

Model User Guide:

Legionnaires' Disease Surveillance and Public Health Policies in Italy: A Mathematical Model for Assessing Prevention Strategies

How to use the model

Key legend to note when using the model

Legend	Description	Action
Input	"Yellow cells" with blue values have a drop-down feature, from which you can select different scenarios	Use drop-down feature to select scenario
Output	"Grey cells" have built in formulas which automatically calculates and generates an output based on selected scenario	Do not edit
Output	"Values in black" have built in formulas which automatically computes and generates an output based on selected input	Do not edit
Input	"Values in blue" are authors assumption and judgment based on expert interviews and/or select publications	Editable
Prompts	"Texts in purple" are visual prompts guiding users to select scenario from drop-down menu in the "Summary section of the model"	Do not edit
Note this output	"Values in red" highlight key sections and critical output(s) users should note	Do not edit

Detailed model:

Do not edit this section

Sections A-B: Estimating the number of B & C1 buildings that needs addressing and the total cost of remediation

ILLUSTRATIVE
(figures may change based on selected scenarios)

Scenarios selected from the drop-down buttons from the “Input tab” is automatically updated in the “Detailed model tab”

		Do nothing	Lp control	L spp control	
Section A:	Premises over action-limit:				
	# of buildings in Italy (B, C1 & E)	9,623,407	9,623,407	9,623,407	See “tables 1 & 7” in the assumption section
	Total priority buildings (B & C1)	94,077	94,077	94,077	
	% of buildings Legionella Contaminated at Action Level	40%	40%	40%	
	Total priority buildings contaminated at action-limit	37,631	37,631	37,631	
	% contaminated with Lp	70%	70%	70%	
	# buildings with Lp	26,342	26,342	26,342	
	% contaminated with L spp	30%	30%	30%	
	# buildings with L spp	11,289	11,289	11,289	
	Buildings that require addressing Lp contamination	-	26,342	26,342	
Buildings that require addressing any Lspp contamination	-	-	11,289		
Total	-	26,342	37,631		
Section B:	Cost of remediation:				
	% of buildings need addressing get remediation	NA	40%	40%	See “table 9” in the assumption section
	Direct cost of remediation	-	18,966,004	27,094,291	
	Replacement cost (pipes, etc)	-	56,898	81,283	
Total cost of remediation	-	19,022,902	27,175,574		

Sections C-F: Estimating the number of cases prevented and the direct spend per cases prevented

ILLUSTRATIVE
(figures may change based on selected scenarios)

Scenarios selected from the drop-down buttons from the “Input tab” is automatically updated in the “Detailed model tab”

Section C:	Average # people affected by Building				
		Repeated exposure (e.g., workers, residents)	454	454	454
		Point exposures at risk (e.g., visitors)	321	321	321
			133	133	133
	total # People exposed to Lp by Building (Assumes ideal scenario, if remediation occurs, no LD cases)		11,957,678	7,174,607	7,174,607
	total # People exposed to non-Lp by Building (Assumes ideal scenario, if remediation occurs, no LD cases)		5,124,719	5,124,719	3,074,832
Section D:	Community-acquired LD Incidence				
	Incidence per 100,000 population		0.000045	0.000045	0.000045
		Lp (all serogroups) caused % of total LD incidence (95% base case)	0.000043	0.000043	0.000043
		Non-Lp caused % of total LD incidence (5% base case)	0.000002	0.000002	0.000002
	Underestimation multiplier		3.0	3.0	3.0
Section E:	Total estimated cases associated with B, C-1 Buildings				
		Lp	1,595	971	957
		L spp	1,560	936	936
Section F:	Health outcome:				
	Cases prevented			624	638
	Spending per LD Case Prevented			30,486	42,591
	<i>Lp vs L spp (%)</i>			-28%	

See “table 1” in the assumption section

See “table 5 & 6” in the assumption section

Sections G: Assessing the economic impact of each control strategy

Scenarios selected from the drop-down buttons from the “Input tab” is automatically updated in the “Detailed model tab”

ILLUSTRATIVE
(figures may change based on selected scenarios)

