample images during whole experiment (HP Pavilion HDX, 20' display size, resolution 1680x1050 pixels)

The test: user info

START user info

File Edit View Project OpenFile Tools Window Help

name (optional)
Jakub Sandak

country
Italy

age
39

gender
male

education
PhD

expertise in wood technology?
yes

Start the hedonistic test

Main Application Instance

Computer & console TaskWaver SANDAK_ge_JWLSA... Hedonistic test LawVIEW 12.00 Internet Explorer, Inc. 18.03

The test: question 1

helenistic test selection of species.vi

File Edit View Project OpenFile Tools Window Help

which wood would you select knowing the appearance after three years exposition?

reference
3 years exposition south

reference
3 years exposition south

The image displays a software window titled "helenistic test selection of species.vi" with a menu bar (File, Edit, View, Project, OpenFile, Tools, Window, Help) and a toolbar. The main content area contains a question: "which wood would you select knowing the appearance after three years exposition?". Below the question is a 2x3 grid of wood samples. The top row shows three different wood species, each with a "reference" (top) and "3 years exposition south" (bottom) image. The bottom row shows the same three species, but the first one is a greyish, weathered wood, while the other two are similar to the reference images. A question at the top asks "which wood would you select knowing the appearance after three years exposition?".

The test: question 2

helenistic test selection of species and cost

File Edit View Project Openix Tools Window Help

which wood would you select knowing the cost and the appearance after three years exposition?

reference
3 years exposition south

Italian spruce, 50€/m²

Siberian larch, 75€/m²

thermowood #1, 100€/m²

reference
3 years exposition south

coated spruce, 85€/m²

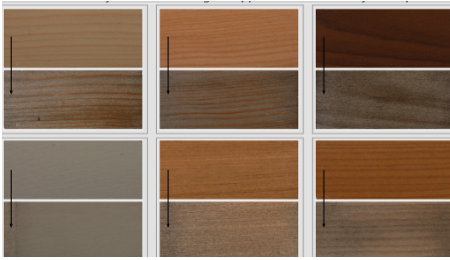
African teak, 250€/m²

thermowood #2, 100€/m²

Main Application Instance

Computer & controls TaskWaver SINDAK_gj_WJISA... helenistic test L&WVIEW 12.00 Document - More...

18.05



material indexes

aesthetics: change to surface

3	3	3
1	2	3

1 – no change
 2 – little change
 3 – a lot of change

aesthetics: uniformity of the surface

2	2	2
1	1	2

1 – uniform
 2 – pattern

function: maintenance

2	2	1
3	1	1

1 – not need
 2 – occasionally
 3 – intensive

function: durability (perception)

1	2	3
2	3	3

1 – not durable
 2 – average
 3 – very durable

environment: provenance

1	2	3
1	3	1

1 – close
 2 – distant
 3 – very faraway

environment: “recyclability”

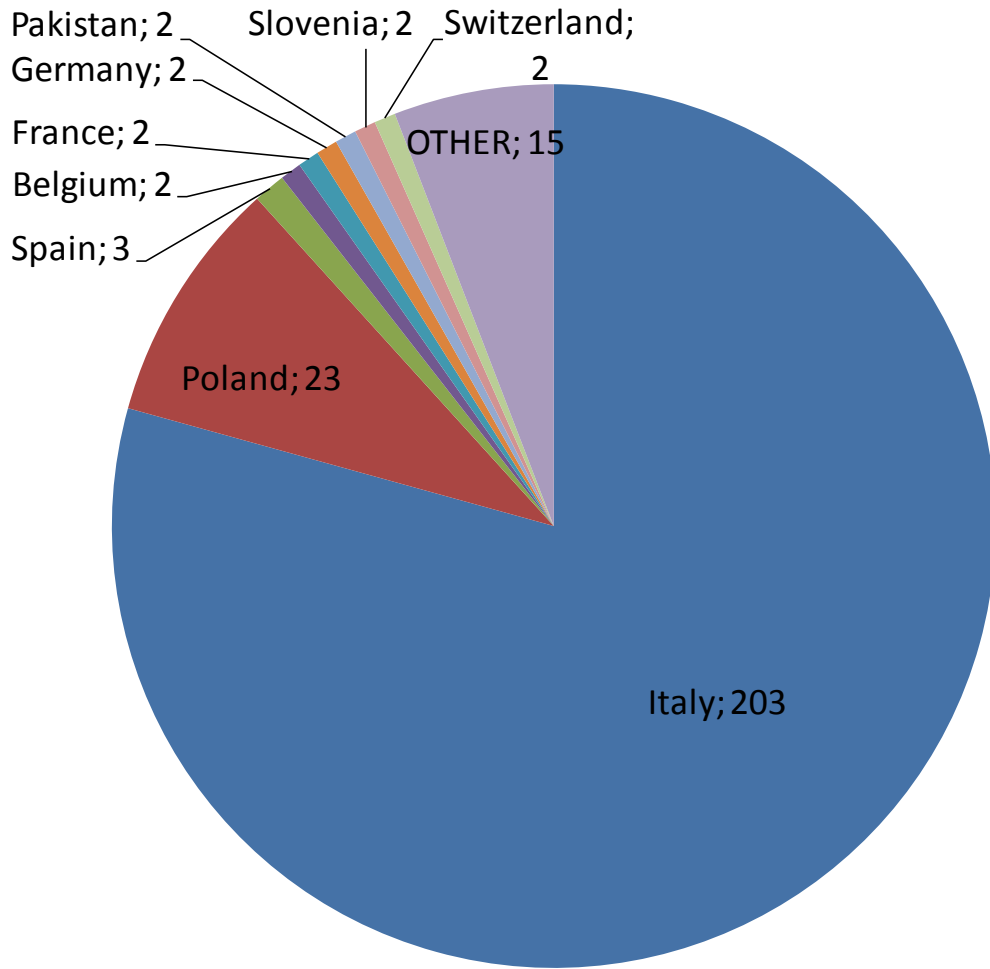
1	1	2
3	1	2

1 – easy
 2 – difficult (?)
 3 – problematic

respondents

- COST Action FP1006 (and FP0904) members
- University of Life Sciences in Poznan (Poland) staff
- University of Trento Structure Engineering students/
staff
- professional secondary school for carpenters in Trento
- carpenters from association SanPatrignano (Italy)
- staff/visitors from IVALSA/CNR San Michele &
Florence
- students/teachers from Scuola Media di Mezzocorona
- others; friends

