Data analytics as inputs for innovations in engineering design

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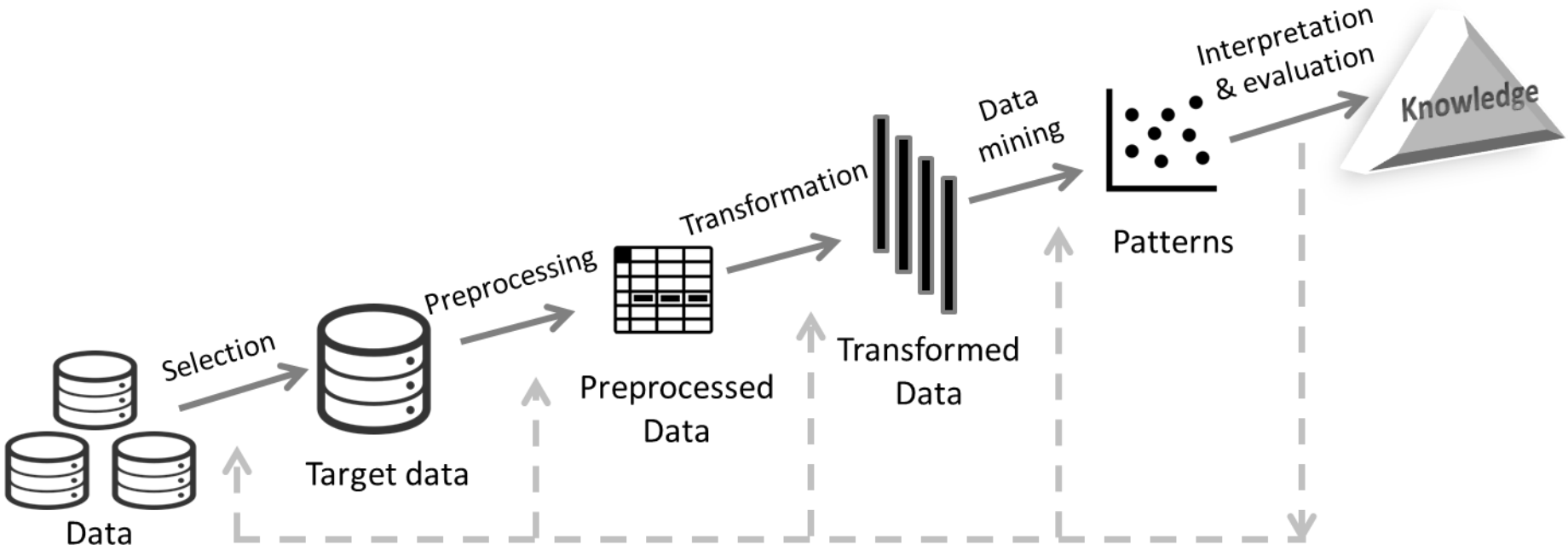
Agenda

- Hypothesis
- KDD
- EDP
- Summary of cases
- Findings

Hypothesis

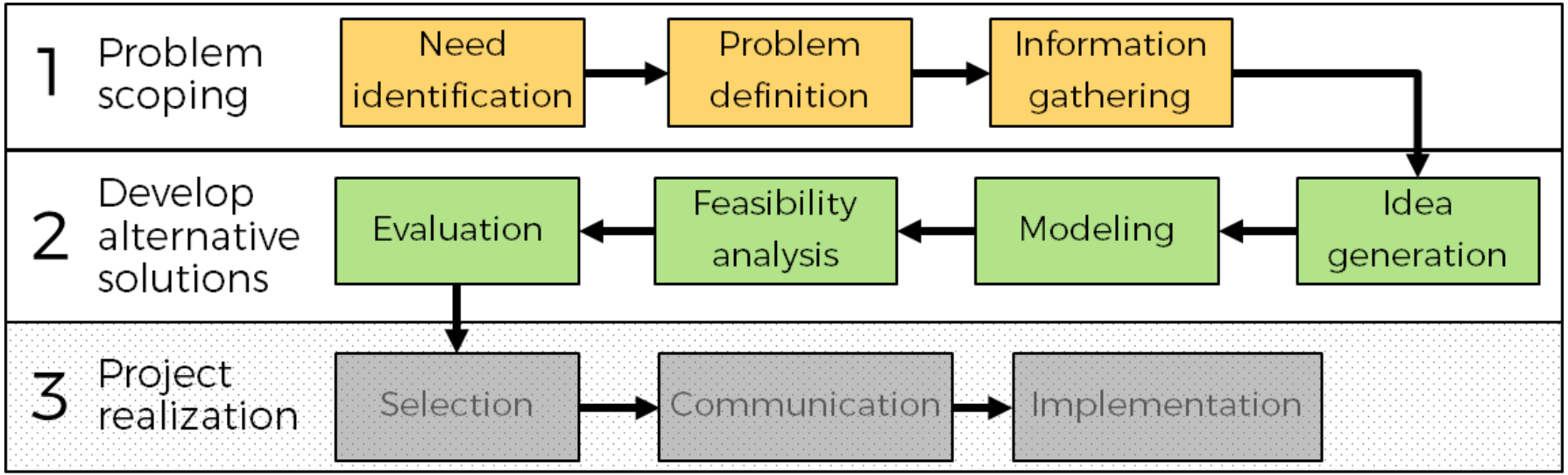
1. Data mining can be used at different stages of the creative process
2. Use of data as input for creativity will increase diversity of ideas
3. Access to data exploration tool will positively impact the generation of "novel combinations"