		Do nothing	Lp control	L spp control
Section G:	Additional Benefits (economic value of case reduction):			
	Hospital care cost:			
	total medical care cost (ICU)	5,637,707	3,432,369	3,382,624
	total medical care cost (non-ICU)	6,190,423	3,768,875	3,714,254
	Cost of prescription:			
	total prescription cost (ICU)	535,967	326,310	321,580
	total prescription cost (non- ICU)	195,405	118,967	117,243
G.1	Total hospitalization cost	12,559,502	7,646,520	7,535,701
	Productivity losses from LD cases:			
	Patients:	884,346	538,411	530,608
	Caregivers:	442,173	269,205	265,304
G.2	Total productivity losses	1,326,519	807,616	795,912
	Shut down of commercial priority buildings (B&C1)			
	# of commercial priority businesses remediated	-	3,899	5,569
	# of days shut-down	-	2	2
	Avg daily turnover foregone (EUR)	-	1,383	1,383
G.3	Total cost of shut-downs (EUR)	-	10,786,240	15,408,914
	Legal costs:			
	% of affected people filing a suit	1%	1%	1%
	Legal "Fines" due to illness or outbreak	12,447,567	7,578,372	7,468,540
	Legal cost of lawsuit	565,350	344,198	339,210
G.4	Estimated legal costs	13,012,917	7,922,570	7,807,750
	Economic cost of LD prevention approach (Cases + Legal Cost + Costs of Building Shutdowns)	26,898,938	27,162,946	31,548,277
	Difference in "Economic Cost" btn Lspp & Lp prevention approach (Case+Legal Cost+Building Shutdown)			4,385,331
	Total cost of LD prevention approach (Cases + Legal costs + Costs of Building Shutdowns+Remediation)	26,898,938	46,185,848	58,723,851
	Difference in "Total cost" btn Lspp & Lp prevention approach (Case+Legal cost+Building Shutdown+Remediation)			12,538,003
	Incremental cost (savings) vs "Do Nothing Scenario		€ 19,286,910	€ 31,824,912

See “table 2” in the assumption section

See “table 3” in the assumption section

See “table 4” in the assumption section

Assumptions

Model Guide

Assumption table 1: Estimating # of people exposed per building type

Priority Type	Building Type	# of Buildings	Average # People Affected by Building?			Total Repeat Exposures per building type	Total Point Exposures per building type	
			Repeat exposures (residents, workers etc.)	Visitors (est. per year)	% of repeat visitors	total repeat exposures	% point exposures at risk	total repeat exposures equivalents
B	Outpatient facilities	8,867	162,500	29,852,584	10.0%	355	10.0%	337
B	Rehab and other non-residential services	5,810	68,563	7,463,146	10.0%	140	10.0%	128
B	Dental facilities	43,782	44,611	23,598,880	2.0%	12	2.0%	11
C1	Accommodation facilities & Hotels	32,425	207,000	25,604,000	2.0%	22	2.0%	16
C1	Penitentiaries	206	40,542	61,049	10.0%	226	10.0%	30
C1	Ships	250	39,180	8,500,000	2.0%	837	1.0%	340
C1	Stations	2,660	60,513	898,470,000	2.0%	6,778	0.7%	2,359
C1	Airports	77	19,634	191,200,000	3.5%	87,109	0.8%	18,623
	Total	94,077	642,542					
	Weighted average					321		133

Source: (a) ISTAT; (b) Ministry of Justice Dep't of Prison Admin - Italy; (c) Company Financial Statement; (d) Company website; (e) Statista;

Assumptions table 2: Hospitalization and Productivity losses

LD by age distribution		Total	<=60yrs	>60 yrs
	Region selected	Italy		
	% of cases requiring hospitalization	70%	45%	80%
	% requiring iCU	30%	15%	36%
	% not requiring iCU	70%	85%	64%
	Medical care cost per day (iCU)	1700	1700	1700
	# bed days	9.9	5	12
	Medical care cost per day (non-iCU)	800	800	800
	# bed days	9.9	5	12
Prescription cost :				
	Total prescription cost (iCU patient)	1600	1600	1600
	Total prescription cost (non-iCU patient)	250	300	300
Productivity losses:				
Patients:				
	Productive days lost	9.9	9.9	0
	Avg wage per day	80	80	0
Caregivers:				
	Productive days lost per caregiver	5.0	2.5	6
	Avg wage per day	80	80	0

Source: (a) ISTAT; (b) Cassini et al, 2018; (c) Rota et al; (d) von Baum et al, 2008; (e) Expert interviews

