A STRUCTURED METHODOLOGY TO UNDERSTAND WASTE GENERATION AT LOCAL LEVEL WITH MINIMISED EFFORT. DEVELOPMENT AND CASE STUDY

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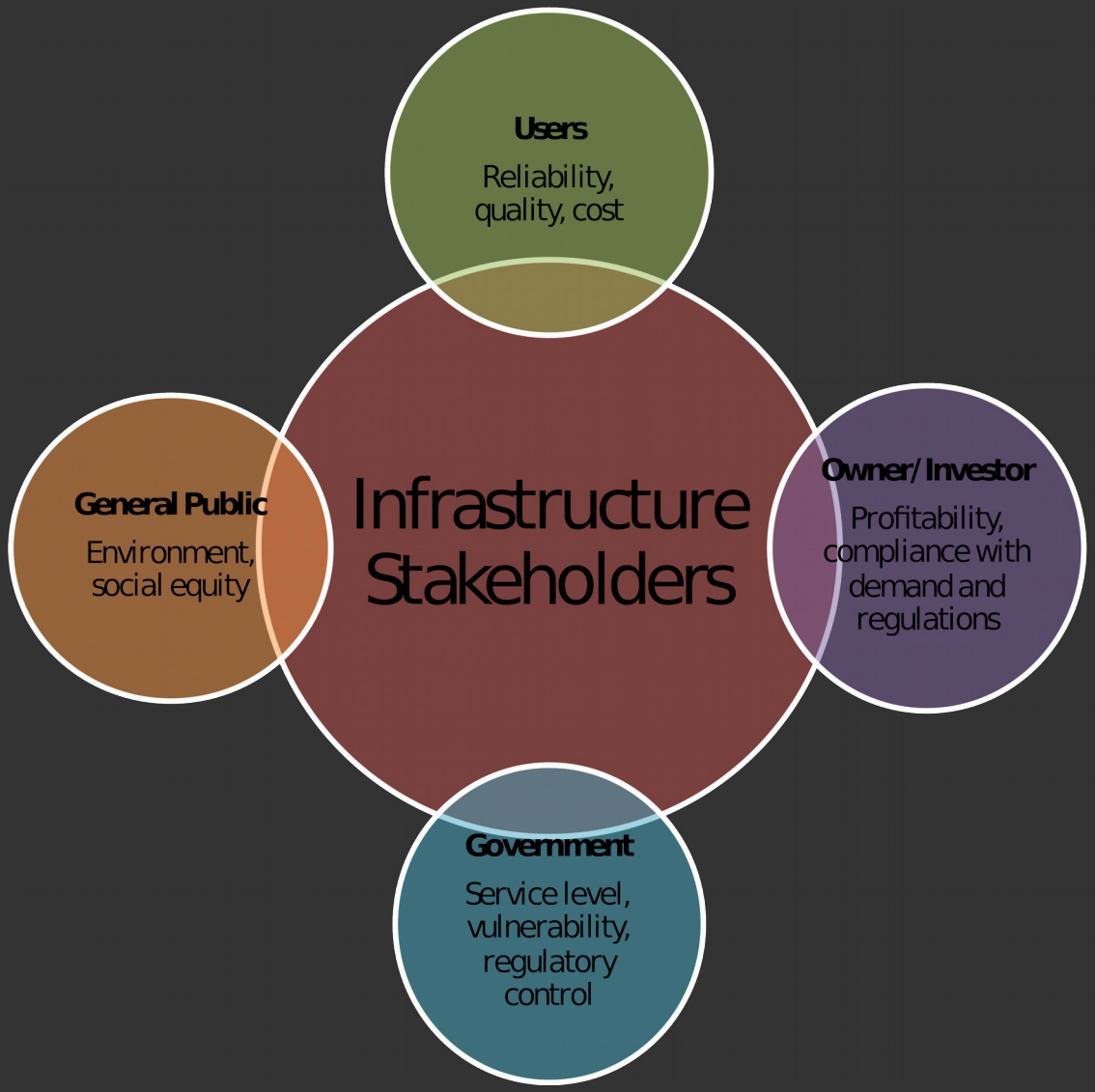
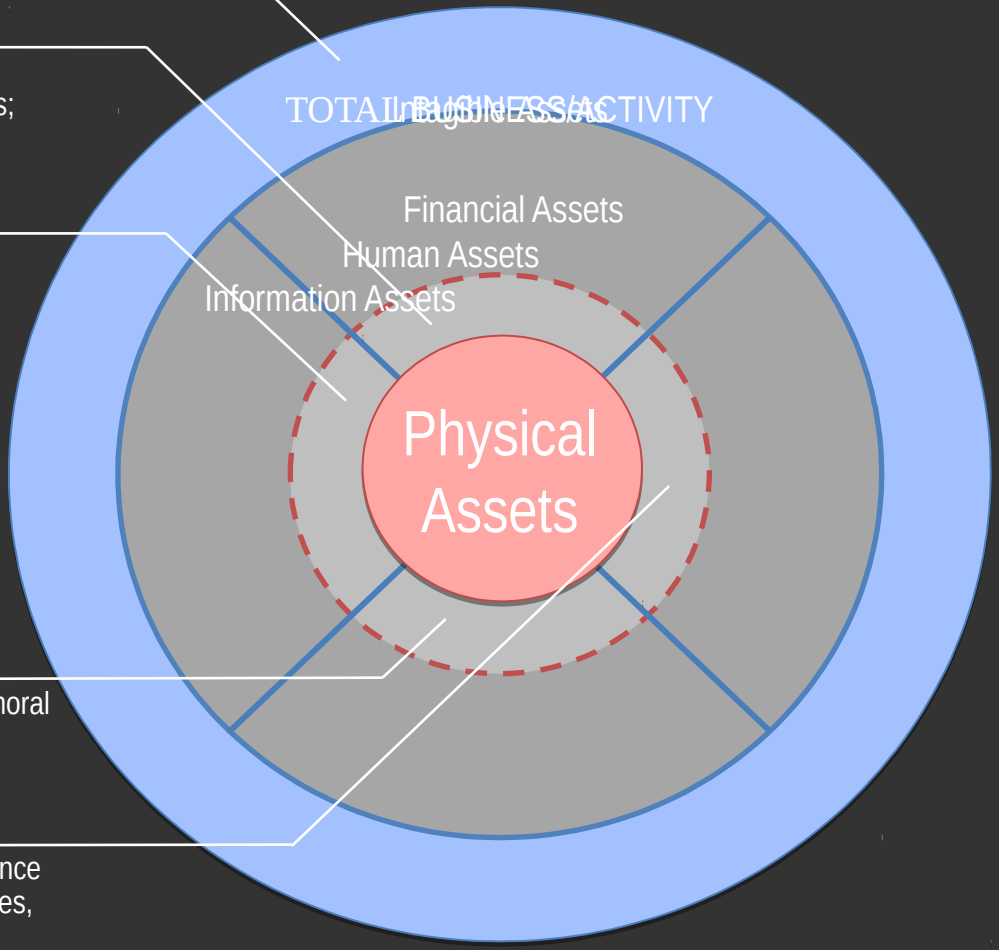

