

ADMT 2018 - Project report

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Contents

List of Figures	3
List of Tables	3
1 Introduction	5
1.1 Business processes	5
1.1.1 CRM - Showroom visit	5
1.1.2 Production	5
2 Conceptual Design	6
2.1 Showroom visit	7
2.2 Production	8
3 Logical Design	8
3.1 Star schemas	8
3.2 Two business questions	11
3.2.1 Fact: Showroom visit	11
3.2.2 Fact: Production	13
4 Implementation	15
4.1 Creation	15
4.1.1 Showroom data mart	15
4.1.2 Production data mart	18
4.2 ROLLUP	19
4.2.1 SQL query using ROLLUP for business process 1 (showroom visit)	19
4.2.2 SQL query with ROLLUP for business process 2 (production)	20
4.3 CUBE	20
4.3.1 SQL query using CUBE for business process 1 (showroom visit)	20
4.3.2 SQL query using CUBE for business process 2 (production)	21
4.4 GROUPING SETS	22
4.4.1 SQL query using GROUPING SETS for business process 1 (showroom visit)	22
4.4.2 SQL query using GROUPING SETS for business process 2 (production)	23
5 Querying	24
5.1 NTILE	24
5.1.1 SQL query using NTILE for business process 1 (showroom visit)	24
5.1.2 SQL query using NTILE for business process 2 (production)	25
5.2 RANK	26
5.2.1 SQL query using RANK for business process 1 (showroom visit)	26
5.2.2 SQL query using RANK for business process 2 (production)	26
5.3 WINDOWING Clause	27
5.3.1 SQL query using a WINDOWING clause for business process 1 (showroom visit)	27

5.3.2	SQL query using a WINDOWING clause for business process 2 (production)	28
5.4	Period-to-period Comparison	29
5.4.1	SQL query using period-to-period comparison for business process 1 (showroom visit)	29
6	Data Analysis Tool	30
6.1	Business questions	30

List of Figures

1	DFM of the showroom visit	6
2	DFM of the production	7
3	Dimension fact model (DFM) of the showroom visit with attributes	8
4	Dimension fact model (DFM) of the production with attributes	9
5	Star schema of the showroom visit	10
6	Star schema of the production	11
7	Best running Showroom	31
8	Customer District	32
9	Customer Municipality	33
10	Visitors per Department	34
11	Visitors per Month	35
12	Sunburst Diagram of ROLLUP query	36

List of Tables

1	Fact table	6
2	Fact table Showroom	7
3	Fact table Production	8
4	Showroom visit	12
5	Visitor	12
6	Showroom	12
7	Date	13
8	Result of the query	13
9	Production	14
10	Machine	14
11	Product	14
12	Result of the query	15
13	Showroom ROLLUP Result	19
14	Production ROLLUP Result	20
15	Showroom CUBE Result	21
16	Production CUBE Result	22
17	Showroom CUBE Result	23
18	Production GROUPING SETS Result	23

19	Showroom NTILE Result	24
20	Production NTILE Result	25
21	Showroom RANK Result	26
22	Showroom RANK Result	27
23	Showroom WINDOWING Result	27
24	Production WINDOWING Result	28
25	Production period-to-period comparison result	29

1 Introduction

The domain of our fictional company is the one of furniture production and retail. The company is located in the province of Bolzano and has several showrooms in the area and one production center.

In order to get a better overview of the various visits to the many showrooms and to be able to use even more targeted advertising media, the company decided to create a data mart for this business process.

The production should also increase in the future in terms of efficiency and quality. Machine processes are to be optimized and critical processes or machines are to be replaced with better solutions. A data mart was also created for this, so that the management can find faster and better solutions in cooperation with the various department heads.

In the future, the company also wants to use several visualization tools and dashboards to immediately identify various key figures and numbers in the various areas of the company so that it can react in real time and optimize processes.

1.1 Business processes

1.1.1 CRM - Showroom visit

One CRM process is the collection of data about visitors at the different showrooms. A visitor can either be one who is just looking around without intention of buying anything (Seeleute), a future potential customer or an already existing customer. A visit can lead to an order.

Business questions:

- Which is the best running showroom (most visitors, most orders, etc.)
- Where are the customers from (with different granularity)
- Which department are the customers the most interested in
- Compare the number of visitors for a time period and/or showroom

1.1.2 Production

The company logs every step in the production process, especially duration, defects and machine failures.

Business questions:

- What is the average time to produce a particular product
- Which is the product with the highest/lowest quality
- How much does a product cost in terms of raw material cost
- Compare the machines inn terms of quality and/or production time
- How many products have been produced in a certain time period

2 Conceptual Design

The first fact of our Data Warehouse represents a showroom visit. The company is registering each visit in a particular showroom and is interested in some very specific details about a the visit. Namely, for each visit they store the date, the visitor and visitor type, the showroom, the department in which the visitor was particularly interested, the order if the visitor placed one, the sales representative who took care about the visitor and the duration and the number of people with respect to the visit.

The second fact collects some relevant information of a production stage. For each production stage of a particular product, in addition to those two information, also start- and end-date, the machine, the result of the quality control, the operator, the costs of the raw material and the duration of the process are stored.

Table 1: Fact table

Fact	Dimensions	Measures
Showroom visit	Date, Showroom, Visitor, Visitor type, Order, Department, Sales representative	Duration (additive: AVG), Amount of people (additive: SUM, AVG)
Production	Start Date, End date, Product, Production Stage, Machine, Quality control, Operator	Duration (additive: AVG), Raw material cost (additive: SUM, AVG)

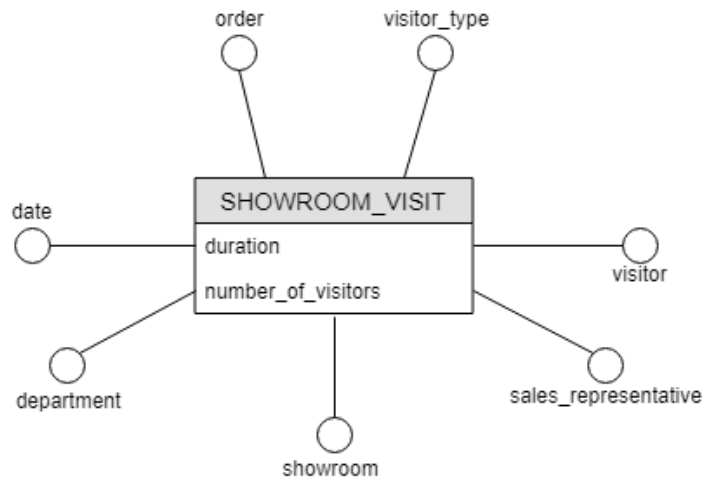


Figure 1: DFM of the showroom visit

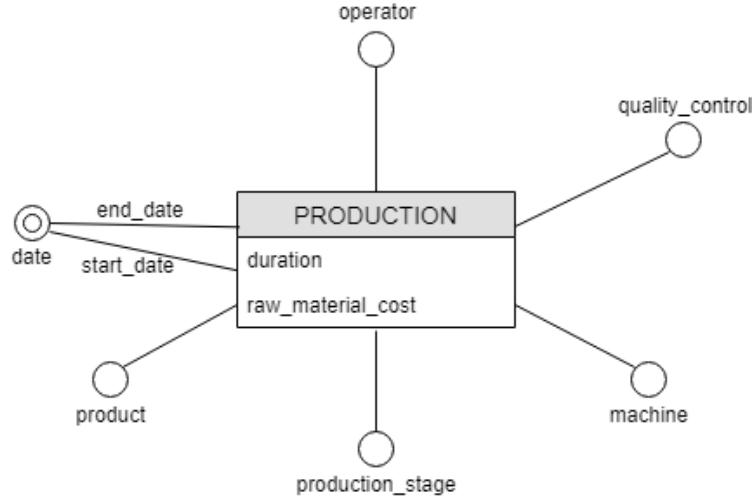


Figure 2: DFM of the production

2.1 Showroom visit

Table 2: Fact table Showroom

Dimension	Attributes
Date	Day, Month, Year, Quartal, Week, Day of Week, Season, Holiday
Showroom	Name, City, District, Province, Region, Country, Manager, Address, Telephone, Size
Visitor	Name, City, District, Province, Region, Country, Language, Telephone, E-Mail, Type, Sector, Gender, Customer number
Order	Order Number, Total Price, Discount
Order Detail	Quantity, Quantity Type, Product, Unit price, Total price
Department	Name
Sales representative	Name, City, District, Province, Region, Country, Language, Telephone, E-Mail, Gender