Assumption table 3: Economic impact of commercial building closure

	Input selected	Range used in model			Commentary	Source
% of remediated buildings that are commercial	37%	37% ^a	53% ^b	62% ^c	We used studies based on hotels as proxy for commercial buildings, and corroborated with data from Aquaitalia	See “table 6” for the detailed references
# of days shut-down	2	2	2	2	Expert interview	Expert interview
Average daily revenue foregone (EUR)	1,383 ^d	-	1,383 ^d	-	Calc as “Turnover” divided by “total # of Enterprises with <250 employees”	ISTAT Enterprise Economic Indicator dashboard (accessed 3/18/2024)

Source: (a) Di Onofrio et al; (b) Leoni et al; (c) Marras et al; (d) ISTAT Enterprise Economic Indicator dashboard (accessed 3/18/2024)

Assumption table 4: Legal cost of LD incidence

	Country	Fines (EUR)	Legal cost (EUR)	Total Cost (EUR)	# of people affected (dead)	Industry	Source
Riaar Plastics Limited	UK	58,431	12,854	71,285	5	Manufacturing	https://press.hse.gov.uk/2023/06/06/firm-fined-following-outbreak-of-legionnaires-disease/
Royal United Hospitals Bath NHS Foundation Trust	UK	350,587	43,766	394,353	1 (1)	Hospital	https://www.georgegreen.co.uk/site/george-green-blog/nhs-trust-fined
Bupa Care Homes	UK	3,500,000	175,500	3,675,500	1	Care-home	https://legionellacontrol.com/news/bupa-care-home-fined-3m-legionnaires-death/
G4S Cash Solutions	UK	2,100,000		2,100,000	1	Cash services & security	https://www.hvnplus.co.uk/news/security-firm-gets-1-8m-fine-for-poor-legionella-management-08-09-2016/
Weighted average per affected person (EUR)		780,343	35,442	815,785			

Assumption table 5: Results from the field – Aquaitalia

		AQUAITALIA SURVEY RESPONSES						Range			
		2018	2019	2020	2021	2022	2023	Min	Weighted Avg	Max	
	Total (unique buildings 175)	12	15	28	52	89	152	12		152	
Buildings tested, Positivity and Lp/Spp split	# contaminated with either Lp, L spp or both	9	10	17	29	29	69	9		69	
	% buildings contaminated	75%	67%	61%	56%	33%	45%	33%	47%	75%	Considered in model
	% buildings contaminated w Lp	58%	67%	54%	44%	33%	43%	33%		67%	
	% buildings contaminated w L spp	17%	-	-	6%	-	1%	-		17%	
	% both Lp & L spp	-	-	7%	6%	-	1%	-		7%	
	% Lp split in contaminated buildings	77.8%	100%	88.2%	79.3%	100%	95.7%	78%		100%	
	% L spp	22.2%	-	-	10.3%	-	2.9%	0%		22%	
% both	-	-	11.8%	10.3%	-	1.4%					
	total samples (455)	28	18	46	64	58	241				
Lp/L spp split of total positive samples	# samples contaminated with Lp	14	18	38	52	58	236				
	# samples contaminated with L spp	14	-	-	3	-	2				
	# both	-	-	8	9	-	3				
	Lp %	50%	100%	83%	81%	100%	98%	50%	91%	100%	Considered in model
	L spp %	50%	-	-	5%	-	1%				
Both %	-	-	17%	14%	-	1%					

Assumption table 6: List of select publications used in model (1/3)

