

Higher Education Authority An tUdarás um Ard-Oideachas











RESEARCH PORTFOLIO

PRTLI 5

Programme for Research in Third-Level Institutions

http://zuse.ucc.ie/grep



BUILDING PERFORMANCE

MODELLING

Abstract For Facility Management (FM) companies, Information Technology (IT) is becoming important. Clients demand that their buildings perform more efficiently and desirable FM contracts are awarded to FM companies who fulfil these requests. IT equipment is being used to monitor energy consumption within a building.

> This allows a Facility Manager to analyse the data, benchmark it against similar buildings and offer the client modernisation procedures for the appropriate systems. Initial projections estimate, that for a FM company that is operating 1000 buildings, the amount of data collected after 5 years will be around 2.5 billion datasets.

Objective

This research aims to deliver a standardized method to acquire the performance data of a building. It discusses the infrastructure needed to harvest data from the buildings and store it in a centralised, efficient Data Warehouse (DW) system.

The main focus will be on analysis functions that are running on top of the DW. Their objective is to support the Manager with clear and understandable Facility visualisations and process the huge amount of information for him in a convenient and non-time intensive way.

Approach

- **CONSOLOIDATION OF INFORMATION:**
 - Information is usually spread across multiple tables
 - A Materialized View (MV) consolidates data
 - MV's can be modelled for individual data representations
 - Unneeded data gets ignored in the MV
 - MV's allow to pre-calculate data for quick access

Materialized Views & Cubes

The Data Warehouse (DW) is used to pre-calculates Performance Indicators (PI) in Materialized Views. The performance gain for using DW-technology compared to regular SQL commands is huge (cf. figure 3)

Results

Creating a Data Warehouse Cubes

- A cube consists of a fact table (w. measured data) and
- Dimensional data, e.g. time, zone, system (cf. figure 1)



Figure 5: Complex Analysis Results (UnderPerformance Indicator – UP_{temp} for one floor)

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27.4



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Figure 1: Dimensions Derived from BIM



Figure 2: Amalgamating BIM and Monitoring Data

elect round(AVG(measurement),2) om readings where ipaddressordatalog = 00030301' nd readingtimestamp > '31-DEC- 0 23.45' nd readingtimestamp < '01-JAN- 2';	select average from yearly, average_temp where ipaddressordatalog = 'D0030301' and year = '2011';
All Rows Fetched: 1 in 11.82 econds.	- All Rows Fetched: 1 in 0 seconds.

Figure 3: Simplification of Queries and Fast Response Times

dium.	Time Period Room						
ENSOR .	YEAR - ZONE - Query Cube						
L							

Export to CSV

SERSOR								TEAR	ZONE ST	396
Electric	ity Consu	mption	Trend					CY201	21 6	37269.74
Carbon T	rend Equi	valent	relat	ed to	Ele	strici	ty Consu	aption CY201	21 9	0.48
Electric	ity Cost	Trend						C¥203	21 7	0.66
G09 Rad	Valve Log				-	\square		CY201	21 1	03.8
G09 Wind	ow status				4			CY201	121 .1	04
G09 C02				ŕ		4	4	CY201	21 61	8315.84
G02-2 Te	mperature							CY203	121 34	146.7
G09 near	door Tem	peratur	e	F			-	CY201	122 0	
Steam HE	xc Flow I	enp						CY203	22 8	692
📕 Script Outp	ut × 🕨 Query	Result ×								
📌 🚇 😽	SQL Al Row	s Fetched: 30	in 0.62 s	econds						
🖁 NA	ME WEEK	COUNT 🖁	AVG 🛔	MAX 🖁	MEN	SUM	ENPI_SQM	ENPI_STAFF	ENPI_ROOMS	BVP1_STOREY
1 143	2013-01	99	0	0	0	0	0	0	0	0
2 143	2013-02	159	0	0	0	0	0	0	0	0
3 143	2013-03	291	0	0	0	0	0	0	0	0
4 143	2013-04	248	0.02	0.28	0	4.76	0.00159	0.0595	0.07933	1.58667
5 143	2013-05	672	0.03	0.45	0	19.47	0.00649	0.24338	0.3245	6.49
6 143	2013-06	576	0.02	0.3	0	10.49	0.0035	0.13113	0.17483	3.49667
7 143	2013-07	672	0.02	0.35	0	12.12	0.00404	0.1515	0.202	4.04
8 143	2013-08	672	0.04	0.48	0	29.85	0.00995	0.37313	0.4975	9.95
9 143	2013-09	592	0.03	0.47	0	18.78	0.00626	0.23475	0.313	6.26
10 143	2013-10	3	0	0	0	0	0	0	0	0
11 145	2013-01	295	0.09	1.5	0	26.3	0.00877	0.32875	0.43833	8.76667
12 145	2013-02	481	0.14	1.4	0	65.5	0.02183	0.81875	1.09167	21.83333
13 145	2013-03	871	0.12	1.5	0	103.3	0.03443	1 29125	1 72167	34 43333

745 0.11 1.5 0 82.2 0.0274 Figure 4: Example for Using Cubes

(Energy Performance Indicators for one building)

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