Presentation 12: Analytic Decisions on Durable or Disposable Plastic Caging systems

Leopoldo ZAUNER, Tecniplast SpA
Giuliano GRIGNASCHI, Head of the Animal Care Unit at Mario
Negri Institute for Pharmacological Research

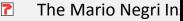
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BIOMEDICAL ENGINEERING



MOLECULAR

MEDICINE



CARDIOVASCULAR

RESEARCH





ENVIRONMENTAL



PUBLIC HEALTH

MOLECULAR **BIOCHEMISTRY**

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2.000 square mt.) new el of flexibility.

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innovation through passion Background



- New Multi Species facility (mice and rats)
- Design and Planning in Early Phase then making all options available (Disposable, Durable caging systems, with or without washing are, with or without flexible warehouse spaces, and so on).
- Objective:
 - Select the best Balance between:
 - Animal Welfare
 - Cost
 - Operational Efficiency
 - Environmental Impact
- Evaluated the suitability of both systems over the long term: 6 years
- 100% of occupancy





innovation through passio Background II



- New Multi Species facility
- Comparison of the following Key Performance indicators:
 - Economic Sustainability
 - Operational Functionality and Efficiency
 - Environmental Impact conducting an Environmental Assessment of each scenario using a LCA process conforming to ISO 14040 and ISO 14044.
- The Facility has a capacity of 2000 mouse cages and a minimum amount of cages to support other species (600 rat cages and metabolic cages)
- Integral cage change
- Water Bottles
- Bedding added to cages onsite





Key Perfomance Indicators (KPIs) II



- Inflation free analysis
- A Life Cycle Analysis was conducted to evaluate the environmental impact of both systems using a specific LCA software (SimaPro of PReNL)
 - The LCA Study was conducted according to PAS 2050 and Study Results were reviewed by an independent LCA Specialist
 - The LCA included the analysis of 5 phases:
 - Materials
 - Manufacturing
 - Transport
 - Use
 - Final Disposal





Modelling Assumption



- Complete Cage Change
- Disposable cage supplied without Bedding
- Similar cost of labor
- Similar cost of Consumables (feed, Bedding, and other supplies) with the exception of the capital and operating costs associated with repeated washing and sterilizing Durable Cages
- Additional Waste Generation and disposal, associated the use of Disposable Cages was also identified as a system specific issue (local regulation requires the handling of caging as hazardous waste)
- Final Disposal







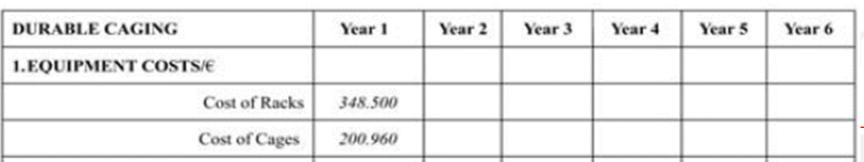
	Durable Cages	Disposable (Single use)
1: IVC CAGE & RACK PURCHASE & OPERAT	INC COSTS	





Rack Capacity (number of cages)	80	88
Cost of Racks with Cages and AHU /€	348,500,00	Leasing cost of €278 Euro per rack month for 3 years plus an initial payment of €1000 and a termination fee of €2,000 per rack
Cost x Replacement Cages /€	€100,48	€3.00
Buffer Supply of cage to support Washing cycles	50%	
Average Cage lifetime (year)	6	
Annual Cage Breakage	2%	4%
Average Cage Change Interval in days	11	11
Complete Cage Changed x person x day	240	240
Labor: Number of Vivarium Technicians	2.7	2.7
Labor: Fully loaded cost x technician/ €/Year	40.000	40,000
2: WASHROOM AND OTHER COSTS/€		
Building Washroom Area	250,000	190.000
Capital Equipment – Washer	€250.000	142.000
Capital Equipment – Sterilizer	€250,000	120.000
Capital Equipment – Bedding	*********	
Recurring Operating Costs		
Annual Maintenance/Supplies	5.000	3.500
Labor: Number of Washroom Staff	2	
Labor: full loaded cost x technician/€/Year	40,000	€40.000