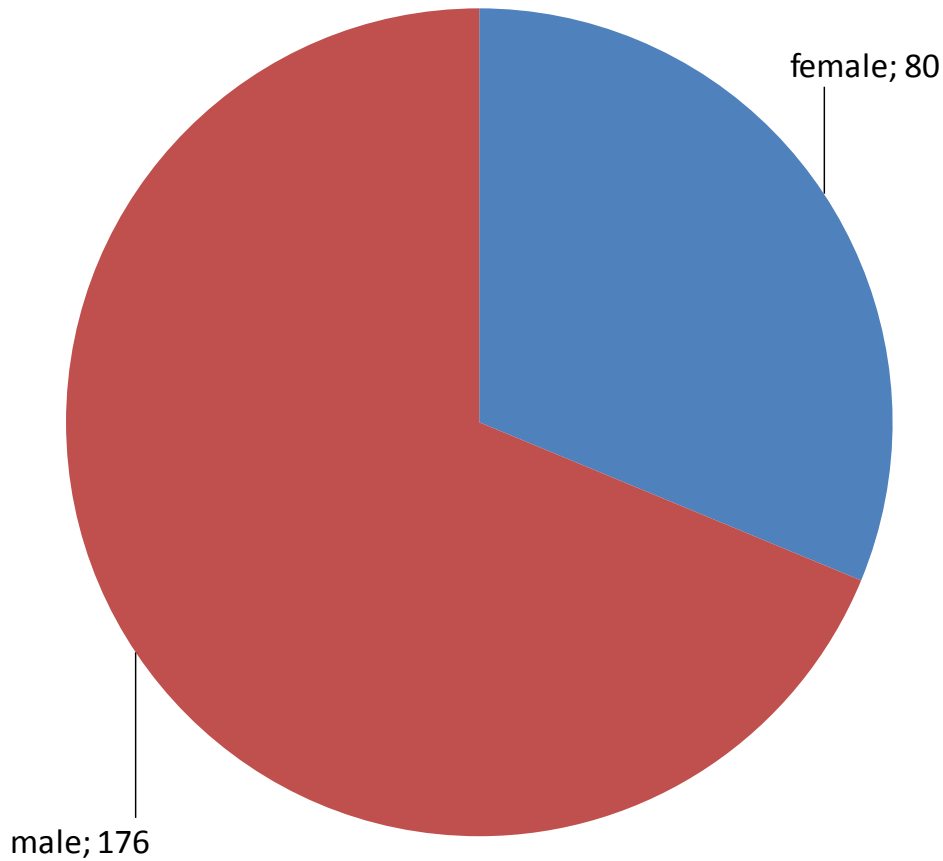
Respondents: country



country	number of responses
Italy	203
Poland	23
Spain	3
Belgium	2
France	2
Germany	2
Pakistan	2
Slovenia	2
Switzerland	2
Ghana	1
Austria	1
Canada	1
Croatia	1
Egypt	1
Eritrea	1
Finland	1
Macedonia	1
Marocchina	1
Netherlands	1
Norway	1
Portugal	1
Romania	1
Serbia	1
Thailand	13
TOTAL:	256

