University of Groningen

400 years passion and performance

SLF Summit 2018

Repair Kit Problems & Wind Farm Logistics

Service Operations Vessel

https://www.youtube.com/watch?reload=9&v=lk_ww_ynWh4

Industry partners

DINALOG
Dutch Institute for Advanced Logistics

NWO
Netherlands Organisation for Scientific Research

provincie groningen

ECN
Energy research Centre of the Netherlands

DHL

eekels | TBI

wijnne barends

DUTCH INSTITUTE WORLD CLASS MAINTENANCE

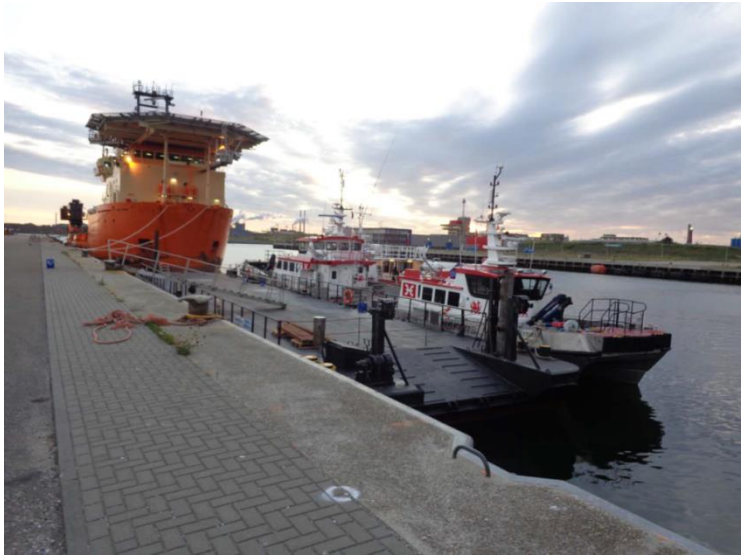
SIEMENS

Van Oord
Marine ingenuity

energy valley

GRONINGEN SEAPORTS

Port facilities

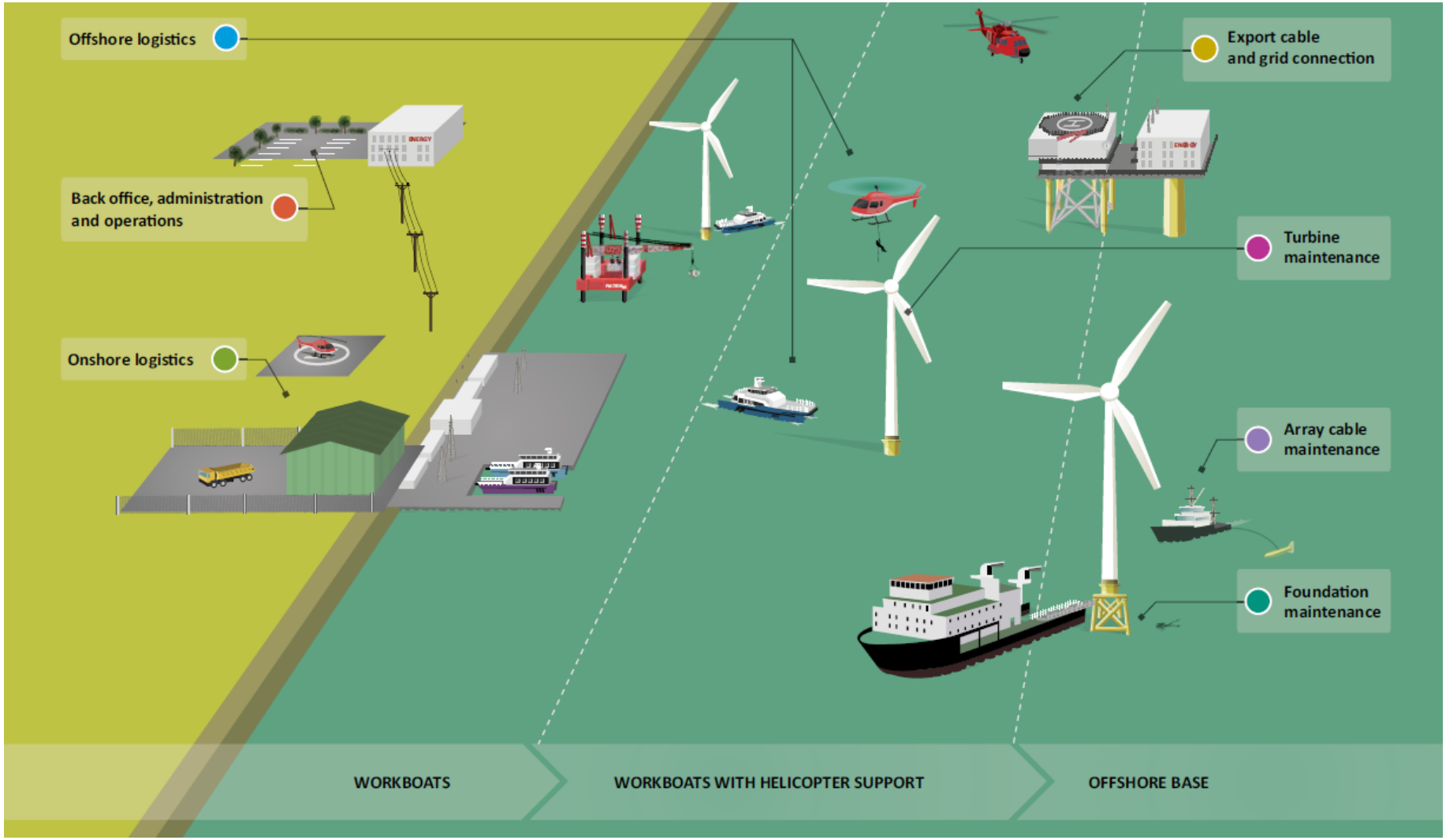


Spare parts

- ✓ Infield cables
- ✓ Export cabless
- ✓ Turbine blades
- ✓ Turbine components
- ✓ Spare turbines

Transport

Logistics Network



Vessel – Spare parts


Top Notch
APPLIANCE REPAIR

Example

Part	Number	Pr{needed}	price
A	1st	0,08	10
A	2nd	0,02	10
B	1st	0,05	40
C	1st	0,25	60
D	1st	0,3	120
D	2nd	0,2	120
D	3rd	0,1	120

- *Kit*={C,D,D,D} (most needed)
- Investment: 60+120+120+120=420
- First fix pr. = (1-0.08)x(1-0.05) x1x1 = 0.874

Science

- It is near optimal to add parts to the Kit in decreasing order of the probability that a part is needed to complete a job divided by the cost price of a part (Pr{needed}/price)

- Biggest Bang for your Buck!