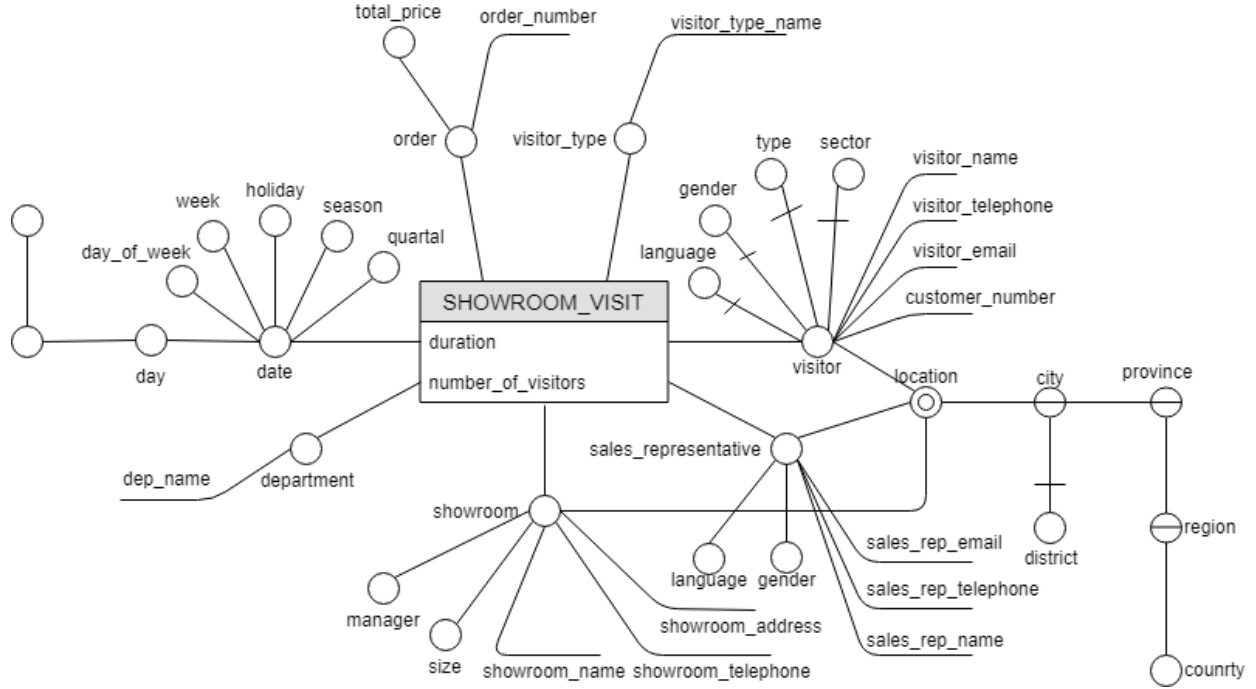


Figure 3: Dimension fact model (DFM) of the showroom visit with attributes

2.2 Production

Table 3: Fact table Production

Dimension	Attributes
Start date	Day, Month, Year, Week
End date	Day, Month, Year, Week
Product	Product number, Name, Department, Category
Production stage	Name
Machine	Name, Purchasing year, Vendor
Quality control	Grade
Operator	Name

3 Logical Design

3.1 Star schemas

The following star schema fig. 5 represent the first business process, namely the showroom visit. In order for being able to obtain more detailed query results, we decided to create the foreign table 'location'. With this approach for example, we are able to understand, from

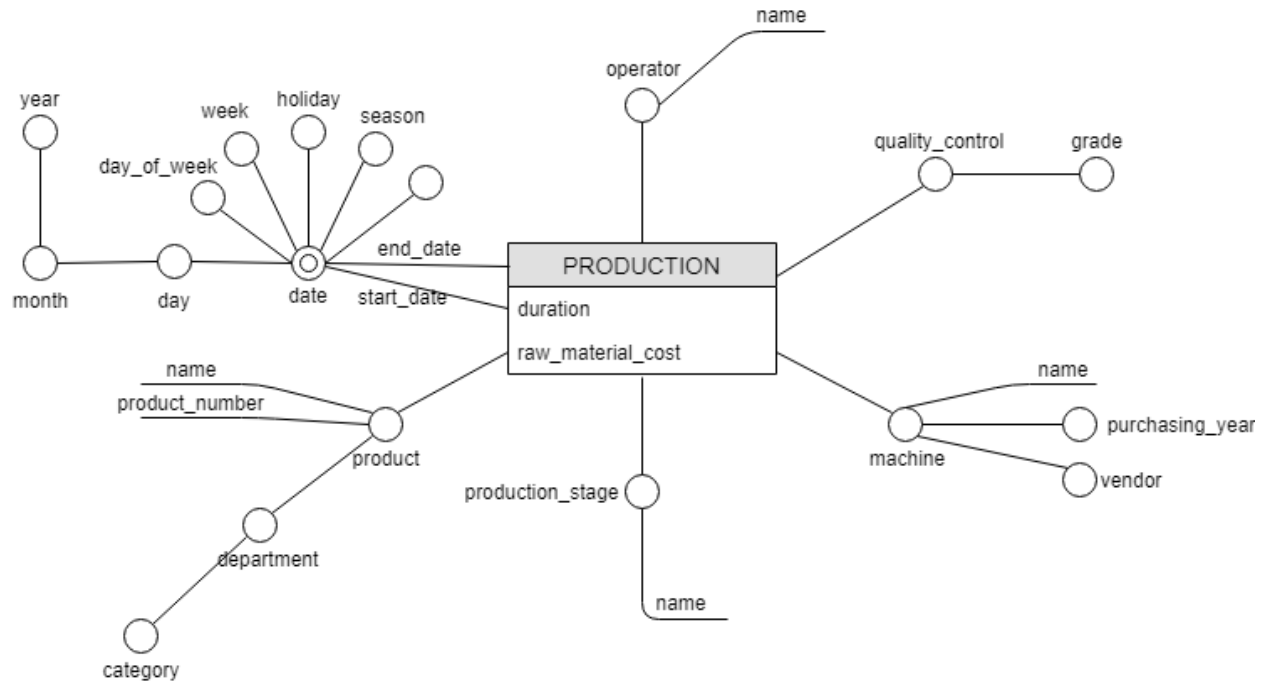


Figure 4: Dimension fact model (DFM) of the production with attributes

which particular place are the different visitors coming and are visiting which showroom in which location. Also for marketing decision the location of the showroom and the location of the different visitors is crucial.

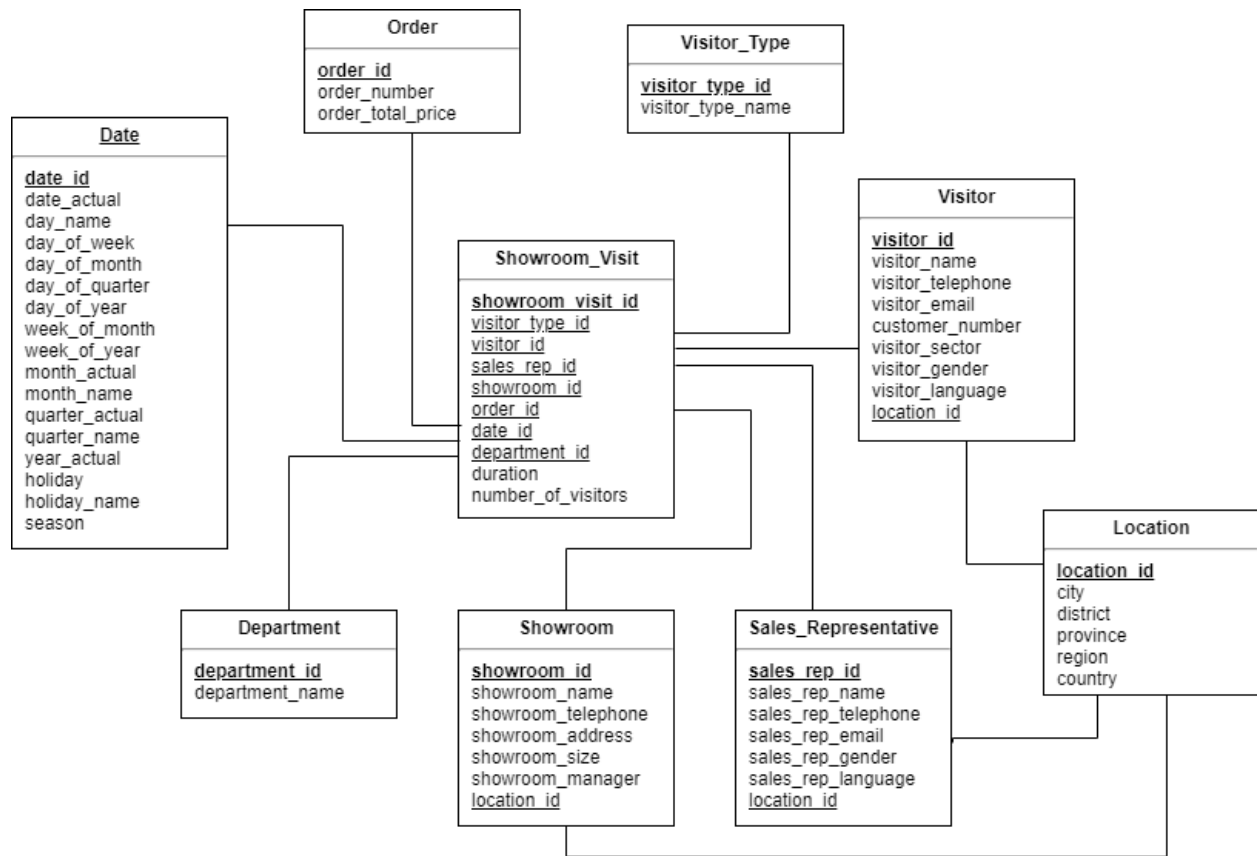


Figure 5: Star schema of the showroom visit

Instead, the star schema fig. 6 represents the production business process.