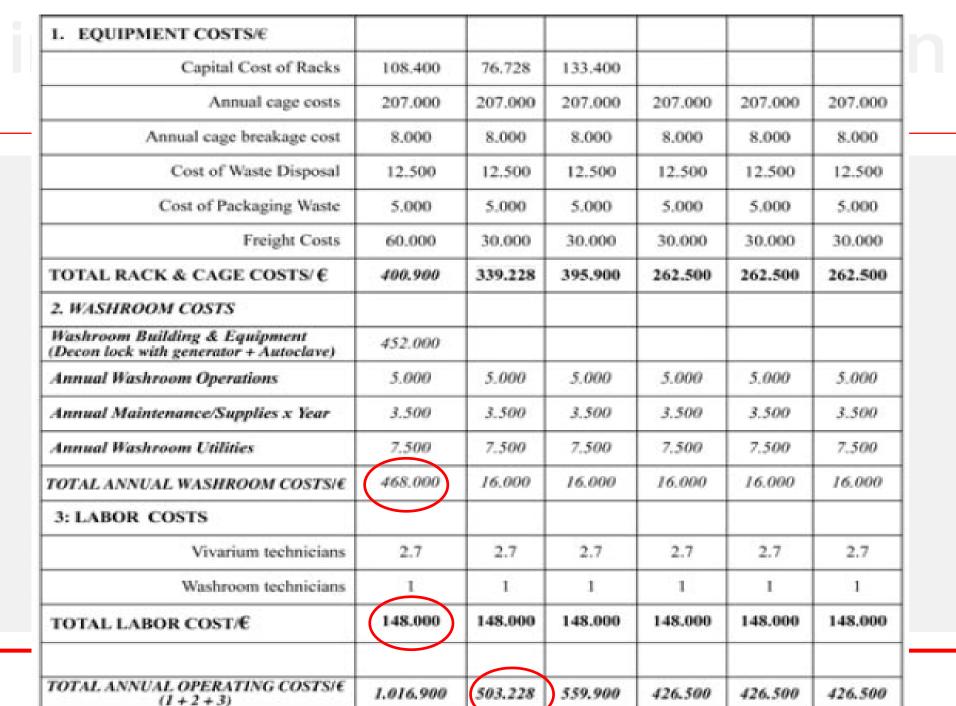






Year I	Year 2	Year 3	Year 4	Year 5	Year 6
348.500					
200.960					
100.480					
0	4.000	4.000	4.000	4.000	4,000
30.000	2.000	2,000	2.000	2.000	2.000
679.890	6.000	6.000	6.000	6.000	6.000
750,000					
15.000	15.000	15.000	15.000	15.000	15.000
5.000	5.000	5,000	5.000	5.000	5.000
30.000	30.000	30.000	30.000	30.000	30000
800.000	50.000	50.000	50.000	50.000	50.000
2.7	2.7	2.7	2.7	2.7	2.7
2	2	2	2	2	2
188.000	188.000	188.000	188.000	188.000	188.000
1.667.940	244.000	244.000	244.000	244.000	244.000
	348.500 200.960 100.480 0 30.000 679.890 750.000 15.000 30.000 800.000 2.7 2	348.500 200.960 100.480 0 4.000 30.000 2.000 679.890 6.000 750.000 15.000 15.000 5.000 5.000 30.000 30.000 800.000 50.000 2.7 2.7 2 2 188.000 188.000	348.500 200.960 100.480 0 4.000 4.000 30.000 2.000 2.000 679.890 6.000 6.000 750.000 15.000 15.000 15.000 5.000 5.000 5.000 30.000 30.000 30.000 800.000 50.000 50.000 2.7 2.7 2.7 2.7 2 2 2 2 188.000 188.000 188.000	348.500 200.960 100.480 0 4.000 4.000 4.000 30.000 2.000 2.000 2.000 679.890 6.000 6.000 6.000 750.000 15.000 15.000 15.000 5.000 5.000 5.000 5.000 30.000 30.000 30.000 30.000 800.000 50.000 50.000 50.000 2.7 2.7 2.7 2.7 2 2 2 2 188.000 188.000 188.000 188.000	348.500 200.960 100.480 0 4.000 4.000 4.000 4.000 30.000 2.000 2.000 2.000 2.000 679.890 6.000 6.000 6.000 6.000 750.000 15.000 15.000 15.000 15.000 5.000 5.000 5.000 5.000 5.000 30.000 30.000 30.000 30.000 30.000 800.000 50.000 50.000 50.000 50.000 2.7 2.7 2.7 2.7 2.7 2 2 2 2 2 188.000 188.000 188.000 188.000 188.000









Durable vs Disposable Caging Systems 6 Years Cash Flow Statement Comparison



	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6
ANNUAL DISPOSABLE SAVING/LOSS	651.040	- 259.228	-315.900	-182.500	-182,500	-182.500
CUMULATIVE DISPOSABLE SAVING/LOSS	651.040	391.812	75.912	-106.588	-289.088	-471.588



Discussion of comparative Capital & Operating Cost Analysis I



Washing and

- In Additio operation support a
- This meal appropria re-use in t

• It is not p Results:

- to wash a Use of Disposable caging system delivers
 - marginal savings in both capital and enew facility operating costs associated with washing and ctices would sterilizing operations.
 - Use of Durable caging system begins to be cessed using cost effective at Year 4.
- Using a disposable system would not entirely eliminate the construction and equipment costs associated with a cage wash facility

ture required

- entry into or



Discussion of comparative Capital & Operating Cost Analysis II



Storage Space

- Disnocable Cages require additional congrate storage snace to hold stocks of: Results:
 - At best the facility footprint and equipment requirements storage would be similar for either system, though the need to weather provide additional storage space to hold stock of clean
 - Disposable Cages (60m²) plus space for storage of soiled extra 20 cages (20m²/day) before disposal could potentially increase the total space required.