Knowledge discovery from databases



Piatetsky-Shapiro, 1991

Engineering design process



Atman et al., 2007

Summary of cases

Case	Objective	Duration	Number of teams	Total participants
1	Need identification	4 hours	3	15
2	Benchmark Novel concept Prototype	≈ 100 hours	8	49
3	Novel concepts	24 hours	34	≈212

Context

Innovation contests


Media


Organizer


Replication


Community functionality


Contest period


Sponsors / partners


Marketing / Activation


Contest phases


Participation as


Target group

Evaluation


Degree of elaboration


Reward / motivation


Facilitation


Task specificity

Case 1

Need identification / Problem definition

Case 1

Need identification / Problem definition

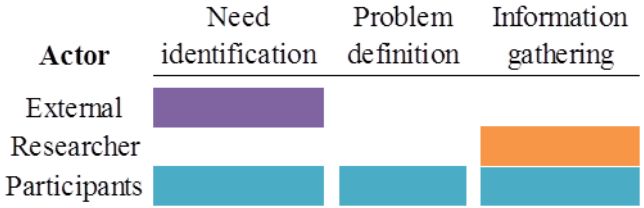
Teams:

- identified elements of the problem world
- generated ideas
- were provided access to data visualization
- generated additional ideas (in less time)

Case 1

Need identification / Problem definition

- Engineering design process



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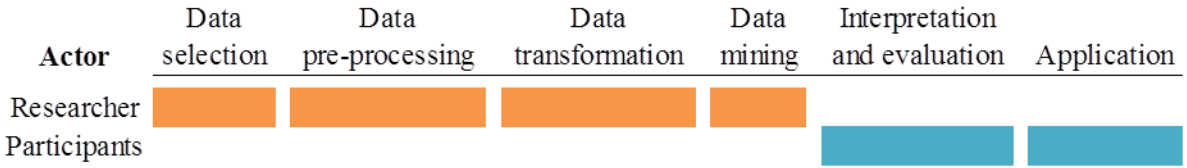
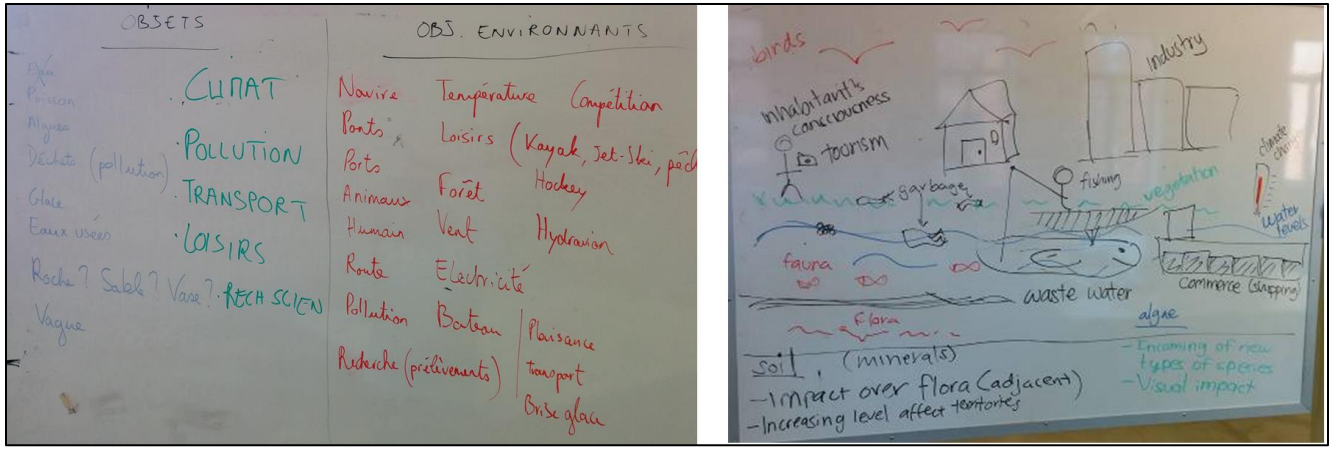