Users
Reliability, quality, cost
General Public
Environment, social equity
Infrastructure Stakeholders
Owner/Investor
Profitability, compliance with demand and regulations
Government
Service level, vulnerability, regulatory control

1. INTRODUCTION

Vital context: business/activity objectives, policies and market; legal and regulatory requirements; socio-cultural context; performance and risk goals

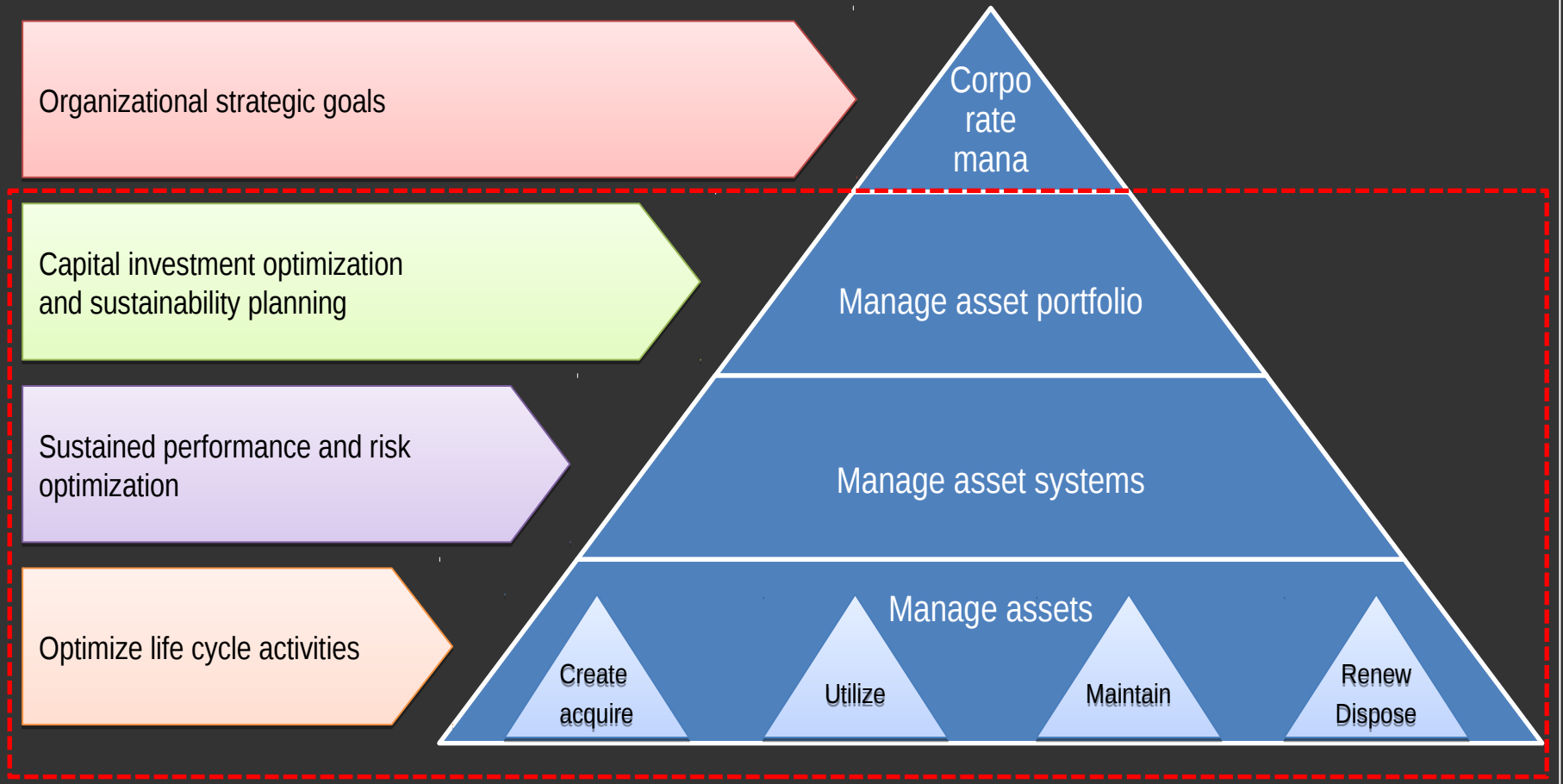
Important interface: motivation; communication; roles and responsabilities; knowledge; experience; competence and capability; leadership; teamwork

Important interface: life cycle cost; investment criteria, value of asset performance



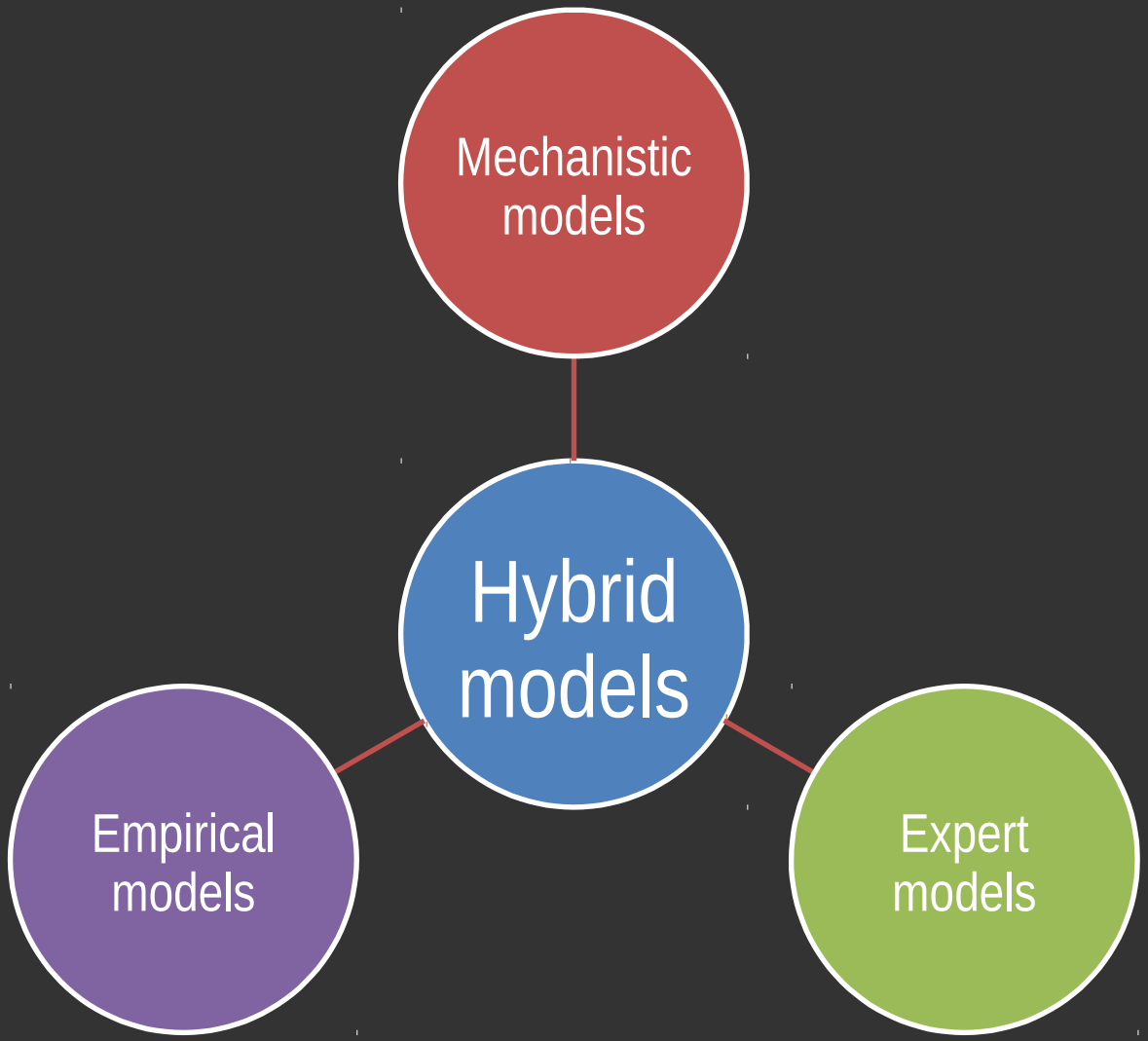
Important interface: reputation/image; moral and etics constraints; socio-cultural and environmental impact