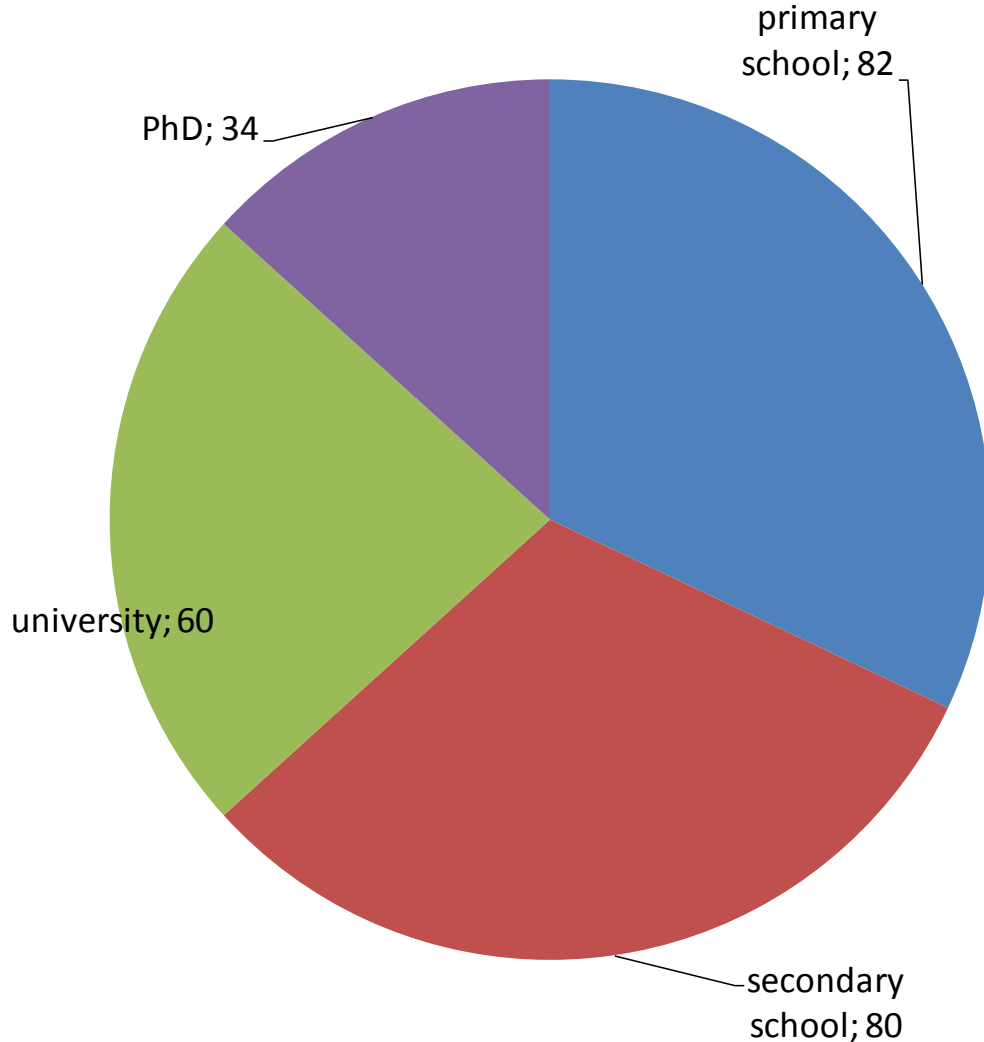
OTHER

Respondents: gender



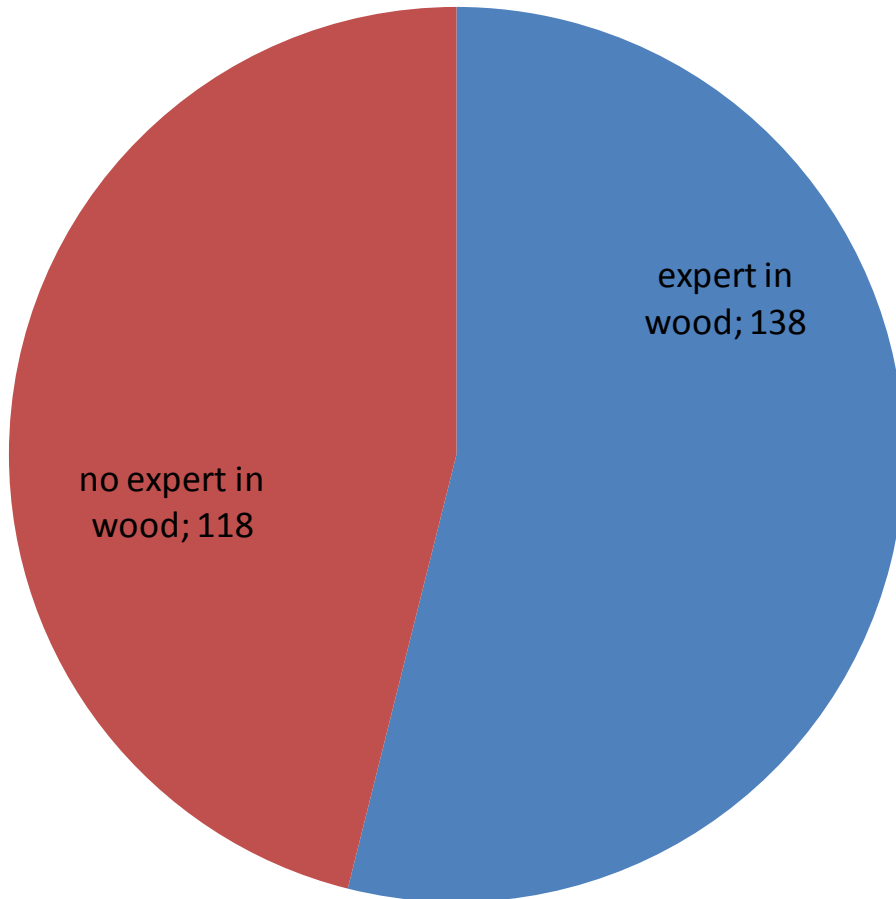
gender	number of responses
female	80
male	176
TOTAL:	256

Respondents: education



education	number of responses
primary school	82
secondary school	80
university	60
PhD	34
TOTAL:	15 256

Respondents: **expertise in wood**