Article Title	Journal	Reference/Link	Main Author	Authors	Summary	Country	Italian Region	Healthcare/ Non Healthcare Setting	Clinical/ Environmental Data	Envir. Lp of Legionella	% NonLp of Legionella
Occurrence of Legionella spp. in Man-Made Water Sources: Isolates Distribution and Phylogenetic Characterization in the Emilia-Romagna Region	Pathogens	https://pubmed.ncbi.nlm.nih.gov/34063633/	Marta Mazzotta	Silvano Salaris, Maria Rosaria Pascale, Luna Girolamini and Sandra Cristino	The high incidence of human-reported disease caused by Lp sg1 is not due to its predominance in the environment, but is rather connected with the higher virulence of this strain; The analysis showed a higher prevalence of L spp (84.1%) compared with L. p 15.9% with a higher frequency. In 2019, n. 53 accommodation facilities were monitored, Legionella genus contaminated 20 (37.7%) of all tourist facilities evaluated. d. Out of the 418 samples, 118 (28.2%) were positive for L. pneumophila. Of the 118 positive samples, 98 samples came from hot water circuits, and the remainder from cold water circuits.	Italy	Northern	Nonhealthcare	environmental	15.9%	84.1%
Contamination of Hotel Water Distribution Systems by Legionella Species: Environmental Surveillance in Campania Region, South Italy	MDPI - Microorganisms	https://www.mdpi.com/2076-2607/11/7/1840	Valeria Di Onofrio	Mariangela Pagano, Marco Santulli, Annamaria Rossi, Renato Liguori, Mirella Di Dio, and Giorgio Liguori	A total of 112 accommodation facilities were analyzed, of which 61.3% were found to be colonized with Legionella , and out of a total of 807 samples, 32.5% were positive for Legionella presence	Italy	Southern	Non-healthcare	environmental	98.5%	1.5%
Legionella spp. Monitoring in the Water Supply Systems of Accommodation Facilities in Sardinia, Italy: A Two-Year Retrospective Analysis	International Journal of Environmental Research and Public Health	https://www.mdpi.com/1660-4601/20/18/6722	Luisa Marras	Giacomo Bertolino, Adriana Sanna, Valentina Carraro, and Valentina Coroneo	We investigated Legionella and Pseudomonas contamination of hot water in a cross-sectional multicentric survey in Italy. Chemical parameters (hardness, free chlorine, and trace elements) were determined. Legionella spp. were detected in 33 (22.6%)	Italy	Central	nonhealthcare	environmental	32.5% total samples contained LP	32.5% total samples were L. spp only
Legionella Infection Risk from Domestic Hot Water	Emerging Infectious Disease	https://wwwnc.cdc.gov/eid/article/10/3/02-0707-t3	Borella	Paola Borella* , M. Teresa Montagna† , Vincenzo Romano-Spica†§ , Serena Stampi¶ , Giovanna Stancanelli# , Maria Triassi** , Rachele Neglia* , Isabella Marchesi* , Guglielmina Fantuzzi* , Daniela Tatò† , Christian Napoli† , Gianluigi Quaranta† , Patrizia Laurenti† , Erica Leoni¶ , Giovanna De Luca§ , Cristina Ossi# , Matteo Moro# , and Gabriella Ribera D'Alcalà*	Study also included hospitals. Statistics here are from apartments and hotels only.	Italy	Multiple	Nonhealthcare	environmental	76%	24%
Legionella waterline colonization: detection of Legionella species in domestic, hotel and hospital hot water systems	Jl of Applied Microbiology	https://academic.oup.com/jambio/article-abstract/98/2/373/6722313?redirectedFrom=fulltext#no-access-message	Leoni	E. Leoni , G. De Luca , P.P. Legnani , R. Sacchetti , S. Stampi , F. Zanetti	Our study provides significant advantages on Legionella identification, providing a reproducible new rpoB gene classification scheme that seems to be more accurate than mip gene sequencing, bringing out greater genetic variation on Legionella species.	Italy	Northern	Nonhealthcare	environmental	73%	27%
New Insight regarding Legionella Non-Pneumophila Species Identification: Comparison between the Traditional mip Gene Classification Scheme and a Newly Proposed Scheme Targeting the rpoB Gene	American Society for Microbiology / Microbiology Spectrum	https://pubmed.ncbi.nlm.nih.gov/34908503/	Maria Rosaria Pascale	Silvano Salaris, Marta Mazzotta, Luna Girolamini, Giulia Fregni Serpini, Laura Manni, Antonella Grottola, Sandra Cristino	300+ water samples collected from 156 control-point taps in 41 buildings comprised in the eight campuses of the University. Legionella was found in only 12 buildings (29% of the total).	Italy	Northern	nonhealthcare	environmental	n/a	n/a
Legionella Survey in the Plumbing System of a Sparse Academic Campus: A Case Study at the University of Perugia	MDPI - Water	https://www.mdpi.com/2073-4441/9/9/662	Ermanno Federici	Silvia Meniconi, Elisa Ceci, Elisa Mazzetti, Chiara Casagrande, Elena Montalbani, Stefania Businelli, Tatiana Mariani, Paolo Mugnaioli, Giovanni Cenci, and Bruno Brunone		Italy	central	nonhealthcare	environmental	85% of taps	15% of taps

Assumption table 6: List of select publications used in model (2/3)