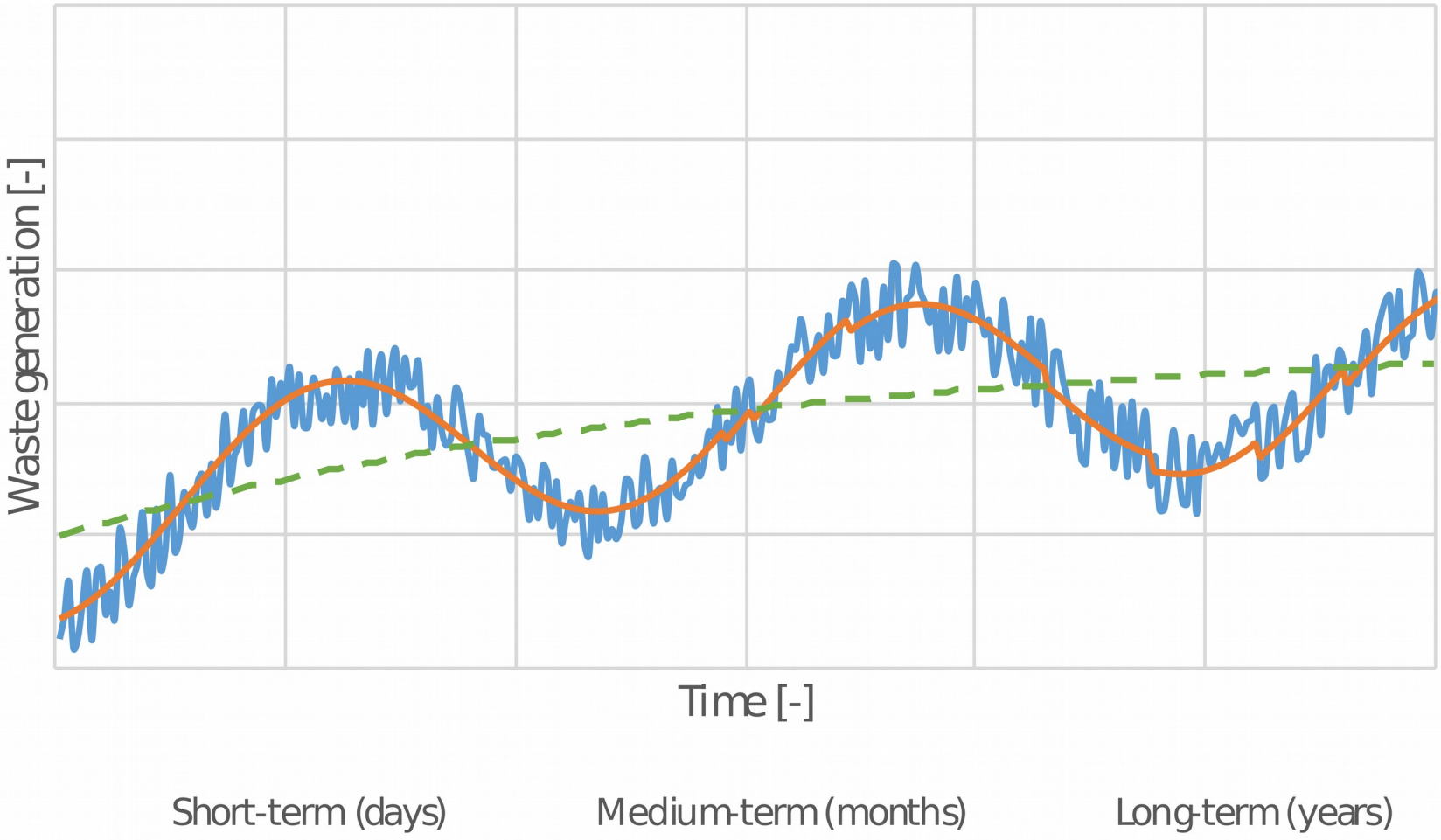
Important interface: condition; performance level; hazards and opportunities; processes, protocols and activities