expertise	number of responses
expert	138
no expert	118
TOTAL:	256

some results...

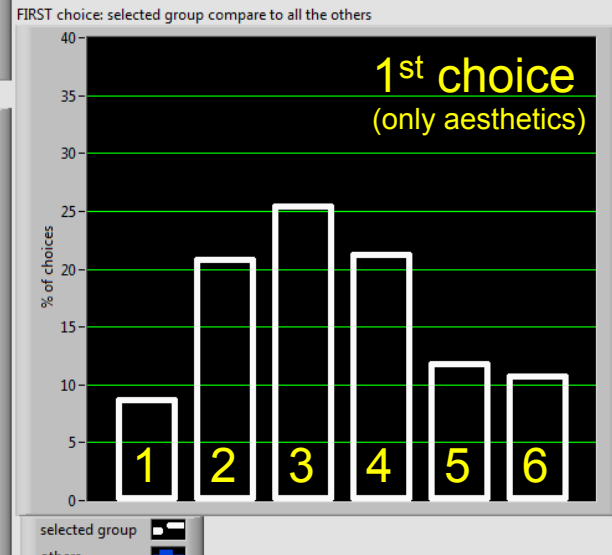
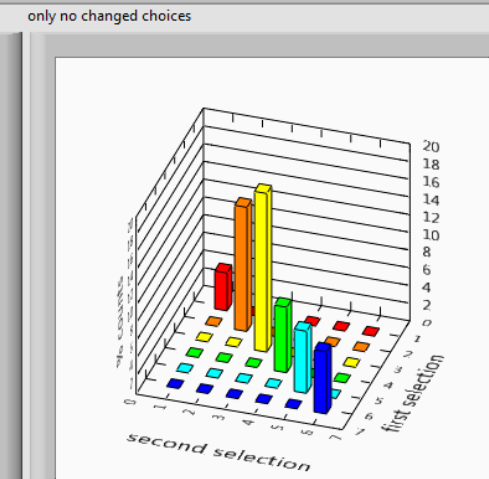
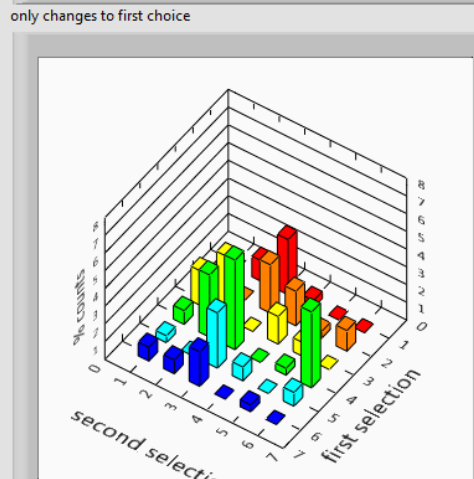
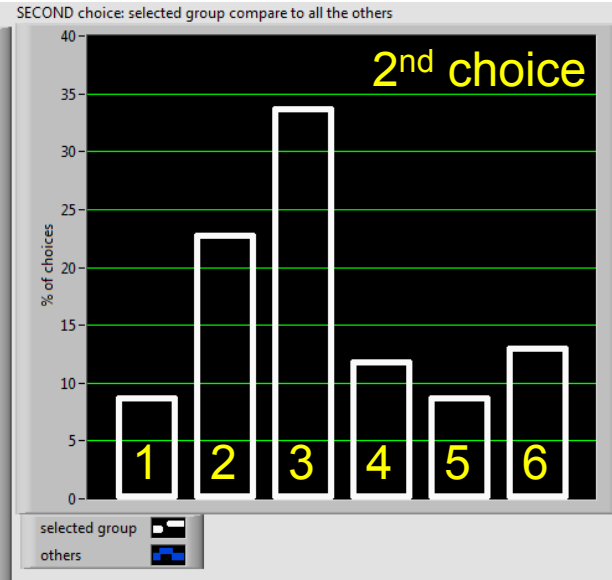
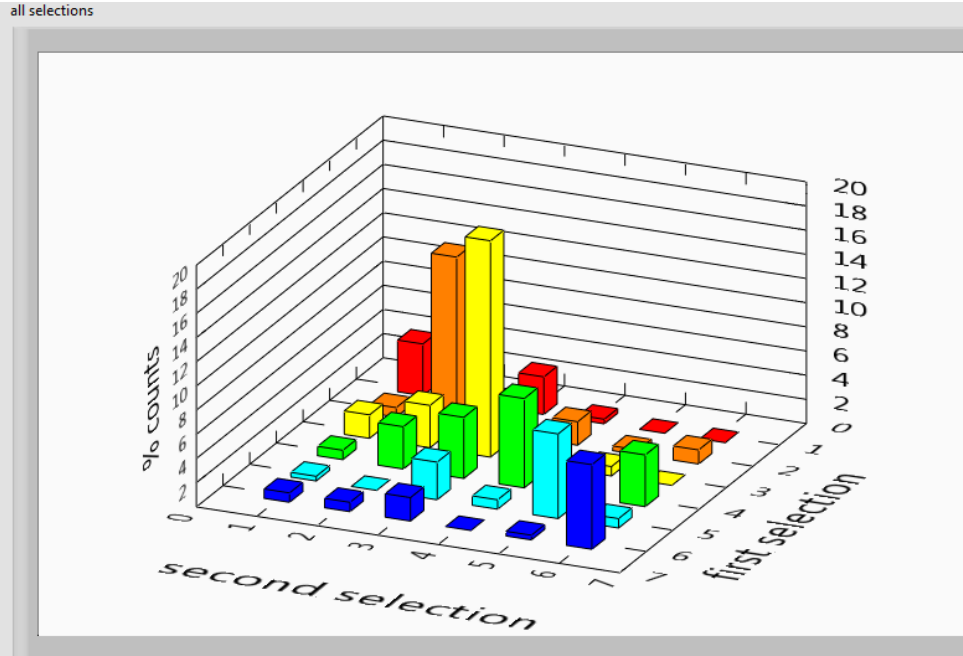
all responses (n = 256)