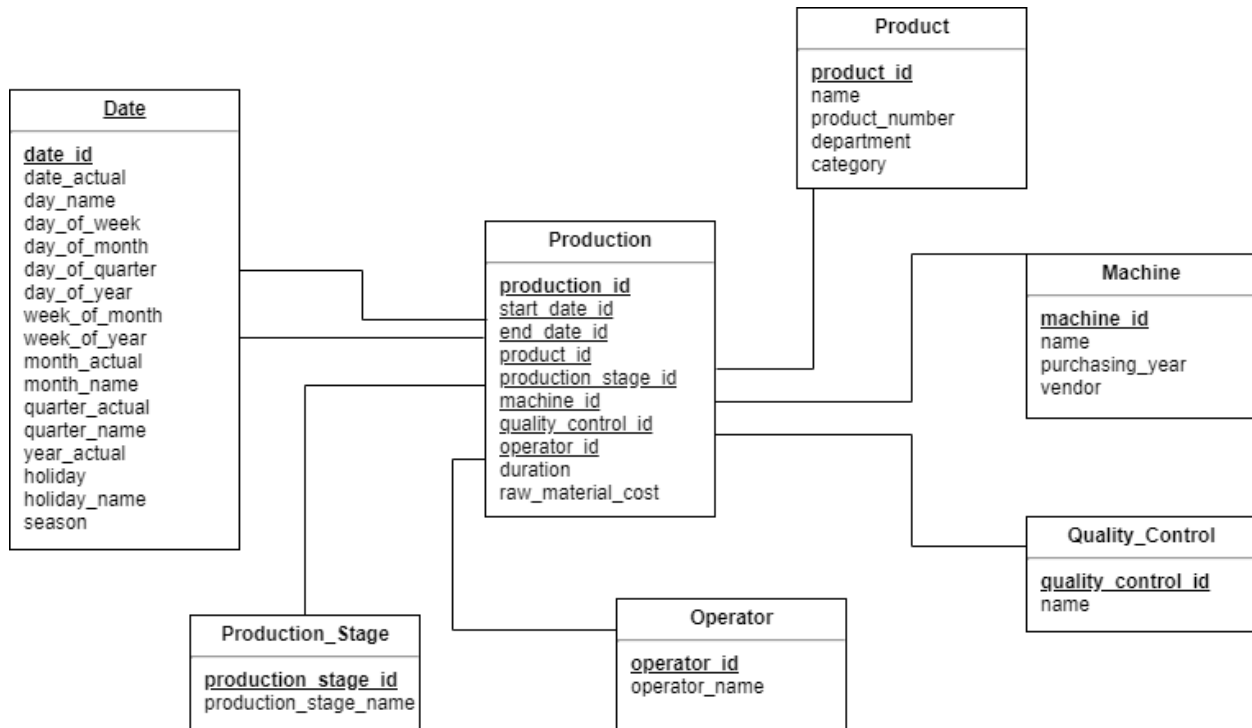


Figure 6: Star schema of the production

3.2 Two business questions

3.2.1 Fact: Showroom visit

In order to be able to make the right marketing decisions, it is very important for the management to know from which sector the various customers or interested parties of a particular showroom come from. So, for example the management wants to know, from which sectors the various customers of showroom "Showroom-Bozen" were coming in the last year.

SQL query:

```

1 SELECT v.visitor_sector , count(*)
2 FROM warehouse.visitor v
3 INNER JOIN warehouse.showroom_visit sv on v.visitor_id = sv.visitor_id
4 INNER JOIN warehouse.showroom s on sv.showroom_id = s.showroom_id
5 INNER JOIN warehouse.date d on sv.date_id = d.date_id
6 WHERE s.showroom_name = 'Showroom-BOZEN'
7 AND d.date_actual >= '2018-01-01' AND d.date_actual <= '2018-12-31'
8 GROUP by v.visitor_sector
  
```

Table 4: Showroom visit

ID	Visitor_id	Sales_rep_id	Showr._id	Depart._id	Date_id	Type_id	Duration	Nr._of_visit.
1282369	570822	6	5	4	20180323	2	90	2
1282370	570823	5	5	2	20160107	4	167	4
1282371	570823	7	5	1	20130526	3	173	6
1282372	570823	11	5	6	20150806	3	100	10
1282373	570823	7	5	1	20121116	4	169	5
1282374	570824	7	5	1	20171210	3	57	3
1282375	570824	18	5	2	20110212	3	166	7
1282376	570824	9	5	4	20130811	3	84	5
1282377	570825	11	5	6	20170507	3	184	10
1282378	570825	12	5	2	20111127	2	26	2
1282379	570825	7	5	1	20150425	3	141	10
1282380	570826	11	5	6	20130208	2	8	2
1282381	570826	12	5	1	20111214	3	61	8
1282382	570827	12	5	1	20170202	3	139	9
1282383	570827	12	5	2	20121012	3	71	7

Table 5: Visitor

ID	Name	Telephone	E-Mail	Sector	Sex	Lang.	Loc._id
570822	Melanie Eder			Gastronomy	F	german	9
570823	Julian Schmidt		j.schmidt@email.com	Private	M	german	9
570824	Marcel Schwarz	306 9579783	m.schwarz@email.com	Hotel	M	german	9
570825	Denise Fuchs	396 5305260	d.fuchs@email.com	Public	F	german	9
570826	Sophie Wimmer	322 7641804	s.wimmer@email.com	Private	F	german	9

Table 6: Showroom

ID	Name	Telephone	Address	Size	Manager	Loc._id
1	Showroom-LATSCH	0477 069655	Herrengasse 8	581	Paul Wolf	42

ID	Name	Telephone	Address	Size	Manager	Loc._id
2	Showroom-MÜHLBACH	0474 039227	Platzerstr. 58	349	Christoph Steiner	54
3	Showroom-MÖLTEN	0470 429676	Vernag 97	857	Christoph Steiner	51
4	Showroom-SALURN	0475 248487	Gewerbezone 44	198	Johannes Egger	77
5	Showroom-BOZEN	0473 723301	St. Urban 73	447	Sabine Schneider	9

Table 7: Date

ID	Date	Day_week	Day	Month	Quartal	Year	Holiday	Season
20160102	2010-01-02	6	Saturday	January	First	2016	false	Winter
20170103	2010-01-03	7	Sunday	January	First	2017	false	Winter
20180108	2018-01-08	5	Friday	January	First	2018	false	Winter
20190109	2010-01-09	6	Saturday	January	First	2019	false	Winter
20200110	2010-01-10	7	Sunday	January	First	2020	false	Winter

Table 8: Result of the query

Sector	Number of visits
Gastronomy	2985
Hotel	4223
Private	5629
Public	1371

3.2.2 Fact: Production

The company's quality control is always interested in optimizing processes. It is therefore interesting for employees to know whether a machine has significant time differences in production in relation to a particular product in comparison to the other machines.