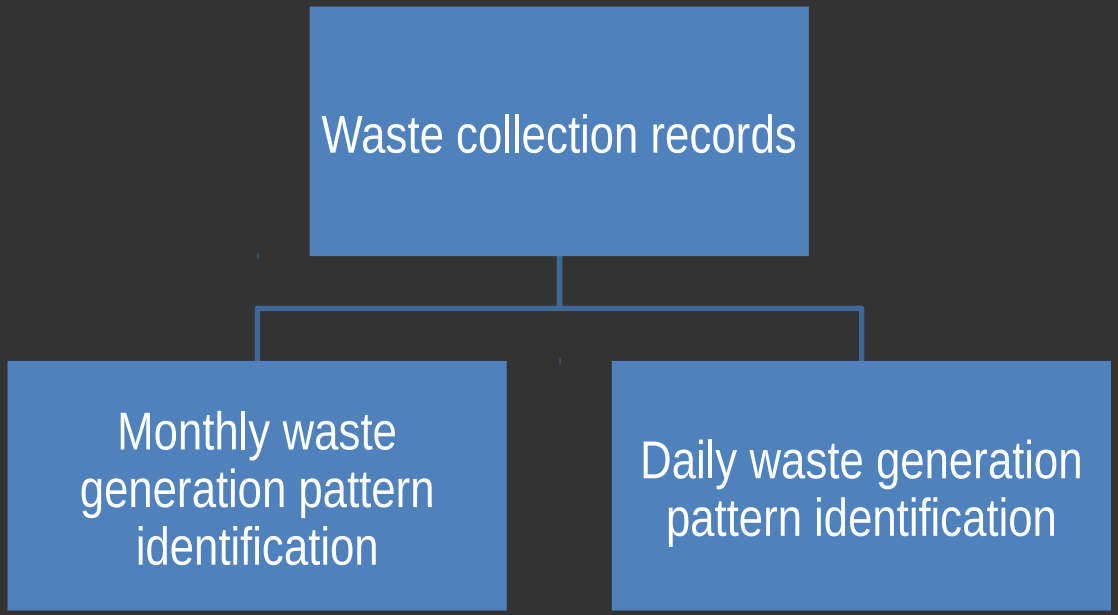

Organizational strategic goals
Capital investment optimization and sustainability planning
Sustained performance and risk optimization
Optimize life cycle activities
Corpo rate mana
Manage asset portfolio
Manage asset systems
Manage assets
Create acquire
Utilize
Maintain
Renew Dispose

Waste generation drivers can be classified into:

- External (e.g., economy; types of goods available to purchase; type of community).
- Service related (e.g., tariff system; waste collection system).
- Internal:
  - non-seasonal (e.g., level of education, age, gender or wealth of the waste producer),
  - seasonal (e.g., weekdays versus weekends; typical vacation months versus typical work months)