1 - Italian spruce
4 - African teak

2 - coated spruce
5 - TMW-hardwood

3 - Siberian larch
6 - TMW-softwood

% of respondents changing selection = 42,4



female ↔ male ($n_{\text{female}} = 80$)

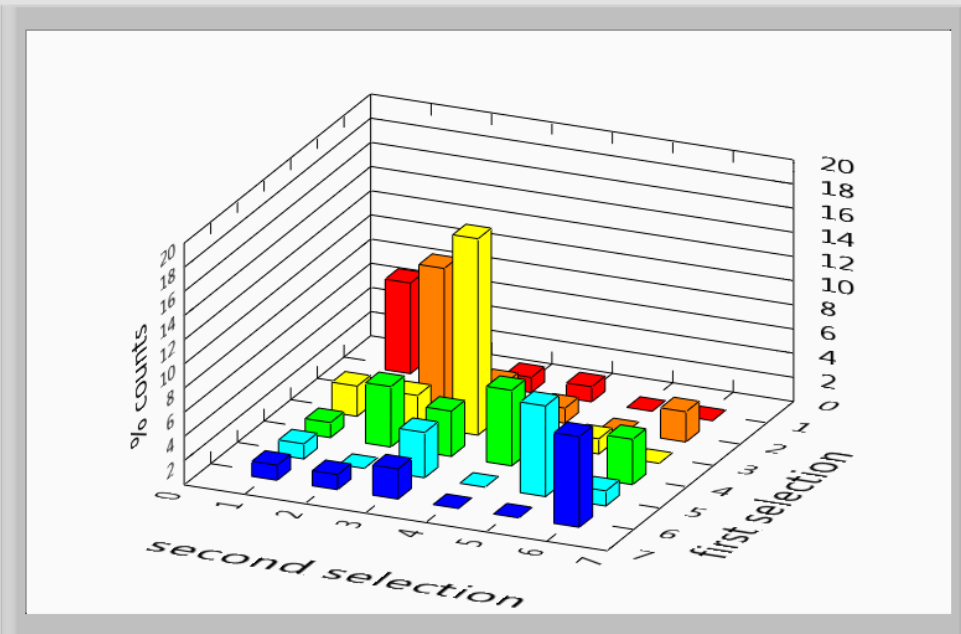
1 - Italian spruce
4 - African teak

2 - coated spruce
5 - TMW-hardwood

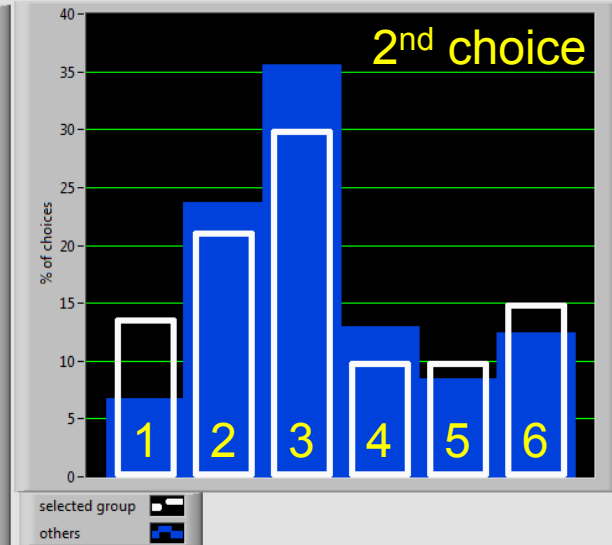
3 - Siberian larch
6 - TMW-softwood

% of respondents changing selection = 43,8

all selections



SECOND choice: selected group compare to all the others

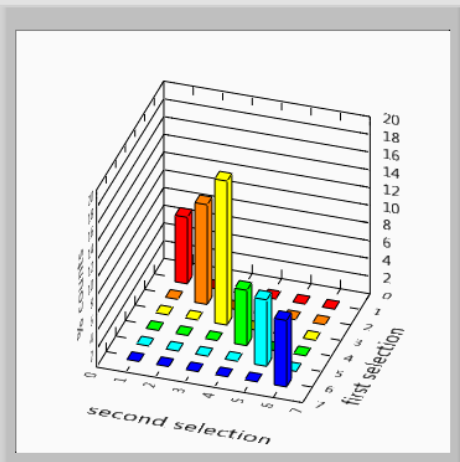
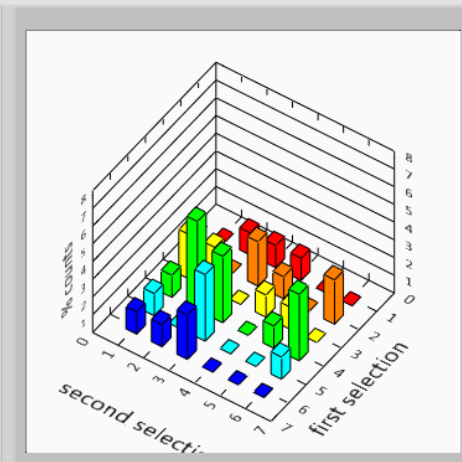


FIRST choice: selected group compare to all the others



only changes to first choice

only no changed choices



experts in wood ($n_{\text{experts}} = 137$)

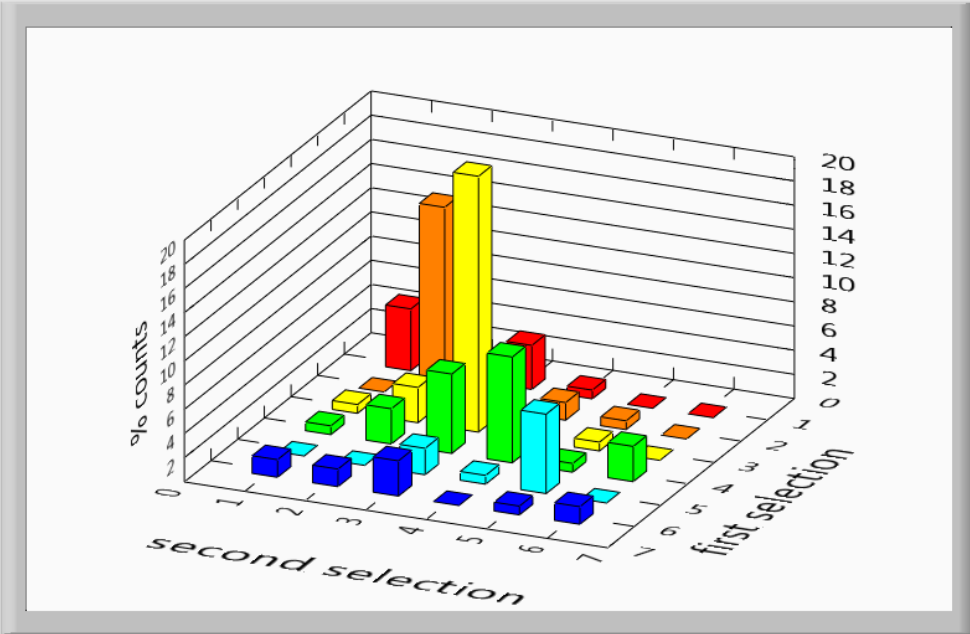
1 - Italian spruce
4 - African teak

2 - coated spruce
5 - TMW-hardwood

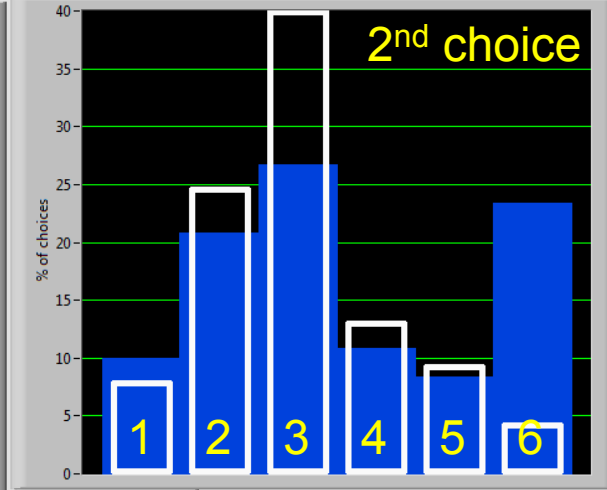
3 - Siberian larch
6 - TMW-softwood

% of respondents changing selection = 40,9

all selections

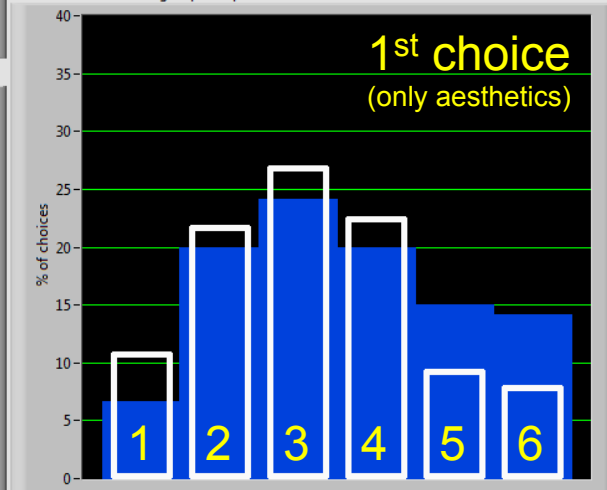


SECOND choice: selected group compare to all the others



selected group [white bar]
others [blue bar]

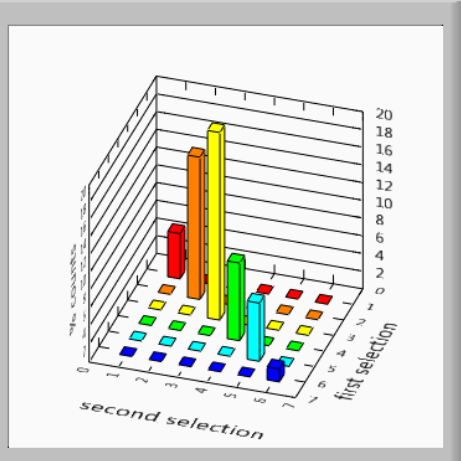
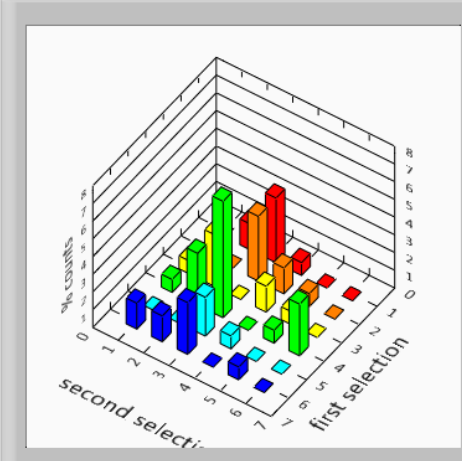
FIRST choice: selected group compare to all the others



selected group [white bar]
others [blue bar]

only changes to first choice

only no changed choices



junior high school students (n = 79)