SQL query:

```

1 SELECT m.machine_name, avg(p.duration) AS avg_production_duration
2 FROM warehouse.machine m
3 INNER JOIN warehouse.production p ON m.machine_id = p.machine_id
4 INNER JOIN warehouse.product o ON p.product_id = o.product_id
5 WHERE o.product_number = 'Warteraum-Couch_10'
6 GROUP BY m.machine_id
7 ORDER BY avg_production_duration DESC LIMIT 10

```

Table 9: Production

ID	Operator*	Machine*	Stage*	Product*	Start_date*	End_date*	Duration	Raw_mat..cost
591814	779	1144	1	361016	20101105	20101202	152	76
591815	780	1174	2	361016	20101202	20101203	1	395
591816	775	1213	3	361016	20101203	20101207	2	277
591817	770	1055	1	361016	20101122	20101214	30	66
591818	722	1176	2	361016	20101214	20110111	133	391
591819	755	1079	3	361016	20110111	20110204	36	275
591820	740	1069	1	361016	20150511	20150520	49	73
591821	756	1025	2	361016	20150520	20150603	54	398
591822	758	1130	3	361016	20150603	20150625	96	278
27064	754	1164	1	361016	20101022	20101026	8	66
27065	739	1028	2	361016	20101026	20101104	6	407
27066	798	1098	3	361016	20101104	20101105	6	280
27067	780	1013	1	361016	20130327	20130411	70	74
27068	737	1145	2	361016	20130411	20130509	18	404
27069	772	1032	3	361016	20130509	20130520	14	281

Note: all columns with the * are foreign key columns and are carrying only the id

Table 10: Machine

ID	Machine_name	Machine_vendor	Purchasing_year
1172	Melichár	Durán	1998
1173	Horn	Lóntos	2009
1174	Chihaia	Murtazaev	2002
1175	Korčák	Durán	2006
1176	Ramóna	Barbora	1996

Table 11: Product

ID	Product_name	Product_number	Product_department	Product_category
361013	Warteraum-Couch	Warteraum-Couch - 7	Büro	Arztpraxis-Set
361014	Warteraum-Couch	Warteraum-Couch - 8	Büro	Arztpraxis-Set
361015	Warteraum-Couch	Warteraum-Couch - 9	Büro	Arztpraxis-Set

ID	Product_name	Product_number	Product_department	Product_category
361016	Warteraum-Couch	Warteraum-Couch - 10	Büro	Arztpraxis-Set
361017	Warteraum-Couch	Warteraum-Couch - 11	Büro	Arztpraxis-Set

Table 12: Result of the query

Machine_name	AVG_Production_duration
Vajda	152.00
Ramóna	133.00
Papandreou	96.00
Kontoléon	70.00
Mitu	54.00
Bercu	49.00
Heinrich	36.00
Martinez	30.00
Pál	18.00
Aguilar	14.00

4 Implementation

4.1 Creation

4.1.1 Showroom data mart

This sql script creates the table structure for the showroom visit data mart:

```

1 CREATE TABLE IF NOT EXISTS warehouse.location(
2     location_id SERIAL PRIMARY KEY NOT NULL,
3     city VARCHAR(100) NULL,
4     district VARCHAR(100) NULL,
5     province VARCHAR(100) NULL,
6     region VARCHAR(100) NULL,
7     country VARCHAR(100) NOT NULL
8 );
9
10 CREATE TABLE IF NOT EXISTS warehouse.date
11 (
12     date_id SERIAL PRIMARY KEY NOT NULL,

```

```

13     date_actual DATE NOT NULL,
14     day_name VARCHAR(9) NOT NULL,
15     day_of_week INT NOT NULL,
16     day_of_month INT NOT NULL,
17     day_of_quarter INT NOT NULL,
18     day_of_year INT NOT NULL,
19     week_of_month INT NOT NULL,
20     week_of_year INT NOT NULL,
21     month_actual INT NOT NULL,
22     month_name VARCHAR(9) NOT NULL,
23     quarter_actual INT NOT NULL,
24     quarter_name VARCHAR(9) NOT NULL,
25     year_actual INT NOT NULL,
26     mmyyyy CHAR(6) NOT NULL,
27     mmddyyyy CHAR(10) NOT NULL,
28     holiday BOOLEAN NOT NULL,
29     holiday_name VARCHAR(50),
30     season VARCHAR(20)
31 );
32
33 CREATE INDEX d_date_date_actual_idx ON warehouse.date(date_actual);
34
35 CREATE TABLE IF NOT EXISTS warehouse.visitor(
36     visitor_id SERIAL PRIMARY KEY NOT NULL,
37     visitor_name VARCHAR(100),
38     visitor_telephone VARCHAR(100),
39     visitor_email VARCHAR(100),
40     customer_number VARCHAR(100),
41     visitor_sector VARCHAR(50),
42     visitor_gender VARCHAR(10),
43     visitor_language VARCHAR(50),
44     visitor_location_id int REFERENCES warehouse.location(location_id
45 );
46
47
48 CREATE TABLE IF NOT EXISTS warehouse.sales_representative(
49     sales_rep_id SERIAL PRIMARY KEY NOT NULL,
50     sales_rep_name VARCHAR(100) NOT NULL,
51     sales_rep_telephone VARCHAR(100) NOT NULL,
52     sales_rep_email VARCHAR(100) NOT NULL,
53     sales_rep_gender VARCHAR(10) NOT NULL,
54     sales_rep_language VARCHAR(50) NOT NULL,
55     sales_rep_location_id int REFERENCES warehouse.location(location_
56 );
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CREATE TABLE IF NOT EXISTS warehouse.showroom(  
    showroom_id SERIAL PRIMARY KEY NOT NULL,  
    showroom_name VARCHAR(100) NOT NULL,  
    showroom_telephone VARCHAR(100) NOT NULL,  
    showroom_address VARCHAR(100) NOT NULL,  
    showroom_size int NOT NULL,  
    showroom_manager VARCHAR(100) NOT NULL,  
    showroom_location_id int REFERENCES warehouse.location(location_id)  
);  
  
CREATE TABLE IF NOT EXISTS warehouse.department(  
    department_id SERIAL PRIMARY KEY NOT NULL,  
    department_name VARCHAR(100) NOT NULL  
);  
  
CREATE TABLE IF NOT EXISTS warehouse.order(  
    order_id SERIAL PRIMARY KEY NOT NULL,  
    order_number VARCHAR(100) NOT NULL,  
    order_total_price numeric NOT NULL  
);  
  
CREATE TABLE IF NOT EXISTS warehouse.visitor_type(  
    visitor_type_id SERIAL PRIMARY KEY NOT NULL,  
    visitor_type_name VARCHAR(100) NOT NULL  
);  
  
CREATE TABLE IF NOT EXISTS warehouse.showroom_visit(  
    showroom_visit_id SERIAL PRIMARY KEY NOT NULL,  
    visitor_id int REFERENCES warehouse.visitor(visitor_id),  
    sales_rep_id int REFERENCES warehouse.sales_representative(sales_rep_id),  
    showroom_id int REFERENCES warehouse.showroom(showroom_id) NOT NULL,  
    department_id int REFERENCES warehouse.department(department_id) NOT NULL,  
    date_id int REFERENCES warehouse.date(date_id) NOT NULL,  
    order_id int REFERENCES warehouse.order(order_id),  
    visitor_type_id int REFERENCES warehouse.visitor_type(visitor_type_id),  
  
    duration int NOT NULL,  
    number_of_visitors int NOT NULL  
);
```

4.1.2 Production data mart

Whereas, this script creates the needed tables for the production data mart:

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```
CREATE TABLE IF NOT EXISTS warehouse.operator(  
    operator_id SERIAL PRIMARY KEY NOT NULL,  
    operator_name VARCHAR(100) NOT NULL  
);  
  
CREATE TABLE IF NOT EXISTS warehouse.quality_control(  
    quality_control_id SERIAL PRIMARY KEY NOT NULL,  
    quality_control_grade int NOT NULL  
);  
  
CREATE TABLE IF NOT EXISTS warehouse.machine(  
    machine_id SERIAL PRIMARY KEY NOT NULL,  
    machine_name VARCHAR(100) NOT NULL,  
    machine_vendor VARCHAR(100) NOT NULL,  
    machine_purchasing_year int NOT NULL  
);  
  
CREATE TABLE IF NOT EXISTS warehouse.production_stage(  
    production_stage_id SERIAL PRIMARY KEY NOT NULL,  
    production_stage_name VARCHAR(100) NOT NULL  
);  
  
CREATE TABLE IF NOT EXISTS warehouse.product(  
    product_id SERIAL PRIMARY KEY NOT NULL,  
    product_name VARCHAR(100) NOT NULL,  
    product_number VARCHAR(100) NOT NULL,  
    product_department VARCHAR(100) NOT NULL,  
    product_category VARCHAR(100) NOT NULL  
);  
  
CREATE TABLE IF NOT EXISTS warehouse.production(  
    production_id SERIAL PRIMARY KEY NOT NULL,  
    operator_id int REFERENCES warehouse.operator(operator_id)  
    quality_control_id int REFERENCES warehouse.quality_control(quality_control_id)  
    machine_id int REFERENCES warehouse.machine(machine_id)  
    production_stage_id int REFERENCES warehouse.production_stage(production_stage_id)  
    product_id int REFERENCES warehouse.product(product_id),  
    start_date_id int REFERENCES warehouse.date(date_id) NOT NULL,  
    end_date_id int REFERENCES warehouse.date(date_id) NOT NULL,  
  
    duration int NOT NULL,
```

```

43         raw_material_cost int NOT NULL
44     );

```

4.2 ROLLUP

4.2.1 SQL query using ROLLUP for business process 1 (showroom visit)

The following sql query shows the number of visits per showroom, in the different areas and in the different seasons. In addition there are the different partial sums. For example, for the showroom in Bolzano, first the number of visits for the 'bedroom' area in autumn is shown, then the total number of visits for the 'bedroom' area, regardless of the season, and finally the total number of visits for the showroom in Bolzano, regardless of the area and the season.