Discussion on Operating Costs I



• Labor:

Disposable Cages do reduce labor input in the washing area but increase labor for ound 7
 Results:

 Disposable cage system reduce the staffing level (from 2
 to 1 in the washing area) and associated labor costs; however, additional labor costs associated with repeated reception, storage and handling of new and soiled cages reduces the overall savings in labor of only about 40.000 Euro/Year



Discussion on Operating Costs II



Washroom onerating Costs: Utilities

Results:

The Disposable System reduce but do not eliminate:

- the operating costs
- Capital costs (Washroom construction and equipment Financial Modeling and operational analysis of the facility operations showed that Disposable Cages produced marginal reductions in the cost of utilities associated with washing and sterilizing equipment and materials

there remain the need to decontaminate the exterior of the packaging prior to introduction into the barrier





Discussion on Operating Costs III



Cage Management and Transportation

- Single use cages increase both the amount of waste generated at the reception (packaging)
 and the amount of waste at exit level, doubling the amount of material entering and exiting.
- This is not balanced by the reduction in time associated with washing and autoclaving durable cages.
- Gains of the elimination of internal transport of racks and cages to and from the cage washer are offset by increased inventory management and clean/dirty disposable handling.

Cage Change Interval

- The cage change interval is a variable with a major impact on the comparative operating costs between Durable (number of washing cycles) and Disposable caging system (number of cages used).

Operating Costs: maintenance costs

 As it would be necessary to retain a washing/Sterilizing area these costs would only be marginally reduced with the use of Disposable caging.





Discussion on Operating Costs III



Italian Waste Disposal Regulations require that soiled bedding must be treated as clinical waste and must be packaged, sealed and incinerated at a cost of Euro 1,00/Kg. Disposable cage tend to have bedding with higher humidity which will likely increase the weight of waste bedding further increasing disposal costs.

On the other hand Durable cages do not generate significant plastic waste with a life span of 6 years and a low breakage rate. Moreover at the end of their useful life, Durable cages can be decontaminated and sold on through local recycling programs to be reprocessed into granules.

One Kg of recycled plastic represents about 19 Kg of avoided CO₂ in the atmosphere

Recycled plastic is valued between 1 euro and 1.5 euro per Kg





Environmental Impact of Durable & Disposable cages



LCA Results:

ICA analysis showed that both energy and material consumption of

LCA Modelling of the facility showed that Disposable Caging would have produced more than 9 tons/year of CO₂ compared with only 0.4 Tons with the Durable caging System (a reduction of 96% in CO₂ emissions)

Cage Type	ENERGY (MJ)		
DURABLE	983		
DISPOSABLE	2245		





Carbon foot Print of Durable & Disposable cages



LCA and Carbon foot Print analysis data show that the Durable cages scored significantly lower in all environmental impact categories than the Disposable cages, even where Durable Cages are repeatedly washed and sterilized.

	Durable Cages		Disposable Cages		
	# Cage Units	Quantity of CO2	# Cage Units	Added Units	
CO ₂ Footprint	2.200	797.4 tons	396.000	55.476 tons	
CO ₂ Saved with Recycling 2	2.160	(- 42 tons)			
Net CO ₂ Footprint		755.00 Tons/CO ₂		53,064.00 Tons/CO ₂	





Conclusions Durable vs Disposable cages



• The decision regarding the which is the most suitable caging system for this specific facility is influenced by a number of factors. This will include: research

Objective comparisons between different products for similar uses in research facilities can be complex and errors can be potentially costly. Different animal care system models and alternative scenarios will generate different outcomes. This case study show the importance of developing and using a combination of Key Performance Indicators (KPI), Financial modeling and Life Cycle Assessment, during the planning of the facility to identify and analyze options and support objective decisions that otherwise would be subjective in nature

ENVIRONMENTAL IMPACT: the most interesting data. We wanted to identify the system that not only
provides efficient performance and effective return of investment but also safeguards the environment. LCA
showed that Disposable cages would have a greater environmental impact due to energy and CO₂
production.