Mechanistic models
Hybrid models
Empirical models
Expert models

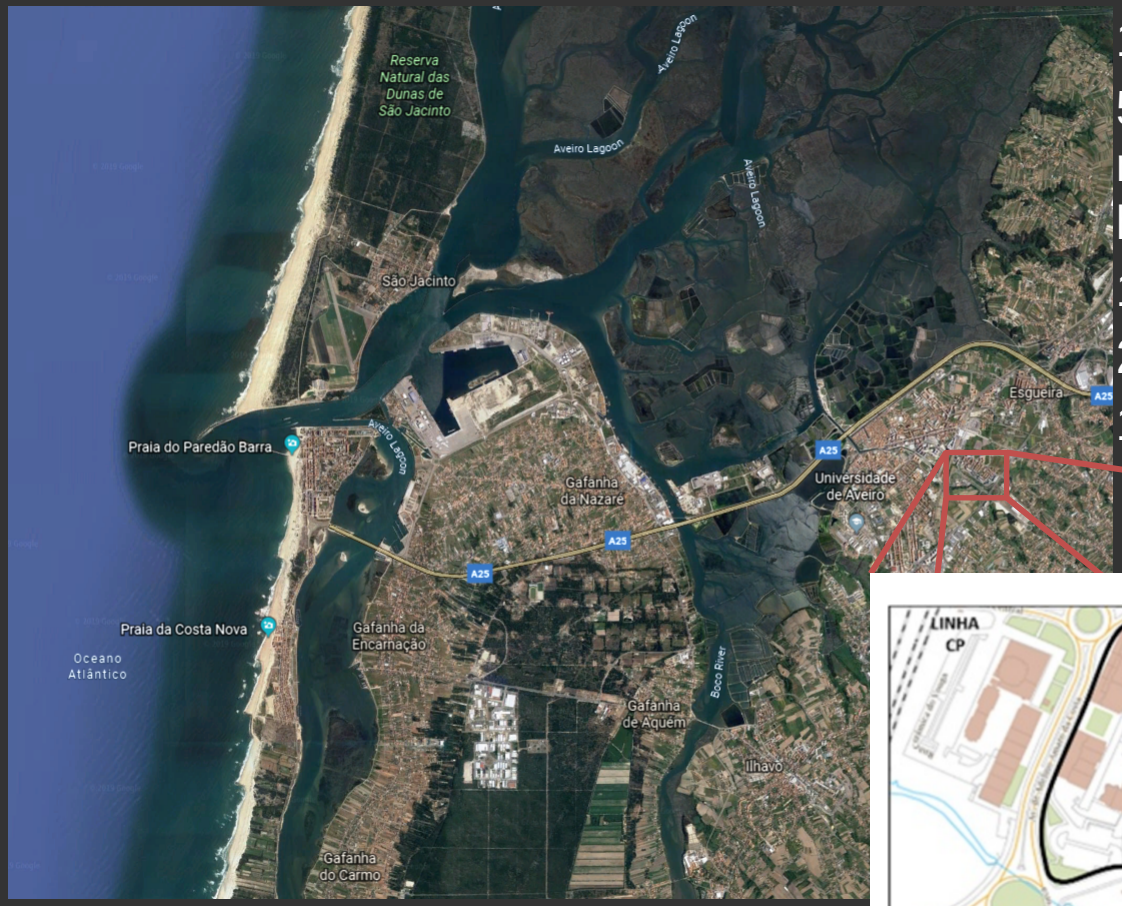

Waste generation [-]
Time [-]
Short-term (days)
Medium-term (months)
Long-term (years)



Use of normalized values by dividing the daily waste generation amounts by:

- The average daily waste generation of each week (weekly waste generation index)
- The average daily waste generation of each year (yearly waste generation index).

4. CASE STUDY



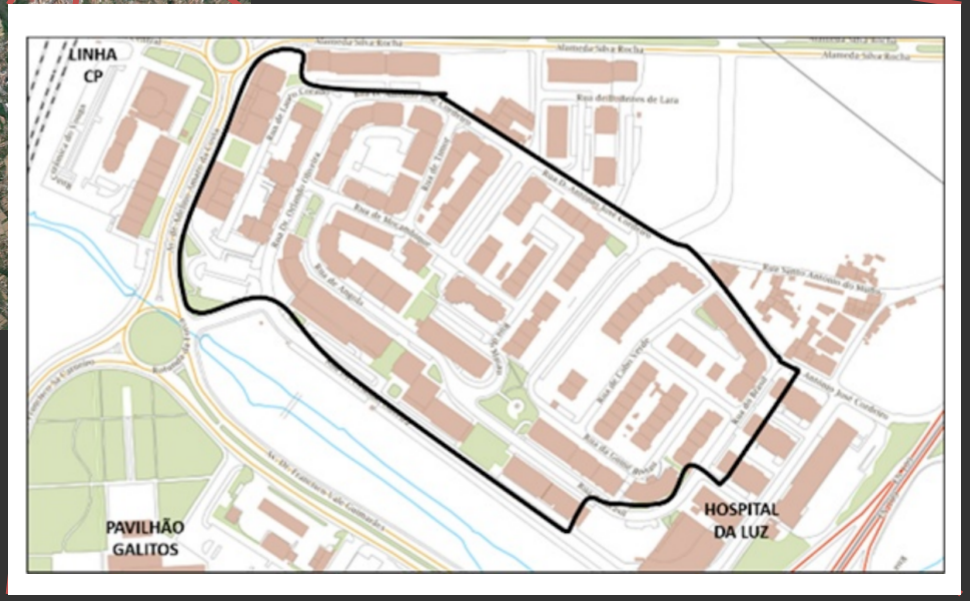
1135 inhabitants

550 domestic producers (75% multifamily buildings, 25% detached houses)