Case 1

Need identification / Problem definition



Group	Number of participants	Issues identified originally	Issues identified with support	Total
1	5	5	3	8
2	6	3	1	4
3	4	5	2	7

Case 2

Development of alternative solutions

Case 2

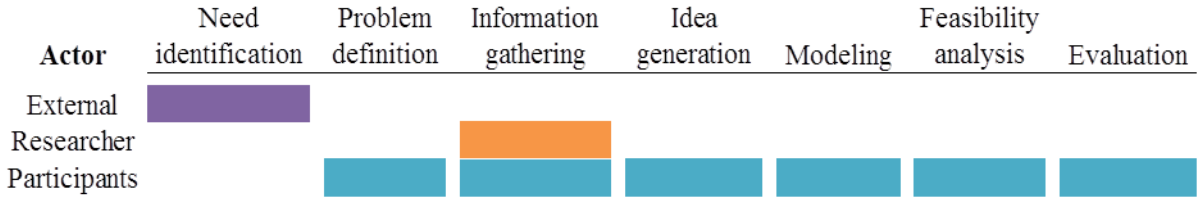
Development of alternative solutions

- Teams
  - were trained in the use of the tool
  - were given access to tool with pre-loaded data
  - use of tool was optional
- Teams with access to tool developed ideas further and were better graded

Case 2

Development of alternative solutions

- Engineering design process



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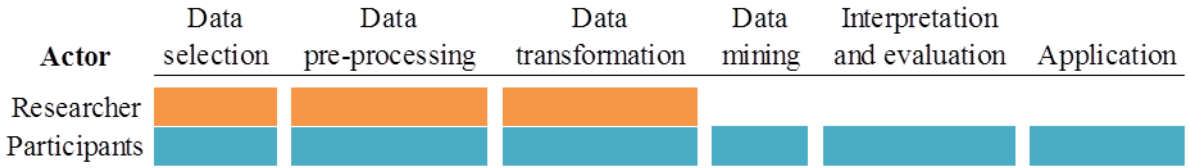

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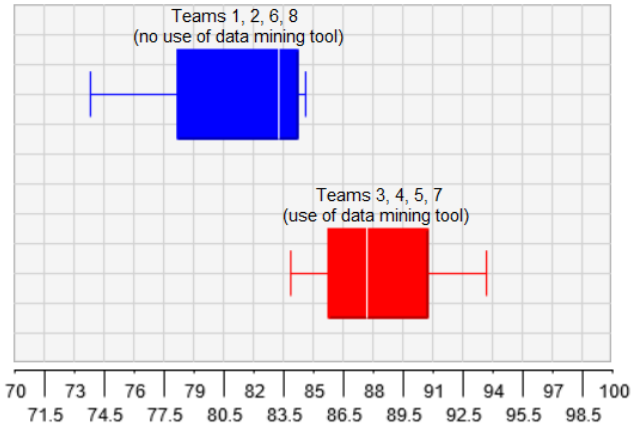
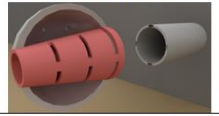
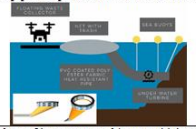
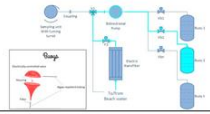
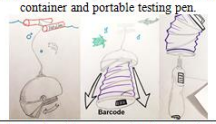
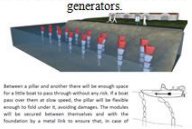
Development of alternative solutions