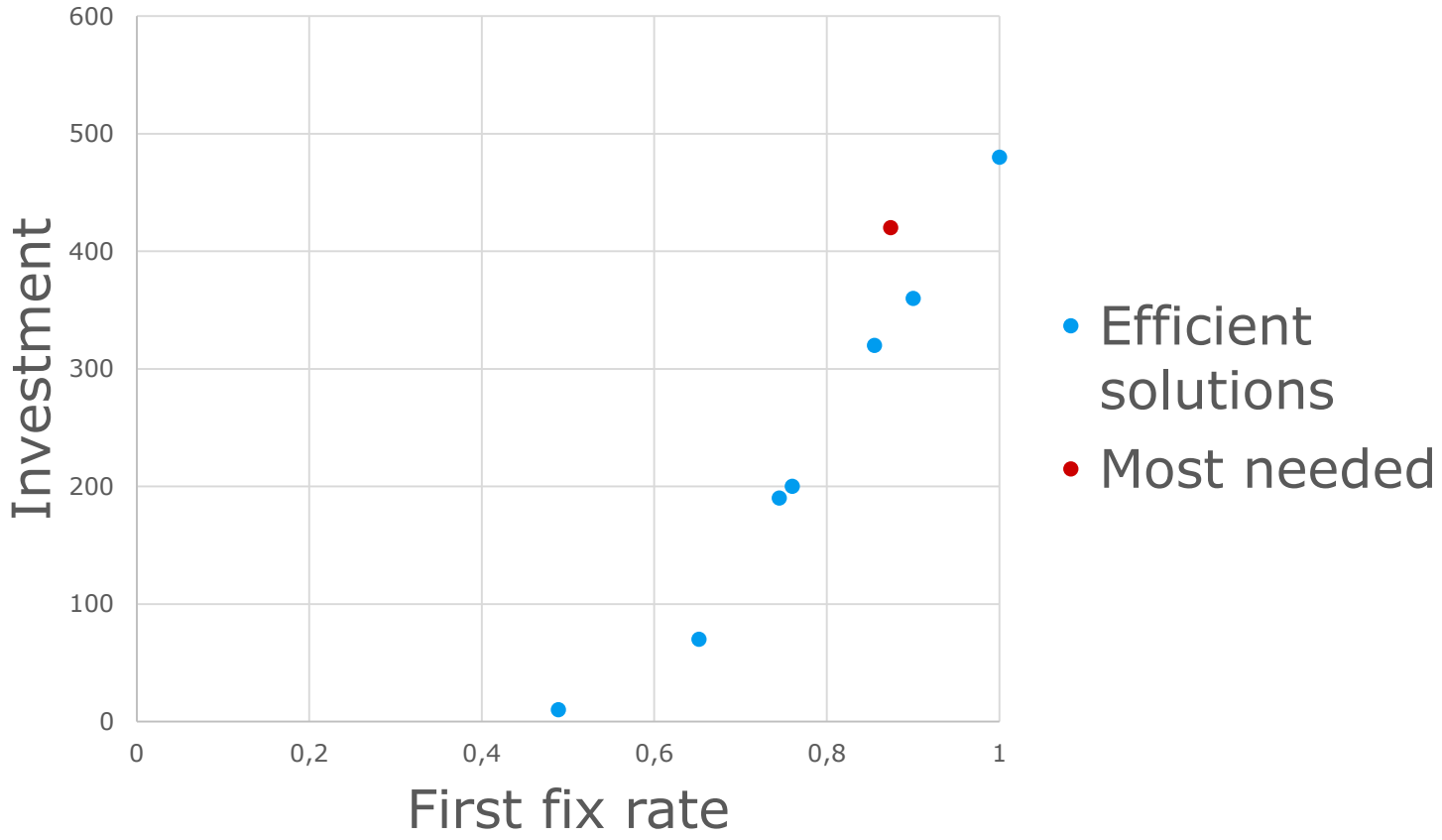
Efficient solutions

Part	Number	Pr{needed}	price	Pr/price	Rank	Kit
A	1st	0,08	10	0,008	1	A
A	2nd	0,02	10	0,002	4	A,A,C,D
B	1st	0,05	40	0,00125	6	A,A,B,C,D,D
C	1st	0,25	60	0,004167	2	A,C
D	1st	0,3	120	0,0025	3	A,C,D
D	2nd	0,2	120	0,001667	5	A,A,C,D,D
D	3rd	0,1	120	0,000833	7	A,A,B,C,D,D,D

Efficient solutions

Kit	first fix rate	invest
A	0,488775	10
A,A,C,D	0,76	200
A,A,B,C,D,D	0,9	360
A,C	0,6517	70
A,C,D	0,7448	190
A,A,C,D,D	0,855	320
A,A,B,C,D,D,D	1	480

Solutions graph



But …

- What if?
  - Multiple jobs (in a tour) before restocking
  - Varying number of jobs per day
- The simple rule is still near optimal
- Realize, though, that the fix rate decreases during the tour since parts are used

Implementation

- Easily done in Excel or any other speadsheet
- Also for thousands of SKUs

- You do need historic usage data

- Distinguish between engineers if possible

Service Operations Vessel

Service Operations Vessel

- Offshore for 2 to 3 weeks
- Can host tens of workers
- Carries spare parts
- Small repair shop
- Small crane
- Helicopter deck

SOV spare parts

- Subassemblies for
  - Hydrolics
  - Generator
  - Gearbox
  - Electric system

Why different?