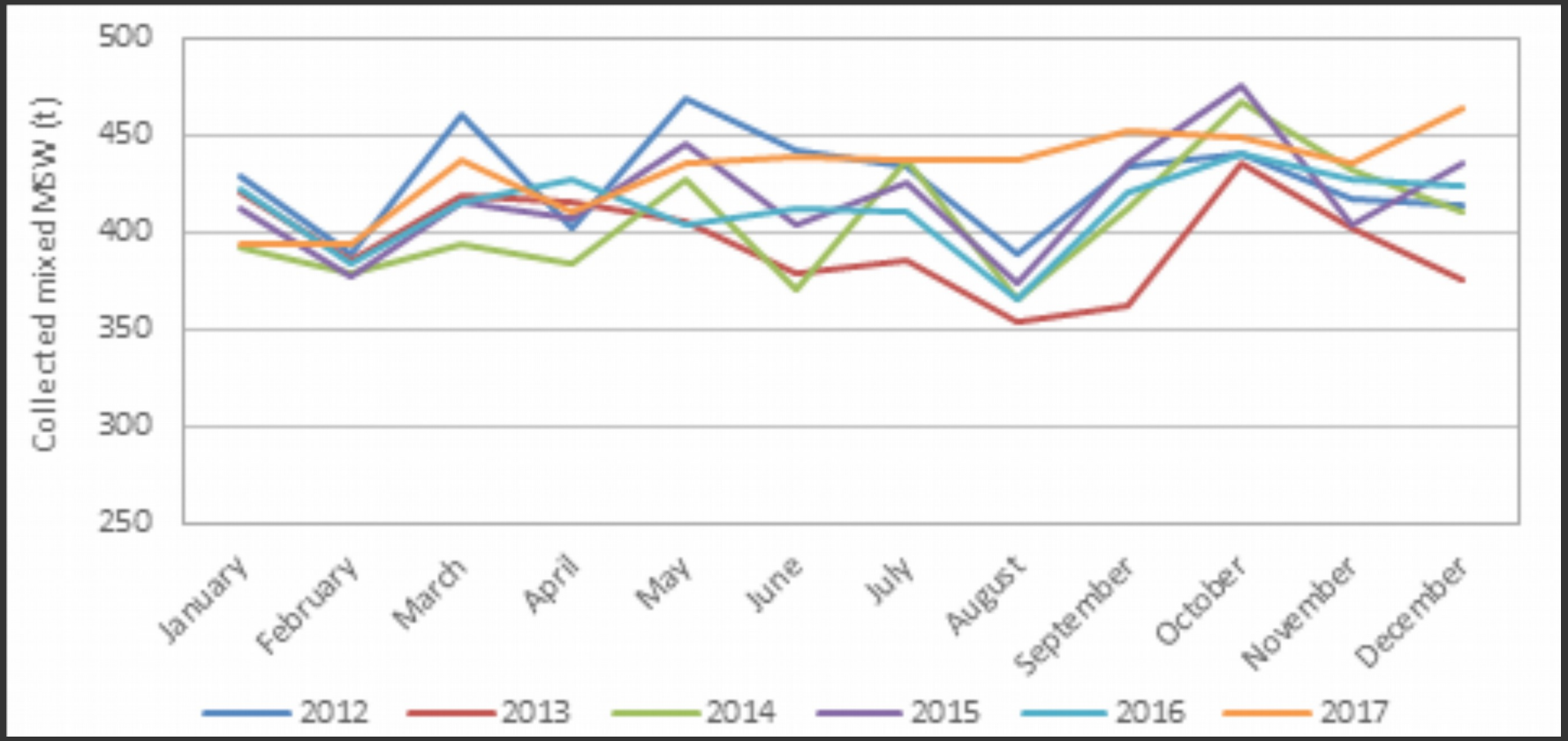
150 non-domestic producers

26 curbside containers (800l)