Team	Initial concept	Final concept
1	Cone shaped filter/turbine which gradually removes garbage of different sizes and stores them in a removable container. 	Cone shaped filter/turbine which gradually removes garbage of different sizes and stores them in a removable container, paired with container changing station in the shore. 
2	Floating waste collector net that traps garbage while water continues to flow through (attached to buoys to float). 	Floating waste collector cone that traps garbage while water continues to flow through (attached to buoys to float). A turbine in the pipes keeps the flow of water and waste. 
3	1: System attached to boat 2: On demand sample and storage 3: Crowdsourcing measurements 4: Onsite bacteria analysis and warning (no image of solution was provided)	Solar-powered set of interconnected buoys which use a Peristaltic pump to send off-shore samples to the shore for collection in QR coded containers. 
4	Autonomous ball-like device that measures in situ parameters and collect water samples. 	Ball-like submersible device with barcoded expansible sample container and portable testing pen. 
5	1: Floating sidewalk 2: Pillar system 3: Buoyant system (no image of solution was provided)	System of wave-breaking pillars that bend under boats and generate electricity from the movement with piezoelectric generators. 

Case 3

Idea generation

Case 3

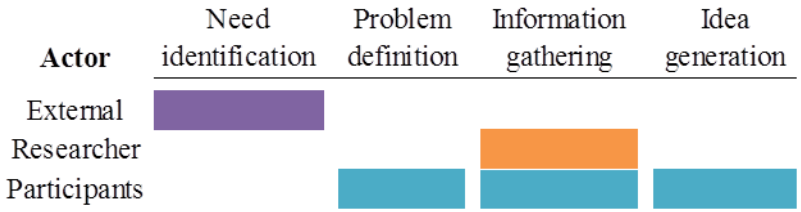
Idea generation

- Identified “twin challenges”
- Provided keywords from the data analysis from the beginning
- Teams with keywords generated more diverse solutions