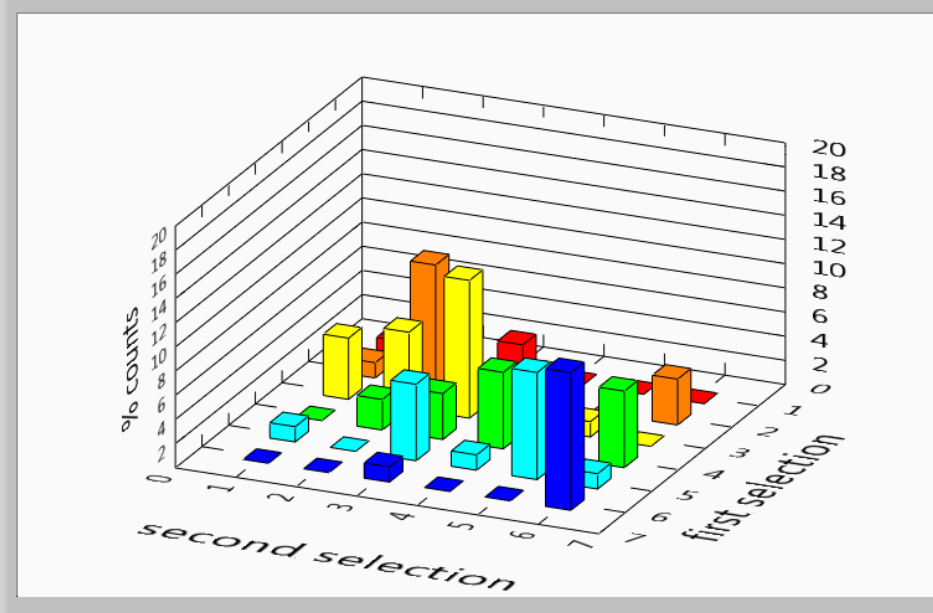
1 - Italian spruce
4 - African teak

2 - coated spruce
5 - TMW-hardwood

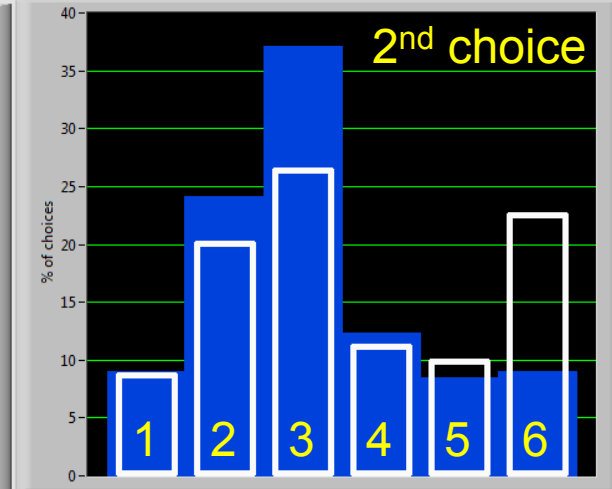
3 - Siberian larch
6 - TMW-softwood

% of respondents changing selection = 50,6

all selections

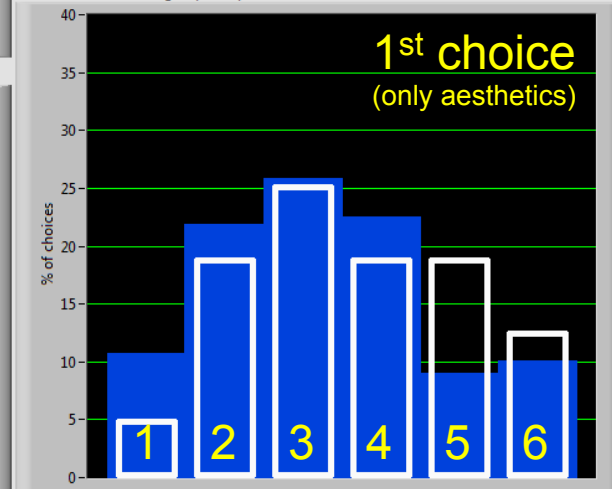


SECOND choice: selected group compare to all the others



selected group
others

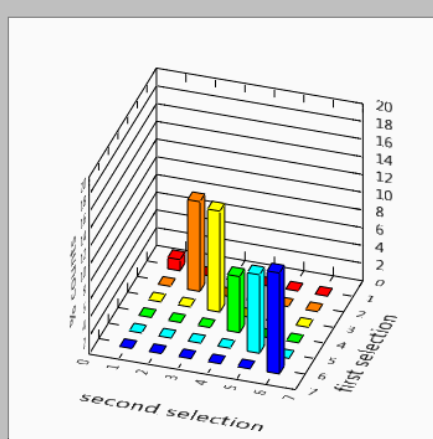
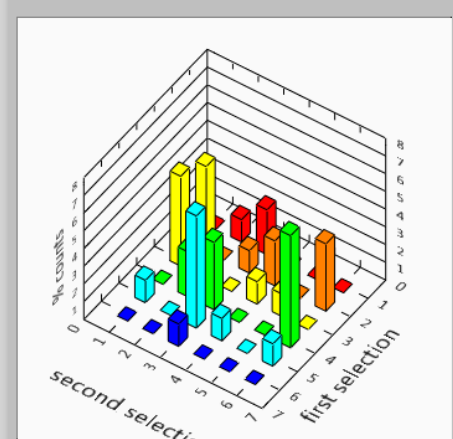
FIRST choice: selected group compare to all the others



selected group
others

only changes to first choice

only no changed choices



criteria for economic advantage:

”new choice is less expensive”

first selection

second selection

	Italian spruce 50€/m²	coated spruce 85€/m²	Siberian larch 75€/m²	African teak 250€/m²	TMW softwood 100€/m²	TMW 2 hardwood 100€/m²
Italian spruce 50€/m²	0	1	1	1	1	1
coated spruce 85€/m²	0	0	0	1	1	1
Siberian larch 75€/m²	0	1	0	1	1	1
African teak 250€/m²	0	0	0	0	0	0
TMW softwood 100€/m²	0	0	0	1	0	0
TMW hardwood 100€/m²	0	0	0	1	0	0

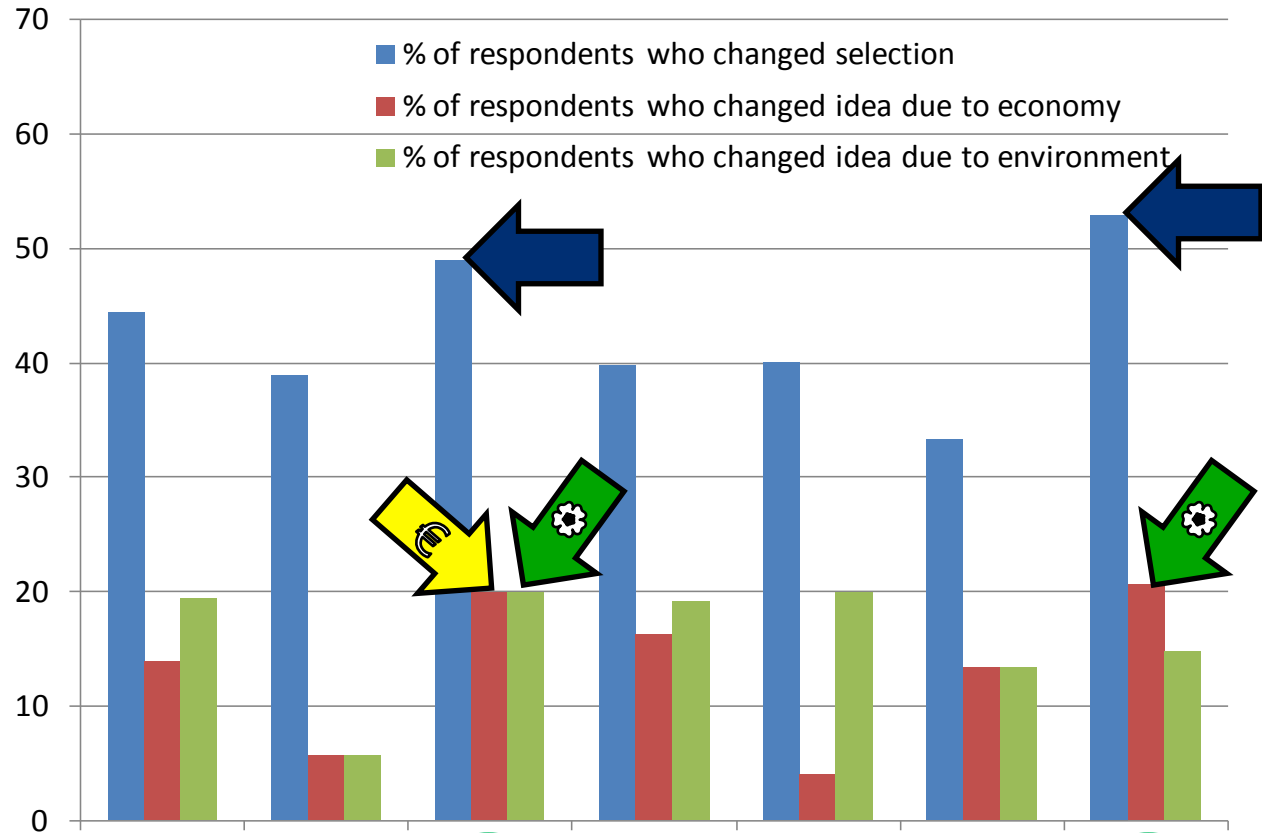
criteria for environmental improve: *"new choice is more eco-friendly"*

first selection

		Italian spruce #1	coated spruce #3	Siberian larch #4	African teak #5	TMW softwood #2	TMW hardwood #2
second selection	Italian spruce #1	0	1	1	1	1	1
	coated spruce #3	0	0	1	1	0	0
	Siberian larch #4	0	0	0	1	0	0
	African teak, #5	0	0	0	0	0	0
	TMW softwood #2	0	1	1	1	0	0
	TMW hardwood #2	0	1	1	1	0	0

interpretation of changes: all data

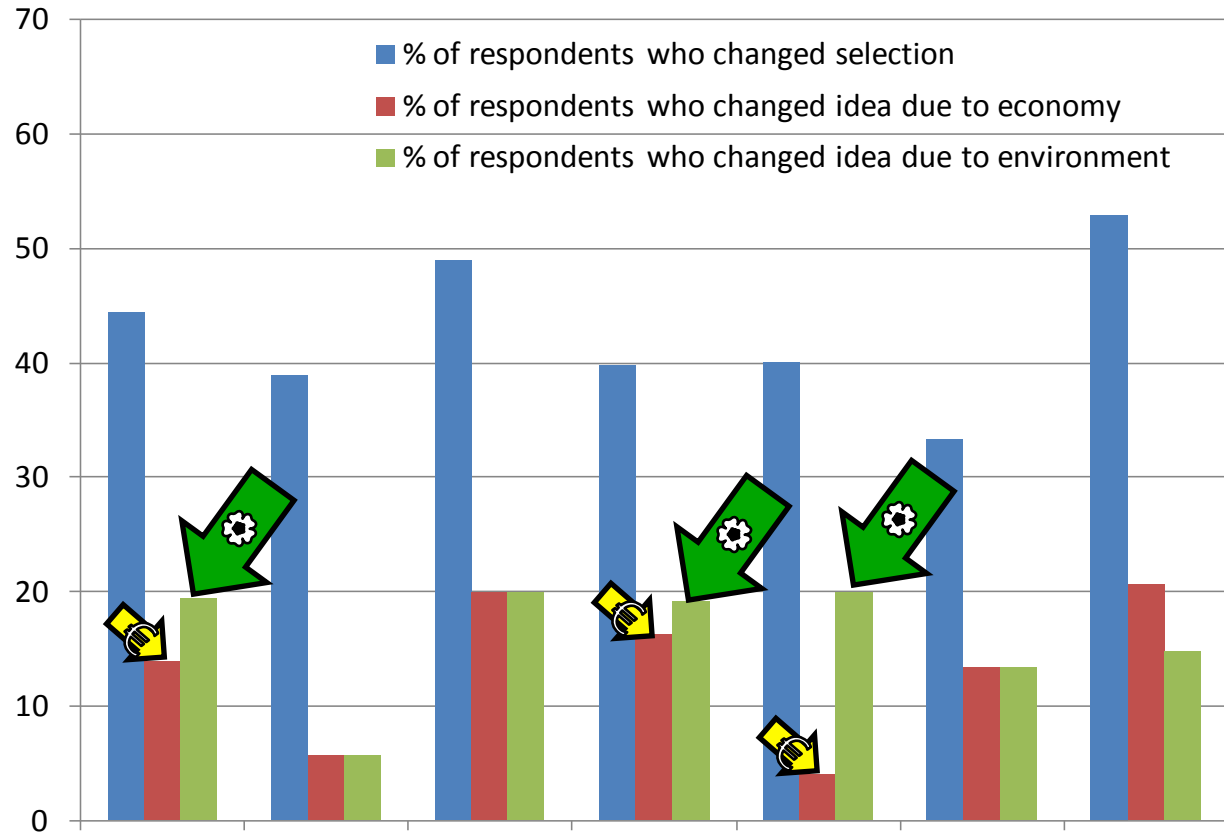
(n >5 respondents)