Article Title	Journal	Reference/Link	Main Author	Authors	Summary	Country Described	Italian Region Described (North, Central, Southern)	Healthcare/Non Healthcare Setting	Clinical/Environmental Data	Envir. Lp % of Legionella	Envir. NonLp % of Legionella
Premise plumbing bacterial communities in four European cities and their association with Legionella	Frontiers in Microbiomes	https://www.researchgate.net/publication/371713187_Premise_plumbing_bacterial_communities_in_four_European_cities_and_their_association_with_Legionella	Maria Scaturro	Del Chierico, Federica and Motro, Yair and Chaldoupi, Angeliki and Flountzi, Anastasia and Moran-Gilad, Jacob and Girolamo, Antonietta and Koutsiomani, Thomai and Krogulska, Bozena and Lindsay, Diane and Matuszewska, Renata and Papageorgiou, Georgios and Pancer, Katarzyna and Panoussis, Nikolaos and Rota, Maria and Uldum, Søren and Velonakis, Emmanuel and Chaput, Dominique and Ricci, Maria	We aimed to profile, by 16S rRNA gene amplicon sequencing (V3-V4), the bacterial communities in premise plumbing systems of buildings in four European cities (Copenhagen, Warsaw, Rome, Athens). Overall, 44.2% of samples were Legionella culture positive: 71.4% in Warsaw, 62.2% in Athens, 22.2% in Rome, and 15.2% in Copenhagen. % Lp in Rome was also determined but not readily apparent from the article.	Multiple, including Italy (Rome only)	Central	Nonhealthcare	environmental		
A Legionnaires' disease cluster in a private buildings in Italy	International Journal of Environmental Research and Public Health	https://www.researchgate.net/publication/352812390_A_Legionnaires'_Disease_Cluster_in_a_Private_Building_in_Italy	Maria Luisa Ricci	Rota, Maria Cristina; Caporali, Maria Grazia; Girolama, Antonietta, Scaturro, Maria	Two LD cases were clinically and laboratory confirmed as Lp SG1. Six water samples from patient apartments (boiler and recirculating hot water) were positive for Lp SG1 at ranges from 1×10^3 to 1.4×10^4	Italy	Northern	Nonhealthcare	Clinical & Environmental	100%	0%
Cluster of Travel-associated Legionnaires' disease in Lazise, Italy. July to August 2011	European Communicable Disease Bulletin	https://www.researchgate.net/publication/51718042_Cluster_of_travel-associated_Legionnaires'_disease_in_Lazise_Italy_July_to_August_2011	Maria Rota	Scaturro, Maria & Fontana, Stefano & Foroni, Maurizio & Boschetto, Gianpiero & Trentin, L & Blengio, Gianstefano & Bandettini, G & Buratto, T & Caporali, Maria Grazia & Napoli, Christian & Ricci, Maria Luisa	56 samples of cold and hot water were collected from water tanks, taps, shower heads, swimming pools, water sprinklers, decorative fountains and jacuzzis at the five accommodation sites.	Italy	Northern	Nonhealthcare	Clinical & Environmental	100%	
Occurrence of Legionella in groundwater used for sprinkler irrigation in Southern Italy.	Environmental Research	https://www.sciencedirect.com/science/article/pii/S0013935118306789?via%3Dihub	Osvelda De Giglio	Christian Napoli, Francesca Apollonio, Silvia Brigida, Angelo Marzella, Giusy Diella, Carla Calia, Maria Scarscia, Claudia Pacifico, Carlo Pazzani, Vito Felice Uricchio, Maria Teresa Montagna	Our data suggest that water that aerosolizes when sprinkled on plants represents a potential source of Legionellosis, with a higher risk from exposure in summer.	Italy	Southern	nonhealthcare	environmental		

Assumption table 6: List of select publications used in model (3/3)