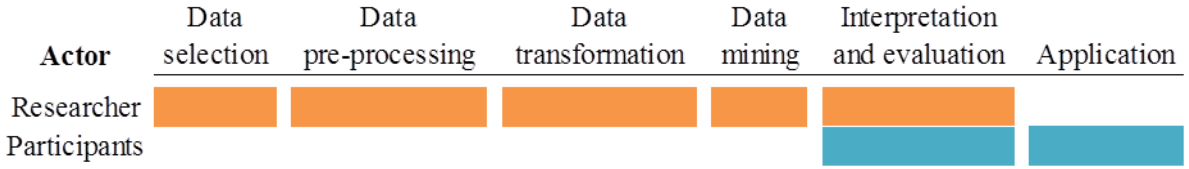
Case 3

Idea generation

- Engineering design process

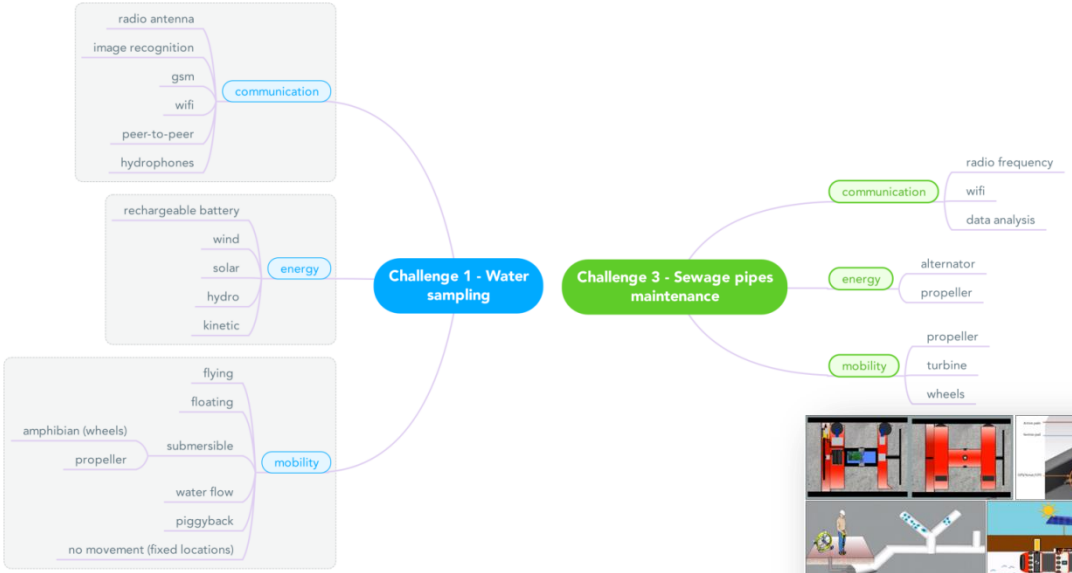


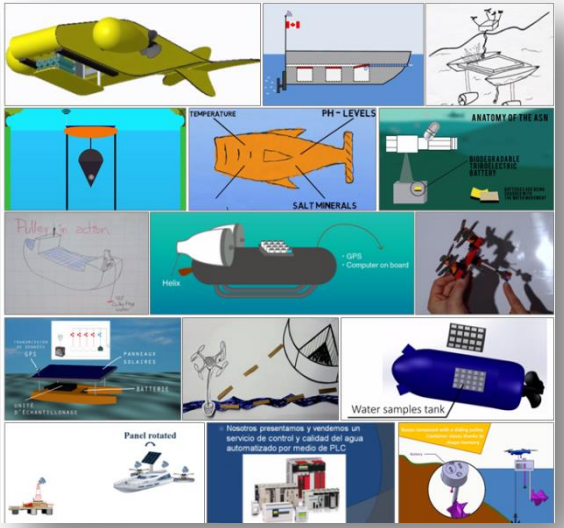
- Knowledge discovery from databases

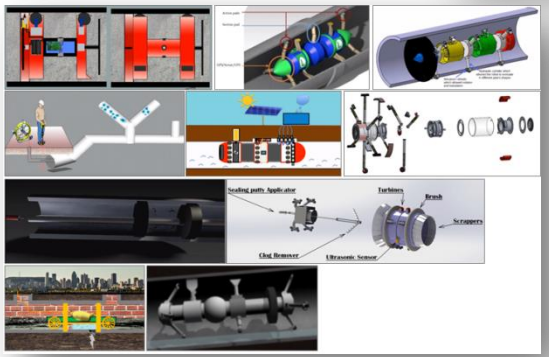


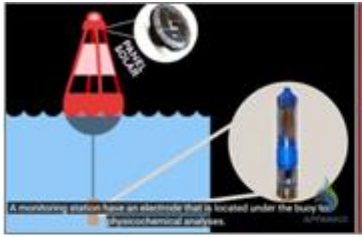
Case 3

Idea generation





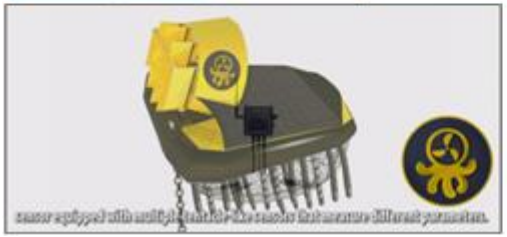


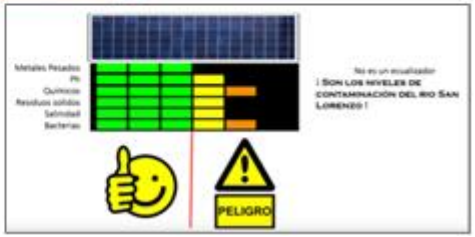


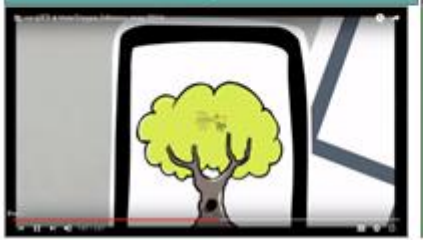

You look Pretty?