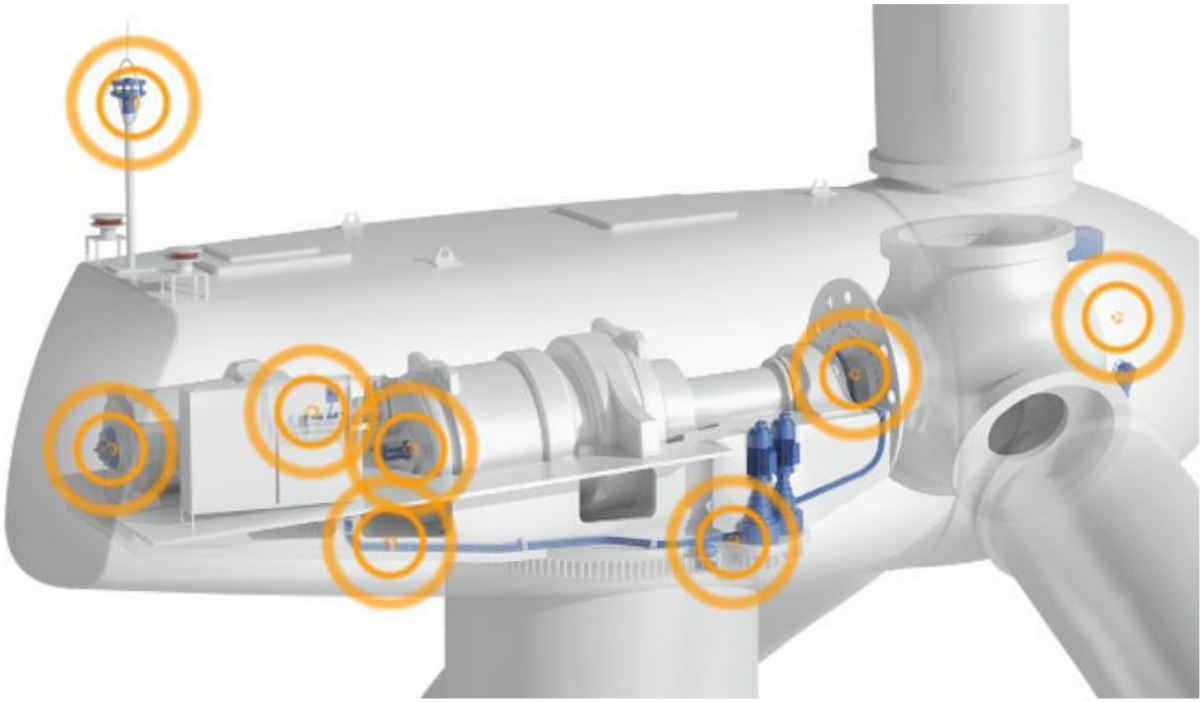
- Repairs – number of jobs and types unknown
- Unfinished job - timing effects revenue loss

- Weather affects deterioration
- Weather affects repair options

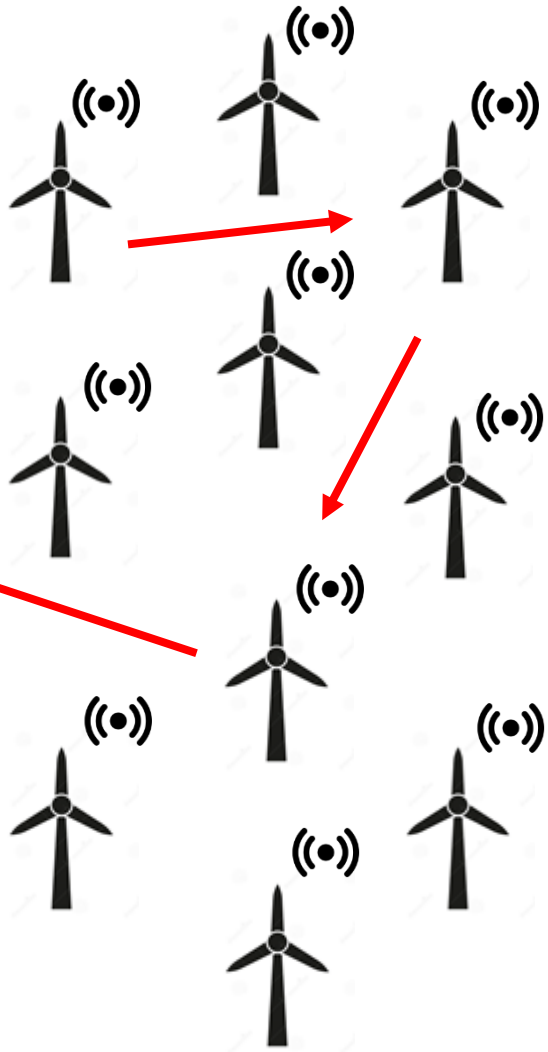
- Emergency supply by boat or helicopter