Article Title	Journal	Reference/Link	Main Author	Authors	Summary	Country Described	Italian Region Described (North, Central, Southern)	Healthcare/ Non Healthcare Setting	Clinical/ Environmental Data	Envir. Lp % of Legionella	Envir. NonLp % of Legionella
Legionnaires' disease outbreak caused by Legionella pneumophila serogroup 2: an uncommon event, Italy, August to October 2018.	Eurosurveillance	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8229375/	Maria Scaturro	Maria Cristina Rota, Maria Grazia Caporali, Antonietta Girolamo, Michele Magoni, Daria Barberis, Chiara Romano, Danilo Cereda, Maria Gramegna, Antonio Piro, Silvia Corbellini, Cinzia Giagulli, Giovanni Rezza, Arnaldo Caruso, Maria Luisa Ricci.	In Italy between August and October 2018, a LD outbreak consisting of 33 cases caused by Lp2 occurred in seven municipalities of the Brescia province located along the Chiese river. In September 2018 in Brescia province, northern Italy, an outbreak of Legionnaires' disease (LD) occurred.	Italy	Northern	both	both		
Legionellosis Associated with Recreational Waters: A Systematic Review of Cases and Outbreaks in Swimming Pools, Spa Pools, and Similar Environments	International Journal of Environmental Research and Public Health	https://www.mdpi.com/1660-4601/15/8/1612	Erica Leoni	Federica Catalani, Sofia Marini, Laura Dallolio	Data were extracted from 47 articles, including 42 events (17 sporadic cases and 25 outbreaks) and 1079 cases, 57.5% of which were diagnosed as Pontiac fever, without any deaths, and 42.5% were of Legionnaires' disease, with a fatality rate of 6.3%. Etiological diagnosis was confirmed by culture of clinical specimens in 75.0% of LD cases and L. pneumophila was the species most frequently involved, in particular L. pneumophila SG 6 (31.2% of LD cases).	Italy	Multiple	nonhealth care	Clinical	~93.8% (15 of 16 LD cases)	6.2% (1 of 16 LD cases)

Assumption table 7: *Lp* and *non-Lp* prevalence summary, culled from key publications

Lp/Non Lp Environmental Prevalence Summary										
Author ¹	Community	Building Type	Region	Multiple Samples/Building	Total Samples	Samples Positive	Samples Lp	Samples Non Lp	% Lp	% Non-Lp
Borella, Spica et al	Yes	Apartments	Multiple	No	146	33	25	8	76%	24%
Mazotta	Yes	Varied	Emilia Romagna	Yes?		84	3	81	4%	96%
Marras	Yes	Hotels	Sardinia		807	262	221	41	84%	16%
Leoni	Yes	Hotel, Apartments	Bologna	Some	105	56	41	15	73%	27%
Ricci et al	Yes	Apartments			6	6	6	0	100%	0%
Federici	Yes	University	Perugia	Some		20	17	3	85%	15%
				Sub-total		461	313	148		
								Weighted average	68%	32%
Aquaitalia (2022) ²	Yes	Institutions	Northern Italy	Some	455	64	61	3	95%	5%
				Grand total		525	374	Weighted average	71%	29%

Note 1: Does not include Di Onofrio et al because locations selected based on prior disease cases

Note 2: Year with most samples selected [see Assumption table 5 - Aquaitalia]

Assumption table 8: Estimating LD incidence rate¹ in Italy

Cases in Italy (2018-2022)	Total cases	% Community acquired	Community-acquired cases
2022	3,039	97.1%	2,951
2021	2,662	96.3%	2,564
2020	2,021	96.7%	1,954
2019	3,164	96.2%	3,044
2018 ^a	2,874	96.6%	2,776
5-year average	2,752		2,658
LD Incidence (2018-2022) per 100,000 population			
2022	5.19	97.1%	4.93
2021	4.60	96.3%	4.47
2020	3.48	96.7%	3.38
2019	5.29	96.2%	5.14
2018	4.89	96.6%	4.75
5-year average	4.69		4.53

Note (a): Authors used 2019 -2022 % community acquired cases to derive the % of community acquired cases in 2018 due to limited data

Assumption table 9: Estimating *remediation and replacement costs*

2023 Remediation by building type	Direct cost	Replacement cost ¹ (e.g., install or re-pipe)	Replacement %
Azienda Alimentare	-		
Casa Di Riposo	2,400		0.3%
Casa di Riposo Privata	-		
Centrocommerciale	-		
Hotel	2,480		0.3%
Ipermercato	5,700		0.3%
Istituto Ecclesiastico	1,800		0.3%
Istituzione Pubblica di Assistenza E Beneficenza	-		
Scoule Materne Private	-		
SPA	-		
Stabilimento Metallurgico	-		
Total (EUR)		1.5 – 17.5k	0.3%

Note 1: Forbes, “How much does it cost to install or replace plumbing in a house in 2024”, accessed Mar 4th, 2024 (<https://www.forbes.com/home-improvement/plumbing/install-replace-plumbing-cost/>)

How to request access:

For access to the mathematical model please send your name,
institutional affiliation, and area of interest to:

igiene@uniroma4.it