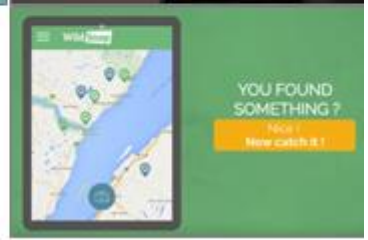

Red light illuminates the water

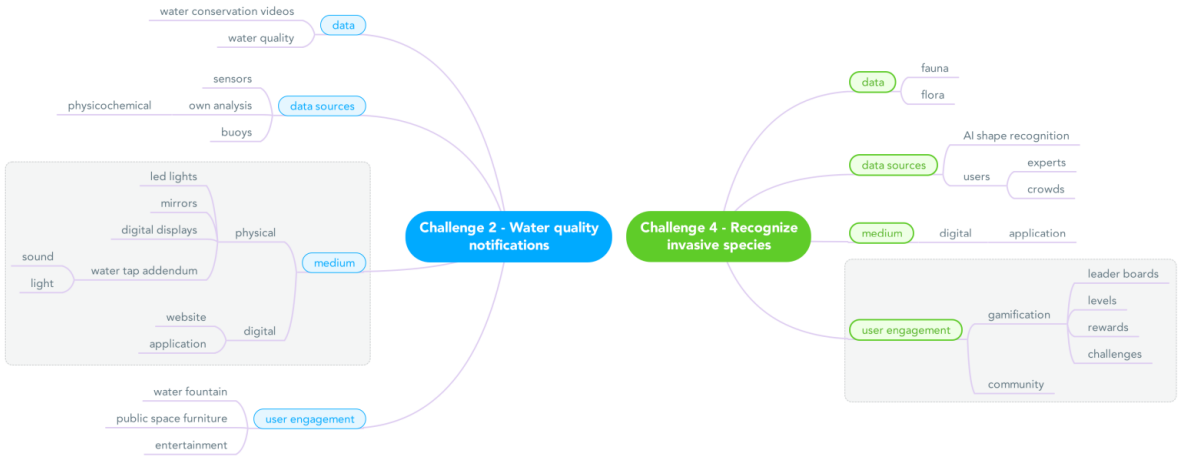

WATCH THE EVOLUTION OF YOUR ECOSYSTEM



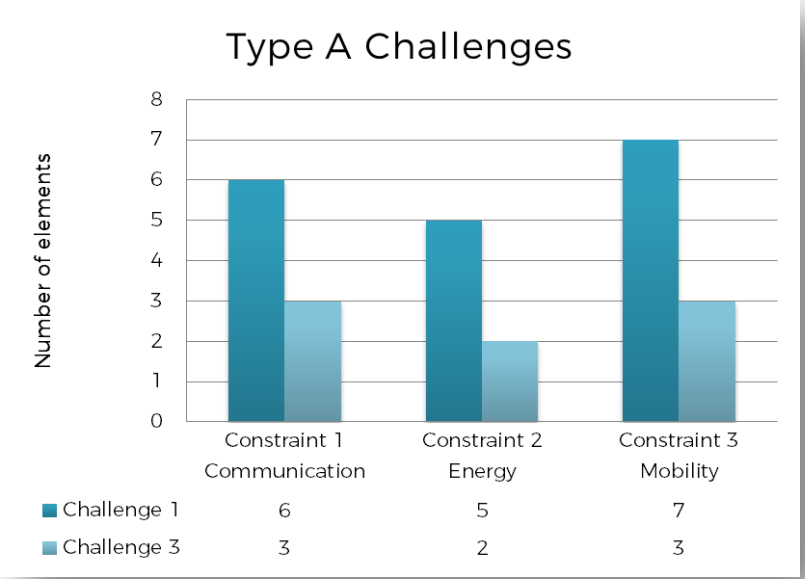

¡ SON LOS NIVELES DE CONTAMINACIÓN DEL RIO SAN LORENZO !
PELIGRO

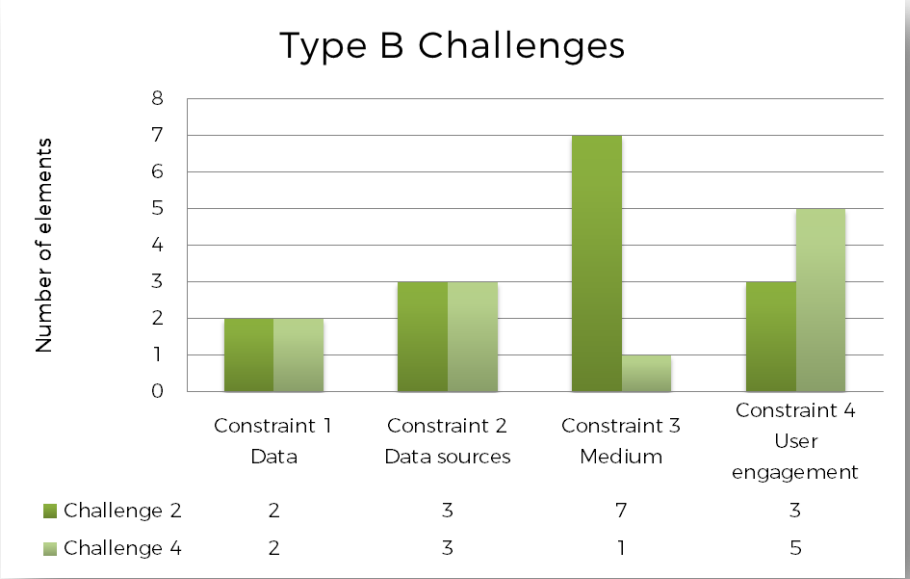



YOU FOUND SOMETHING ?


water conservation videos
water quality
data
sensors
physicochemical
own analysis
data sources
buoys
led lights
mirrors
digital displays
physical
sound
water tap addendum
light
medium
website
application
digital
water fountain
public space furniture
entertainment
user engagement
Challenge 2 - Water quality notifications
Challenge 4 - Recognize invasive species
data
fauna
flora
AI shape recognition
data sources
users
experts
crowds
medium
digital
application