```

1 SELECT showroom_name, department_name, season, count(visitor_id)
2 FROM warehouse.showroom_visit
3 JOIN warehouse.showroom using (showroom_id)
4 JOIN warehouse.department using (department_id)
5 JOIN warehouse.date using (date_id)
6 GROUP BY ROLLUP(showroom_name, department_name, season);

```

Table 13: Showroom ROLLUP Result

showroom_name	department_name	season	count
Showroom-BOZEN	Badezimmer	Frühling	2579
Showroom-BOZEN	Badezimmer	Herbst	3285
Showroom-BOZEN	Badezimmer	Sommer	1311
Showroom-BOZEN	Badezimmer	Winter	4708
Showroom-BOZEN	Badezimmer	*	11883
Showroom-BOZEN	Büro	Frühling	298
Showroom-BOZEN	Büro	Herbst	281
Showroom-BOZEN	Büro	Sommer	156
Showroom-BOZEN	Büro	Winter	480
Showroom-BOZEN	Büro	*	1215
Showroom-BOZEN	Hotel	Frühling	4032
Showroom-BOZEN	Hotel	Herbst	4472
Showroom-BOZEN	Hotel	Sommer	2022
Showroom-BOZEN	Hotel	Winter	6808
Showroom-BOZEN	Hotel	*	17334
...			

4.2.2 SQL query with ROLLUP for business process 2 (production)

The following sql query shows the average machining time for a particular production stage of a particular product of a particular product category. The query also returns the average machining times of the higher levels, in other words, a granularity is removed step by step. For example, the average machining time of 'table XY' is shown first for the 'fine grinding' process. Then you get the average machining time of all processes on 'table XY' and finally the average machining time of all processes on all table models, thus of the whole product category 'table'.

```
1 SELECT product_category , product_name ,  
2         production_stage_name , ROUND(avg(duration)::numeric,2) as avg  
3 FROM warehouse.production  
4 JOIN warehouse.product using (product_id)  
5 JOIN warehouse.production_stage using (production_stage_id)  
6 GROUP BY ROLLUP(product_category , product_name , production_stage_name);
```

Table 14: Production ROLLUP Result

product_category	product_name	production_stage_name	avg
AdsH-Set	AdsH-Fähnchen	Ausführung	44.28
AdsH-Set	AdsH-Fähnchen	Feinschliff	44.18
AdsH-Set	AdsH-Fähnchen	Vorbereitung	43.35
AdsH-Set	AdsH-Fähnchen	*	43.94
AdsH-Set	AdsH-Goldabzeichen	Ausführung	45.11
AdsH-Set	AdsH-Goldabzeichen	Feinschliff	44.15
AdsH-Set	AdsH-Goldabzeichen	Vorbereitung	43.71
AdsH-Set	AdsH-Goldabzeichen	*	44.32
AdsH-Set	AdsH-Goldpokal	Ausführung	46.37
AdsH-Set	AdsH-Goldpokal	Feinschliff	43.60
AdsH-Set	AdsH-Goldpokal	Vorbereitung	47.80
...			

4.3 CUBE

4.3.1 SQL query using CUBE for business process 1 (showroom visit)

The following query shows the number of visitors from the province of Bolzano and its commercial sector in the different districts of the showrooms. In addition, the query shows all possible sub-totals, removing step by step different granularities. In other words, for each combination of values, the sum is shown, finally the total sum of all visits from visitors from the province of Bolzano.

```

1 SELECT visitor_sector, vl.district as visitor_district,
2         sl.district as showroom_district, sum(number_of_visitors)
3 FROM warehouse.showroom_visit
4 JOIN warehouse.visitor using (visitor_id)
5 JOIN warehouse.location as vl
6     on warehouse.visitor.location_id = vl.location_id
7 JOIN warehouse.showroom using (showroom_id)
8 JOIN warehouse.location as sl
9     on warehouse.showroom.location_id = sl.location_id
10 WHERE vl.province = 'Bozen'
11 GROUP BY CUBE(visitor_sector, vl.district, sl.district)
12 ORDER BY visitor_sector, vl.district, sl.district;

```

Table 15: Showroom CUBE Result

visitor_sector	visitor_district	showroom_district	sum
Gastronomy	Bozen	Bozen	55749
Gastronomy	Bozen	Burggrafenamt	2574
Gastronomy	Bozen	Eisacktal	1554
Gastronomy	Bozen	Pustertal	2887
Gastronomy	Bozen	Salten Schlern	3501
Gastronomy	Bozen	Überetsch-Südtiroler Unterland	1842
Gastronomy	Bozen	Vinschgau	2278
Gastronomy	Bozen	Wipptal	3031
Gastronomy	Bozen	*	73416
...			

4.3.2 SQL query using CUBE for business process 2 (production)

The following query shows the average grade of the quality control for a machine and for the product category. Also all partial average values of all different combinations and groupings can be read off.

```

1 SELECT product_department, machine_name,
2         ROUND(avg(quality_control_grade)::numeric,2) as avg
3 FROM warehouse.production
4 JOIN warehouse.product using (product_id)
5 JOIN warehouse.machine using (machine_id)
6 JOIN warehouse.quality_control using (quality_control_id)
7 WHERE quality_control_grade is not NULL
8 GROUP BY CUBE(product_department, machine_name)

```

```
9 ORDER BY product_department;
```

Table 16: Production CUBE Result

product_department	machine_name	avg
Badezimmer	José Alberto Córdova	5.00
Badezimmer	Herrera	4.59
Badezimmer	Dzurjanin	4.46
Badezimmer	Șchiopu	4.44
Badezimmer	Groșescu	4.53
Badezimmer	Văcăroiu	4.46
Badezimmer	Germanós	4.47
Badezimmer	Holuby	4.42
Badezimmer	Bogza	4.31
Badezimmer	Păcurariu	4.34
Badezimmer	Giurescu	4.42
Badezimmer	Raudsepp	4.63
Badezimmer	Argeșanu	4.67
Badezimmer	Ciupe	4.14
Badezimmer	Linda	4.53
...		

4.4 GROUPING SETS

4.4.1 SQL query using GROUPING SETS for business process 1 (showroom visit)

The following query shows the sum of order prices per language served by a sales representative in a showroom. Also the total sum on order prices can be taken from a language in that showroom as well as the total sum served by that sales representative.

```
1 SELECT showroom_name, sales_rep_name,
2       visitor_language, sum(order_total_price)
3 FROM warehouse.showroom_visit
4 JOIN warehouse.visitor using (visitor_id)
5 JOIN warehouse.sales_representative using (sales_rep_id)
6 JOIN warehouse.order using (order_id)
7 JOIN warehouse.showroom using (showroom_id)
8 GROUP BY GROUPING SETS(
9       (showroom_name, sales_rep_name, visitor_language),
10      (showroom_name, visitor_language),
```

11

```
(showroom_name, sales_rep_name));
```

Table 17: Showroom CUBE Result

showroom_name	sales_rep_name	visitor_language	sum
Showroom-BOZEN	Caroline Eder	english	277049.23
Showroom-BOZEN	Elisabeth Schwarz	english	240820.64
Showroom-BOZEN	Noemi Bruno	english	8688.9
Showroom-BOZEN	Simone Serra	english	265751.20
Showroom-BOZEN	Valerio Adami	english	184714.18
Showroom-BOZEN	*	english	977024.15
Showroom-BOZEN	Caroline Eder	german	5384090.56
Showroom-BOZEN	Elisabeth Schwarz	german	8917292.85
Showroom-BOZEN	Mario Lang	german	2448919.46
Showroom-BOZEN	Martina Lehner	german	3255981.32
Showroom-BOZEN	Noemi Bruno	german	6188561.63
Showroom-BOZEN	Simone Serra	german	4546093.16
Showroom-BOZEN	Valerio Adami	german	5940355.45
Showroom-BOZEN	*	german	36681294.43
...			

4.4.2 SQL query using GROUPING SETS for business process 2 (production)

The following query shows the number of a certain grade for a product category in a specific year. The query also shows the number of a certain rating in a certain year.