10 drop-off containers



TÉCNICO LISBOA

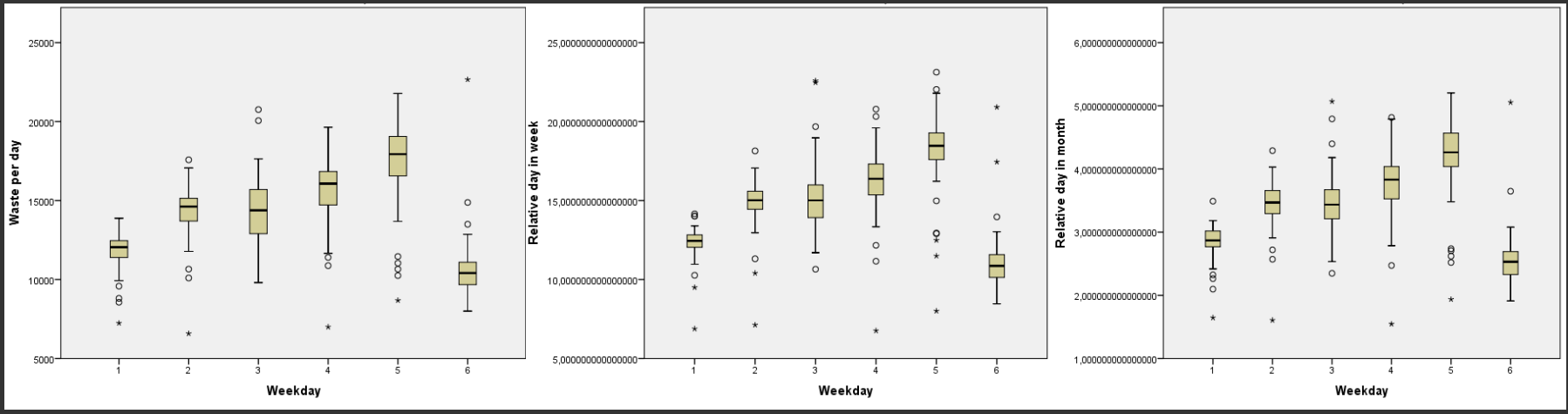

Collected mixed MSW (t)
500
450
400
350
300
250
January
February
March
April
May
June
July
August
September
October
November
December
2012
2013
2014
2015
2016
2017

		Sum of Squares	df	Mean Square	F	Sig.
Waste Monthly	Between Groups	23110275110,000	11	2100934101,000	4,826	,000
	Within Groups	20895289280,000	48	435318526,700		
	Total	44005564390,000	59			
Relative Monthly Waste	Between Groups	9,477	11	,862	7,219	,000
	Within Groups	5,729	48	,119		
	Total	15,205	59			
Average Daily Waste	Between Groups	20852159,500	11	1895650,864	4,146	,000
	Within Groups	21948959,110	48	457269,981		
	Total	42801118,610	59			
Relative Average Daily Waste	Between Groups	,859	11	,078	6,038	,000
	Within Groups	,621	48	,013		
	Total	1,479	59			

			Subset for alfa = 0.05		
	Month	N	1	2	3
Tukey HSD	8,00	5	2,4315		
	12,00	5	2,6698	2,6698	
	1,00	5		2,6812	
	6,00	5		2,7109	
	7,00	5		2,7171	
	4,00	5		2,7300	2,7300
	3,00	5		2,7423	2,7423
	2,00	5		2,7694	2,7694
	9,00	5		2,7941	2,7941
	11,00	5		2,8042	2,8042
	5,00	5		2,8316	2,8316
	10,00	5			2,9647
	Sig.		,068	,524	,076
Ryan-Einot-Gabriel-Welsch	8,00	5	2,4315		
	12,00	5		2,6698	
	1,00	5		2,6812	
	6,00	5		2,7109	
	7,00	5		2,7171	
	4,00	5		2,7300	
	3,00	5		2,7423	
	2,00	5		2,7694	2,7694
	9,00	5		2,7941	2,7941
	11,00	5		2,8042	2,8042
	5,00	5		2,8316	2,8316
	10,00	5			2,9647
	Sig.		1,000	,500	,152

5. RESULTS AND DISCUSSION

		Test Statistic	df1	df2	Sig.
Waste per day	Welch	143,692	5	217,786	,000
	Brown-Forsythe	148,009	5	403,225	,000
Relative day in week	Welch	180,773	5	216,875	,000
	Brown-Forsythe	177,799	5	403,430	,000
Relative day in month	Welch	150,661	5	217,864	,000
	Brown-Forsythe	154,534	5	393,314	,000



Despite the robustness of the ANOVA to the normality of the residuals and the existence of alternative tests post-hoc for the case of heterogeneity of the variance, a non-parametric test (Kruskal-Wallis) was also conducted.

Statistically significant different waste generation amounts in absolute and relative terms between weekdays were found.

Performing the pairwise comparison between weekdays and considering the significance adjusted by the Bonferroni correction, three groups of days are possible to identify in terms of waste generation:

- Saturday, Sunday and Monday;
- Tuesday, Wednesday and Thursday;
- Friday.

Regarding the 12 sampling possible to perform, it was decided to:

- split the 12 sampling days evenly between the two groups of months that have been detected;
- assign at least one sampling day to every statistically significant month, which meant in total 10 days.

The two days left were assigned respectively to the months of minimum and maximum generation (August and October, respectively).

Months	Jan	Feb	Mar & Apr	May	Jun & Jul	Aug	Sep	Oct	Nov	Dec
High generation		Mon		Fri			Thu	Fri & Sat	Tue or Wed	
Low generation	Thu		Tue or Wed		Mon	Fri & Sat				Fri

Cluster of days	Average MSW collected on the neighbourhood	Average MSW collected on the whole circuit	Percentage of the neighbourhood on the whole circuit
Monday + Saturday + Sunday	1245 t	12020 t	10.36
Tuesday + Wednesday	1100 t	13455 t	8.18
Thursday	1310 t	13360 t	9.81
Friday	1410 t	19000 t	7.42