leader boards
levels
rewards
challenges
gamification
user engagement
community

Case 3
Idea generation





Findings

1. In all cases, teams using data as input performed better compared to teams not using it
2. Teams using data showed wider diversity in proposed ideas
3. Teams with no support resort to known solutions
4. Direct access to the tool actually decreased the benefits of data access

Conclusions

- It appears to be better to artificially limit the exploration space
- There is value in the combination of existing knowledge + KDD
- Need to align use of data with stage & objective of EDP

THANK YOU!

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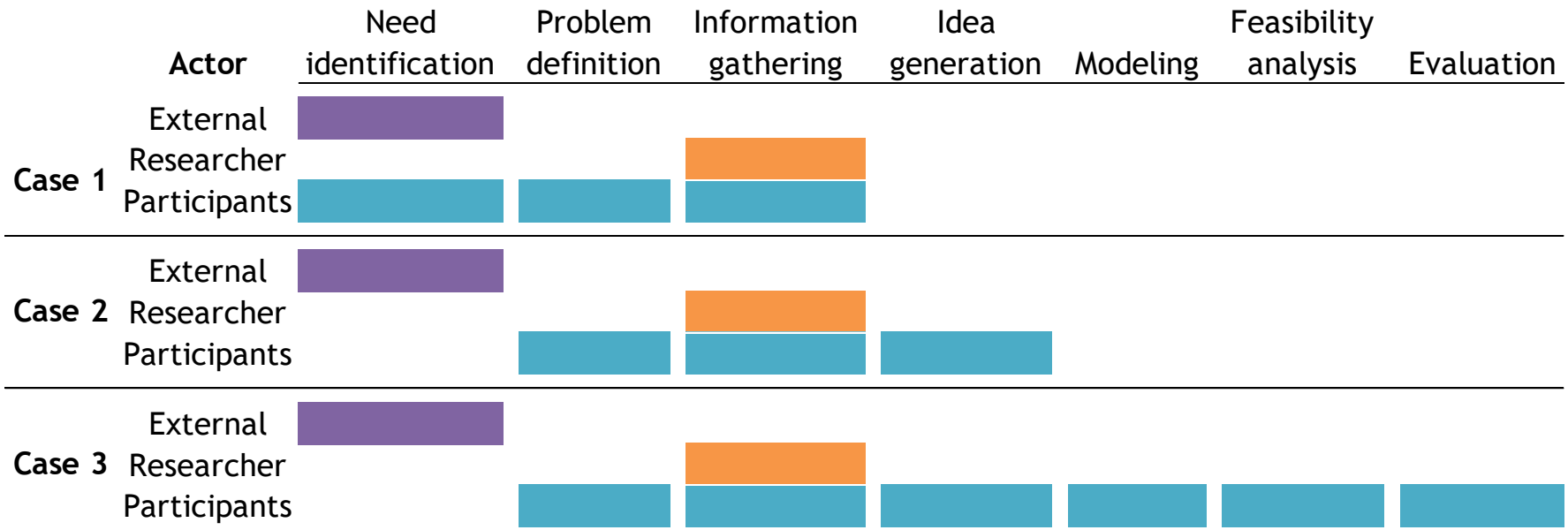
Engineering design process



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