```

1 SELECT product_category, year_actual,
2       quality_control_grade, count(product_id)
3 FROM warehouse.production
4 JOIN warehouse.product using (product_id)
5 JOIN warehouse.date ON date.date_id = production.end_date_id
6 JOIN warehouse.quality_control using (quality_control_id)
7 GROUP BY GROUPING SETS(
8       (product_category, year_actual, quality_control_grade),
9       (year_actual, quality_control_grade));

```

Table 18: Production GROUPING SETS Result

product_category	year_actual	quality_control_grade	count
AdsH-Set	2010	0	2

product_category	year_actual	quality_control_grade	count
Arztpraxis-Set	2010	0	32
Bonsai-Set	2010	0	8
Bühnen-Set	2010	0	11
Café-Set	2010	0	9
Computer-Set	2010	0	2
Einsame-Insel-Set	2010	0	8
Forschung-Set	2010	0	3
Haushaltsgeräte-Set	2010	0	4
Heizgeräte-Set	2010	0	9
Küchen-Set	2010	0	16
Lampen-Set	2010	0	7
Masken-Set	2010	0	2
...			

5 Querying

5.1 NTILE

5.1.1 SQL query using NTILE for business process 1 (showroom visit)

The following sql statement calculates the number of visits coming from a particular location of the province of Bolzano and assigns each row to a group from 1-4, depending on the size of the number of visits.

```

1 SELECT vl.city, count(visitor_id),
2         NTILE(4) OVER (ORDER BY count(visitor_id)) AS TILE4
3 FROM warehouse.showroom_visit
4 JOIN warehouse.visitor using (visitor_id)
5 JOIN warehouse.location as vl
6     on warehouse.visitor.location_id = vl.location_id
7 WHERE vl.province = 'Bozen'
8 GROUP BY vl.city;
```

Table 19: Showroom NTILE Result

city	count	tile4
VINTL	1116	1
TOBLACH	1149	1
TERENTEN	1161	1

city	count	tile4
PRETTAU	1166	1
ENNEBERG	1172	1
GSIES	1177	1
ABTEI	1195	1
BRUNECK	1221	1
SEXTEN	1235	1
MÜHLWALD	1235	1
OLANG	1241	1
GAIS	1250	1
CORVARA	1254	1
...		

5.1.2 SQL query using NTILE for business process 2 (production)

The next sql query averages all processing times of an operator and groups them to 4 groups, where each operator gets assigned to a specific group relatively to the average of duration of all production steps.

```

1 SELECT operator_name , ROUND(avg(duration)::numeric,2) as avg,
2       NTILE(4) OVER (ORDER BY avg(duration)) AS TILE4
3       FROM warehouse.production
4       JOIN warehouse.operator using (operator_id)
5       GROUP BY operator_name;
```

Table 20: Production NTILE Result

operator_name	avg	tile4
Machaela Moser	43.51	1
Clemens Bauer	44.01	1
Patrick Haas	44.19	1
Machaela Schmid	44.20	1
Alexander Wallner	44.25	1
Martina Wagner	44.33	1
Georg Steiner	44.40	1
Tanja Lehner	44.43	1
Johanna Maier	44.51	1
Viktoria Schmidt	44.52	1
Maximilian Schmid	44.56	1

operator_name	avg	tile4
...		

5.2 RANK

5.2.1 SQL query using RANK for business process 1 (showroom visit)

The following query identifies the overall total number of visits per showroom and ranks them according to their number of visits.

```

1 SELECT showroom_name, count(distinct visitor_id),
2     RANK() OVER (ORDER BY count(distinct visitor_id) DESC)
3 FROM warehouse.showroom_visit
4 JOIN warehouse.showroom using (showroom_id)
5 GROUP BY showroom_name;
```

Table 21: Showroom RANK Result

Showroom	Count	Rank
Showroom-BOZEN	43863	1
Showroom-ULTEN	20032	2
Showroom-SEXTEN	18765	3
Showroom-MÖLTEN	18711	4
Showroom-LATSCH	18078	5
Showroom-MÜHLBACH	15183	6
Showroom-SALURN	14788	7
Showroom-RATSCHINGS	13442	8
...		

5.2.2 SQL query using RANK for business process 2 (production)

The following sql query ranks the different products with respect to their average raw material costs.

```

1 SELECT product_category, ROUND(avg(raw_material_cost)::numeric,2),
2     RANK() OVER (ORDER BY (avg(raw_material_cost)) DESC)
3 FROM warehouse.production
4 JOIN warehouse.product using (product_id)
5 GROUP BY product_category;
```

Table 22: Showroom RANK Result

Product_category	AVG_raw_material_cost	Rank
Himmelsphänomene-Set	373.96	1
Sekretär-Set	357.47	2
Pflanzendeko-Set	345.56	3
Urkunden-Set	324.72	4
Melonen-Set	319.97	5
Regal-Set	317.39	6
Zitrus-Set	315.05	7
Kisten-Set	314.72	8
Frosch-Set	312.50	9
Birnen-Set	312.47	10
...		

5.3 WINDOWING Clause

5.3.1 SQL query using a WINDOWING clause for business process 1 (showroom visit)

The following windows clause query shows the total sum of orders of a particular day. In addition, using the functionality of a window function, the average of the last 7 days is shown.

```

1 SELECT date_actual, this_day, average_last_7_days
2 FROM (
3     SELECT date_actual, year_actual, sum(order_total_price)
4         as this_day,
5         ROUND(AVG(SUM(order_total_price))
6             OVER ( ORDER BY date_actual
7                 ROWS BETWEEN 7 PRECEDING
8                 AND CURRENT ROW)::numeric,2)
9             as average_last_7_days
10    FROM warehouse.showroom_visit
11   JOIN warehouse.date using (date_id)
12   JOIN warehouse.order using (order_id)
13   GROUP BY date_actual, year_actual
14   ORDER BY date_actual)
15 AS res where year_actual > 2017;
```

Table 23: Showroom WINDOWING Result

Date_actual	this_day	average_last_7_days
-------------	----------	---------------------

Date_actual	this_day	average_last_7_days
2018-01-01	679797.25	255967.71
2018-01-02	68135.18	229689.79
2018-01-03	187257.15	243683.57
2018-01-04	180453.50	248296.45
2018-01-05	402369.89	282831.82
2018-01-06	463596.47	301014.82
2018-01-07	427284.56	321012.68
2018-01-08	24863.57	304219.70
2018-01-09	97464.25	231428.07
2018-01-10	5871.16"	223645.07
...		

5.3.2 SQL query using a WINDOWING clause for business process 2 (production)

The following query sums the raw material costs of each month in the production. In addition, the average costs of raw material per month are calculated for the preceding six months.

```

1 SELECT year_actual, month_actual, this_month, average_last_months
2 FROM (
3 SELECT year_actual, month_actual, sum(raw_material_cost) as this_month,
4         ROUND(AVG(SUM(raw_material_cost))
5               OVER ( ORDER BY year_actual, month_actual
6                     ROWS BETWEEN 6 PRECEDING
7                           AND CURRENT ROW)::numeric,2)
8         AS average_last_months
9     FROM warehouse.production
10    JOIN warehouse.date ON date.date_id = production.end_date_id
11   GROUP BY year_actual, month_actual
12   ORDER BY year_actual, month_actual)
13 AS res where year_actual = 2018;
```

Table 24: Production WINDOWING Result

Year_actual	Month_actual	this_month	average_last_7_days
2018	1	2243166	2089025.86
2018	2	2009709	2070697.43
2018	3	2140313	2072766.71
2018	4	1898116	2048190.43

Year_actual	Month_actual	this_month	average_last_7_days
2018	5	2186836	2051346.43
2018	6	2066625	2052404.57
2018	7	2163526	2101184.43
2018	8	2175590	2091530.71
2018	9	1935040	2080863.71
2018	10	1879026	2043537.00
...			

5.4 Period-to-period Comparison

5.4.1 SQL query using period-to-period comparison for business process 1 (showroom visit)

The following query shows the total number of visits per quartal per year. In addition, it shows the same information for the year before and difference between those two years.