Conclusions Durable vs Disposable cages



«Conditio sine qua non»: we tl essential for safety, effectivenes

Transport

gle Use Cage are important and lity and first choice and we have

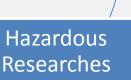
adopted in the tollowing applications:

SINGLE USE MOUSE CAGE



Disposable Retrofittable on GM500 racks Recyclable in case Contingency Housing

Satellite Facilities or Biotech StartUp Quarantine as IVC retrofittable on existing Racks



- Irradiation
- Infective Disease







Conclusions Durable vs Disposable cages





Decisions on Durable or Disposable Plastic Caging Systems

The following case study describes a decision making process to evaluate the impact of utilizing either a reusable (Durable) or single use (Disposable) ventilated caging system in a new multi-species facility being constructed for the Mario Negri Institute for Pharmacological Research, located in Bergamo, Italy. The basis of the decision making process was the development and comparison of the following key performance indicators; economic sustainability operational functionality and efficiency and environmenta mpact. It was assumed there was no obvious difference in animal welfare between the two systems and so this was not considered in the evaluation. The facility has a capacity of 2000 mouse cages, which were the focus of the study Facility operating protocols dictated the need for changing the complete case with each case change, the use of water bottles, and that bedding is added to cages onsite. It was determined a minimum amount of cage processing would be required to support other species and that all materials entering the facility would require chemical decontamination The location of the facility limited the availability of options for recycling Disposable caging and local regulations requires the andling of caging as hazardous waste. Equipment, space, and operating costs for each system were developed into cash flow statements and an incremental cash flow comparison developed. A review of the operational impacts related to material handling flows, cage change operations, and biosecurity were conducted. An environmental assessment of each scenario was conducted using a Life Cycle Assessment (LCA) process conforming to ISO14040 and ISO14044. Economic indicators demonstrated short-term gains with the use of Disposable caging due to reductions in initial capital costs. Higher long-term operational costs associated with Disposable caging reduced initial capital savings and in Year 4, the two systems were at a breakeven point with further cumulative losses in subsequent years. Operational impact analysis demonstrated no significant space savings or labor savings and additional operational complexities were associated with the frequent delivery and entry of materials to the facility. Results of the environmental impact analysis demonstrated Durable cages produced 50% of the carbon footprint over its entire useful life when compared with Disposable caging. With Durable caging scoring higher on all three key performance indicators it was concluded that Durable caging provided the best solution to the specific functional and operational characteristics of the

1. Background

New developments in technology and equipment are major considerations when planning new facilities. During the design and planning phases for an additional multi-species research animal facility in Bergamo, Italy, we aimed to evaluate rodent caging options currently available on the market with the goal of selecting the best blance between animal welfare, cost, operational efficiency and environmental impact. The new multi- species facility would have a capacity of approximately 2000 mouse cages and 600 rat cages. The project was in early design making all options available including Disposable or Durable caging systems, used with or without washing facilities, with or without



In case of interest:

A complete White Paper has been published

Do not hesitate to contact us!

Leopoldo.zauner@tecniplast.it giuliano.grignaschi@marionegri.it



VOEN Analytics Conference 2018 Impact Summary

Title: Analytic Decisions on Durable or Disposable Plastic Caging Systems

Problem and analysis method: a decision making process to evaluate the impact of utilizing either a reusable (Durable) or single use (Disposable) ventilated caging system in a new multi-species facility. The basis of the decision making process was the development and comparison of the following key performance indicators; economic sustainability, operational functionality and efficiency, and environmental impact

Summary: A review of the operational impacts related to material handling flows, cage change operations, and biosecurity were conducted. An environmental assessment of each scenario was conducted using a Life Cycle Assessment (LCA) process conforming to ISO14040 and ISO14044.



Impact of the analytics study

Decisions made/Actions Taken: A Durable caging System was selected

Calculated or actual Improvements:

Economic Reasons: Financial modeling over a 6 year life cycle showed a decreasing cost/ benefit from in the use of Disposable versus Durable caging. The reduction in savings occur from the second year forward, even when the cost of replacement of Durable cages is factored in and inflationary factors are excluded from the costs of Disposable cages. Transport was responsible for 7-8% of the cost. Initial savings from Disposable cages are eroded by year 4. After 6 years there is a recurring annual loss of approximately € 500.000

Operational Efficiency and Functionality: operations and flexibility are better supported where facilities for cage washing and sterilization/autoclaving are available. Potential capital and operating cost savings in cage wash processes from using Disposable cages were reduced by the necessity to retain cage wash and autoclaving facilities. Regular receiving of Disposable cages, increased waste disposal, additional storage facilities, materials handling and increased labor add to the operational complexity of the facility.

Environmental Impact: Life Cycle Assessment of both systems showed that Disposable cages would have a greater environmental impact due to energy and CO2 production during manufacture, transport, disposal/recycling and volume of waste generated. Durable cages have a lower environmental impact and CO2 footprint, even though they need to be washed and autoclaved regularly

Cost avoidance: Cumulative loss of 471.000 Euro of Disposable Caging System after 6 year operations

THANK YOU!

Leopoldo ZAUNER