gender	male	male	male	male	female	female	female
education	university	university	primary school	secondary school	university	university	primary school
expertise in wood	yes	no	no	yes	yes	no	no
number of respondents	36	18	45	68	25	15	34

interpretation of changes: all data

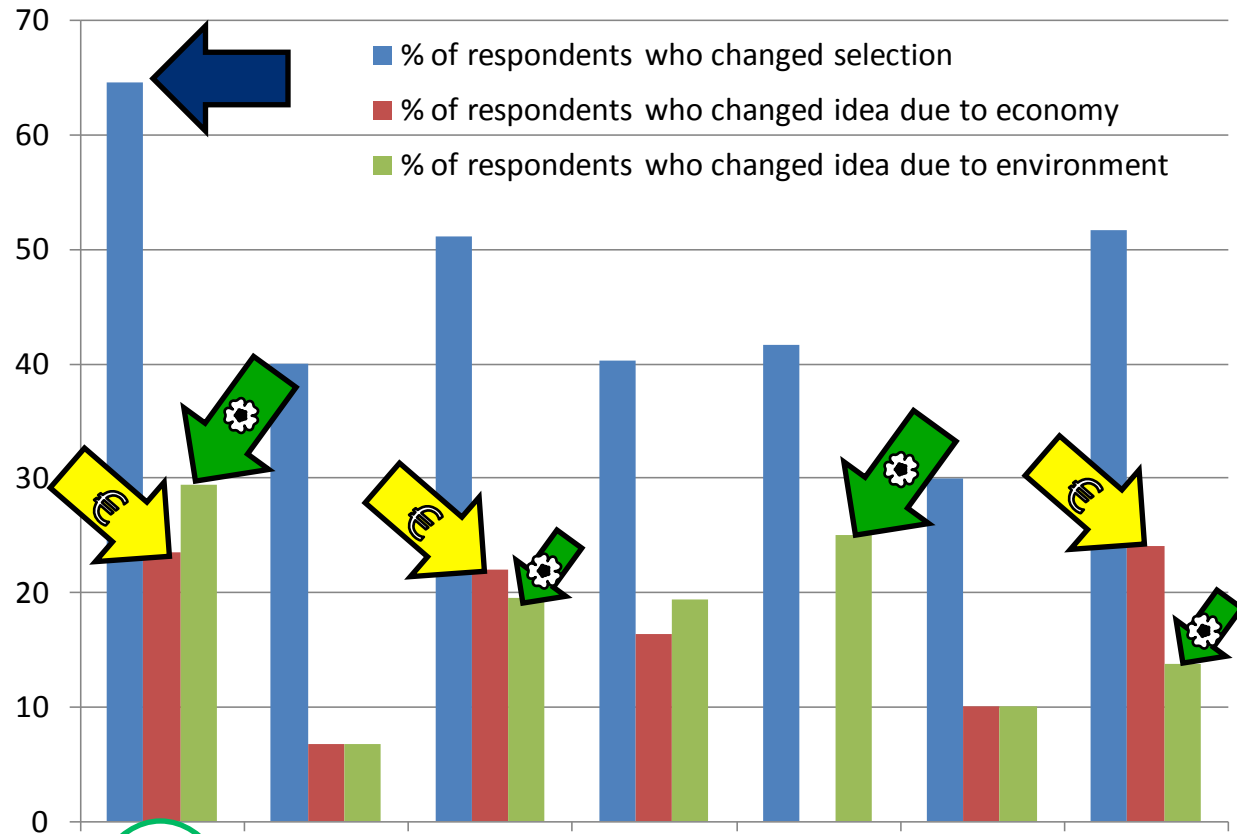
(n >5 respondents)



gender	male	male	male	male	female	female	female
education	university	university	primary school	secondary school	university	university	primary school
expertise in wood	yes	no	no	yes	yes	no	no
number of respondents	36	18	45	68	25	15	34

interpretation of changes: Italy

(n >5 respondents)



gender	male	male	male	male	female	female	female
education	university	university	primary school	secondary school	university	university	primary school
expertise in wood	yes	no	no	yes	yes	no	no
<i>number of respondents</i>	17	15	41	67	12	10	29

conclusions

- the test is a preliminary approach: therefore “**the statistical significance**” is **questionable**
- however, some clear trends in responses can be found;
 - **aesthetics** is not the only criteria for selection of biomaterial!
 - at least 40% of respondents has **changed their selection** after knowing additional information as reading the bio-material
 - not really clear **pattern of change** can be noticeable, even if material traditionally perceived as most durable (larch) was frequently chosen at the second time
 - the most **changing opinion (64%)** was a group of Italian males with university degree and expertise in wood
 - 20% of high school students changed their choice and opted for **less expensive bio-materials**
 - highly educated people were more **aware of environmental aspects** when choosing bio-materials
 - problematic (due to limited number of responses) to interpret **variations between nations**, even if Italian group of respondents differed from other countries
- **the economic and environmental advantage of TMW are not known to the users (yet)...**

To be continued within COST FP1407... (???)²⁷

acknowledgments

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ex-SWORFISH team

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mechanical engineer

Jakub Sandak, PhD
wood technologist

Ilaria Santoni, PhD
chemist

Anna Sandak, PhD
biologist

MariaPaola Riggio, PhD
architect