```

1 SELECT year_actual , quarter_actual ,
2       visits_this_year , visits_last_year ,
3       visits_this_year - visits_last_year as difference
4       FROM (
5           SELECT year_actual , quarter_actual ,
6                 count(visitor_id) as visits_this_year ,
7                 LAG(count(visitor_id), 4) OVER
8                   (ORDER BY year_actual , quarter_actual)
9                 AS visits_last_year
10          FROM warehouse.showroom_visit
11          JOIN warehouse.date using (date_id)
12          GROUP BY year_actual , quarter_actual
13          ORDER BY year_actual , quarter_actual)
14 AS last_year WHERE year_actual > 2010;
```

Table 25: Production period-to-period comparison result

Year_actual	Quarter_actual	Visits_this_year	Visits_last_year	Difference
2011	1	9567	9775	-208
2011	2	5171	5993	-822
2011	3	3368	4018	-650
2011	4	8915	9975	-1060
2012	1	12976	9567	3409
2012	2	8003	5171	2832
2012	3	5096	3368	1728

Year_actual	Quarter_actual	Visits_this_year	Visits_last_year	Difference
2012	4	12760	8915	3845
2013	1	12049	12976	-927
2013	2	6377	8003	-1626
2013	3	4503	5096	-593
2013	4	11470	12760	-1290
...				

6 Data Analysis Tool

The two chosen visualization tools are on the one hand, Python with pyplot from the library matplotlib and on the other hand, Power BI from Microsoft. The business questions are visualized by using pyplot whereas one ROLLUP query is visualized as sunburst diagram within the Power BI environment (screen shot in figure 12). In the environment one is able to interact with the diagram in order to differentiate between different hierarchies.

6.1 Business questions

- Which is the best running showroom 7
- Where are the customers from 8 and 9
- Which department are the customers the most interested in 10
- Compare the number of visitors for a time period and/or showroom 11

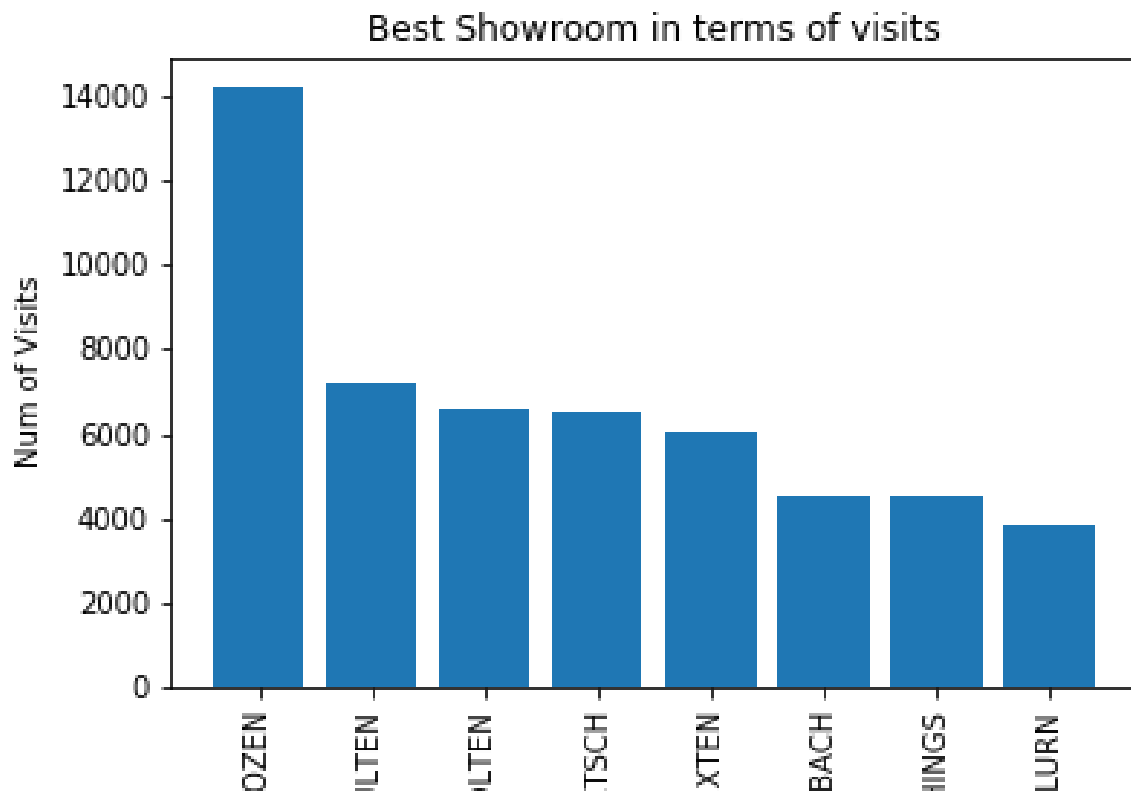


Figure 7: Best running Showroom

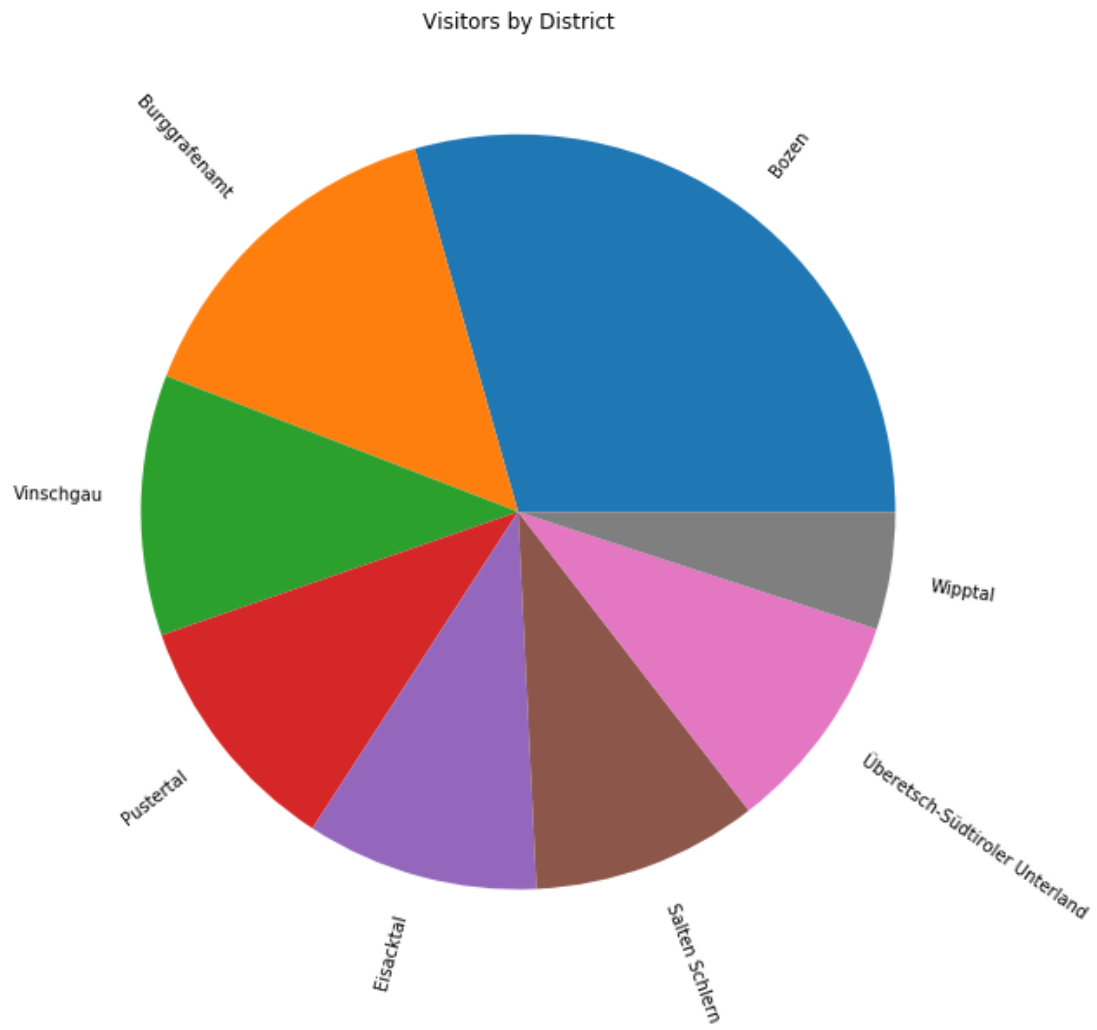


Figure 8: Customer District

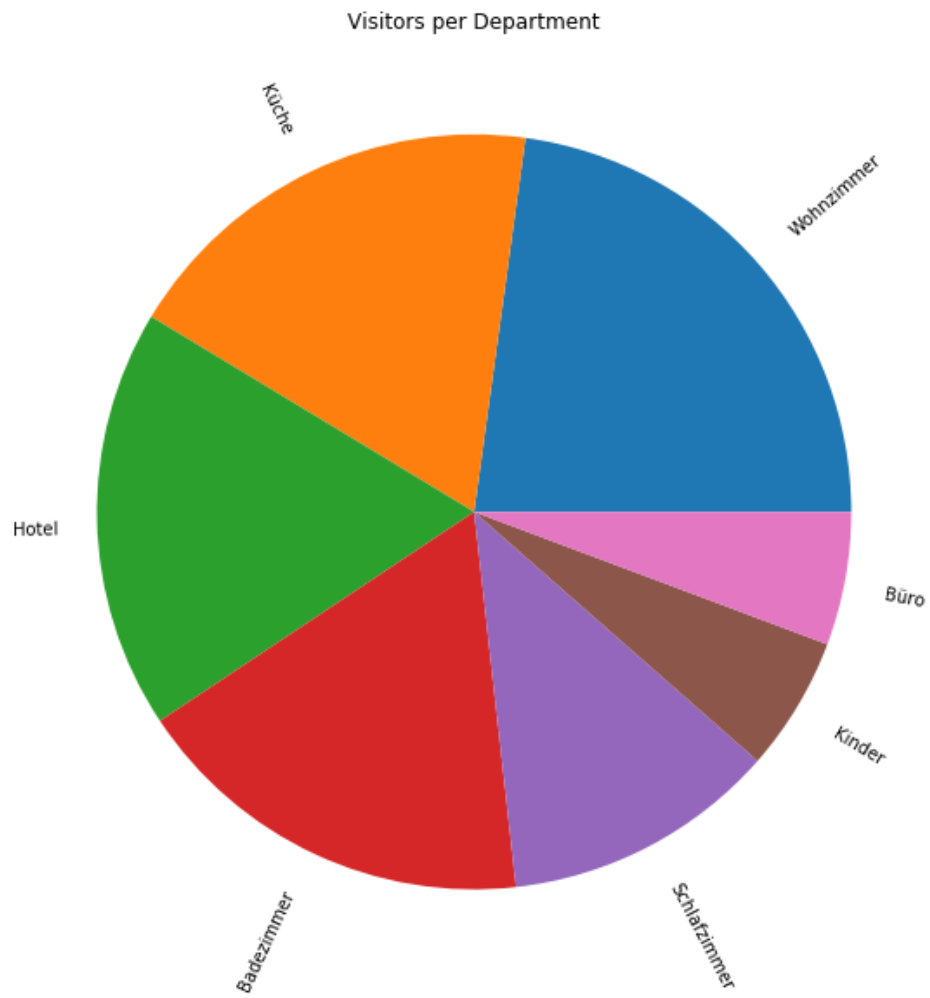


Figure 10: Visitors per Department

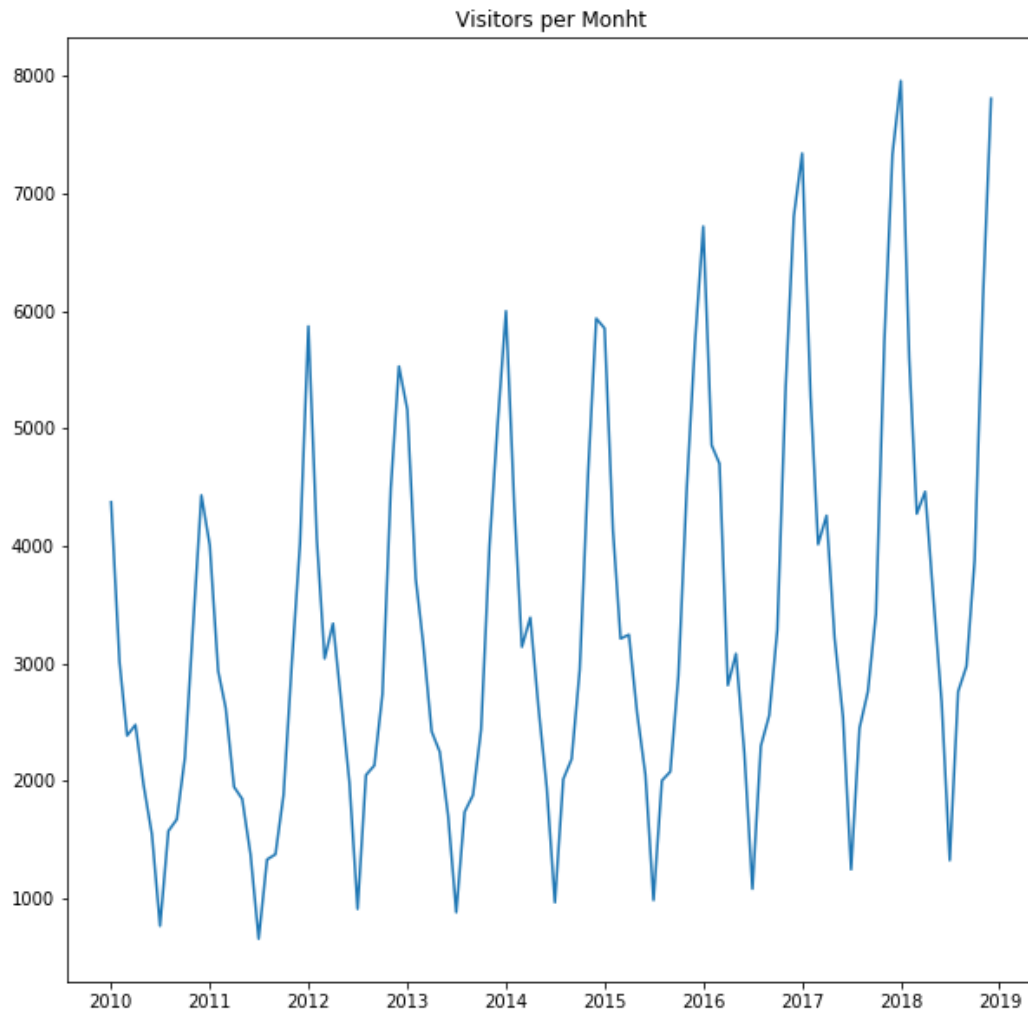


Figure 11: Visitors per Month

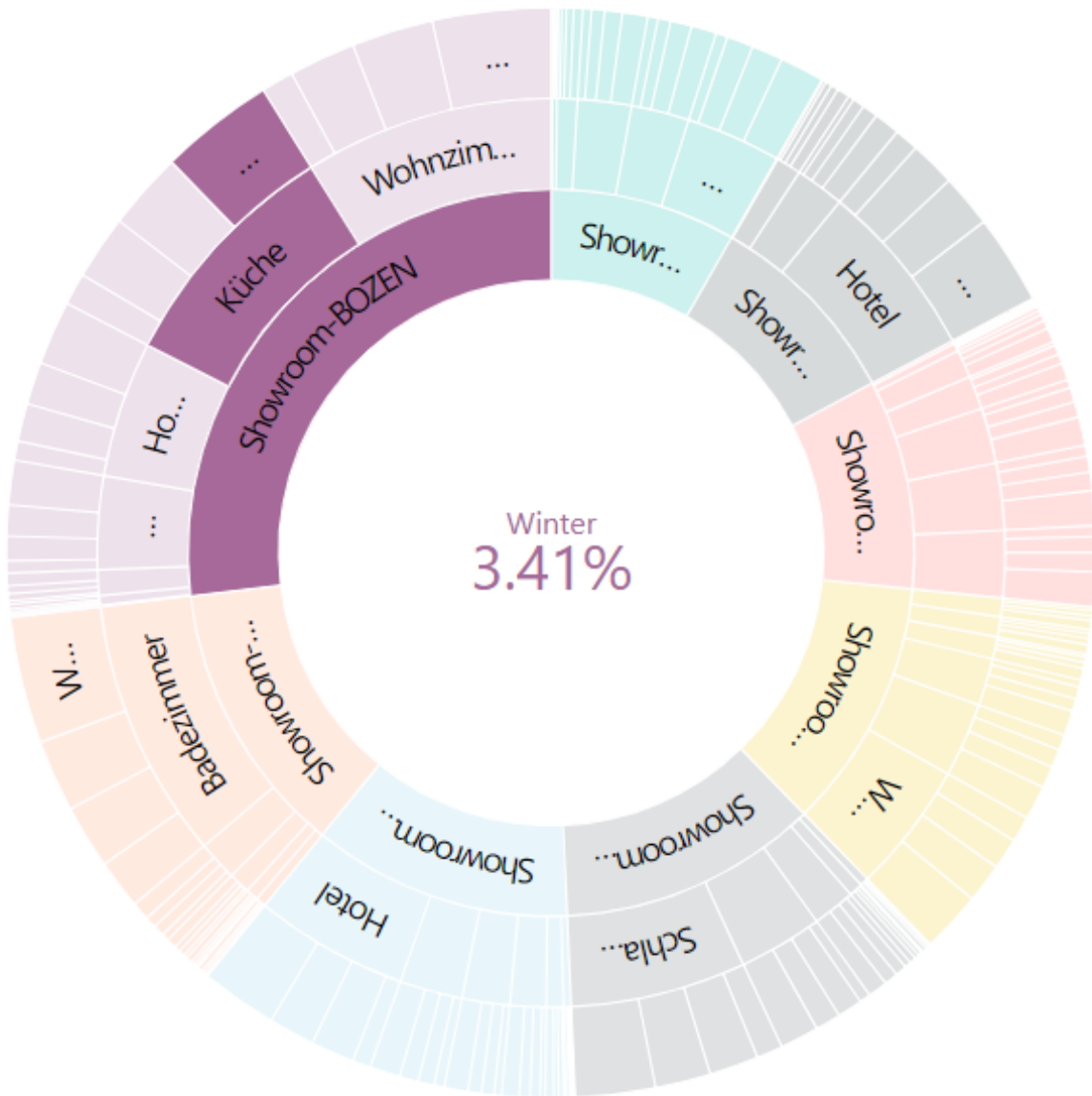


Figure 12: Sunburst Diagram of ROLLUP query