- Condition and Weather Monitoring – Big Data

Windmill sensoring

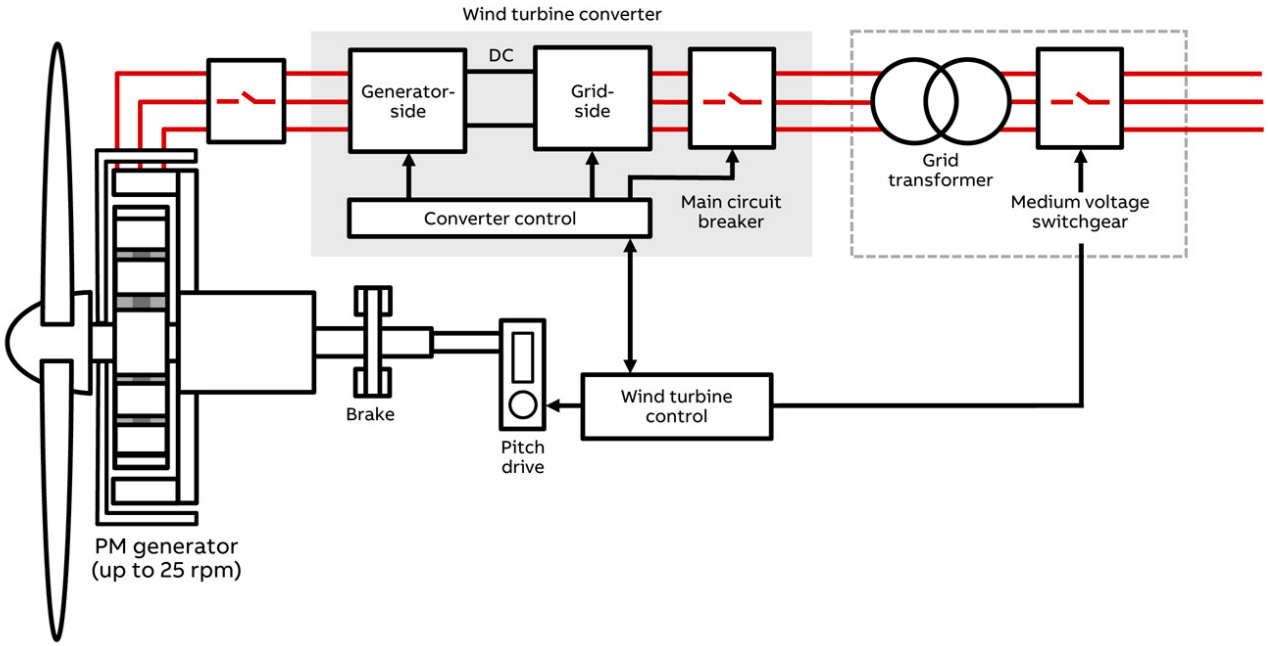


Smart Supply Chain



Internet of Things (IoT)

Smart Production & SC



A block diagram of a wind turbine system (ABB, 2011)

Smart Production & SC

- Variable production speed
- Higher production speed leads to more vibration and higher temperature
- Trade off production versus deterioration

Contact

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