The Knowledge Destination –
Customer-based Knowledge through
Business Intelligence

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Östersund
• Knowledge Destination
  – Knowledge Destination Framework
  – Knowledge Destination Architecture

• BI-based Destination Management Information System
  – Destination Data Warehouse Model
  – Examples for Knowledge Generation
  – DMIS-Prototype

• Conclusion & Outlook
Knowledge Destination

• **Tourism destination**: Strategic unit in Travel & Tourism
  
  – **Competitiveness of destination** ⇔ attractiveness, **potential to adapt to** customer needs

• **Knowledge need** for innovation,... resource re-configuration, self-transformation...

• **Learning Tourism Destination**
  
  – **External knowledge** to develop strategic options ⇔ **inclusion of customer**

  – Networked **ICT infrastructure** and **services collecting data for creating**, applying and disseminating **new knowledge**
Knowledge Destination

• Majority of tourism information, transactions and communication processes **electronically**
  – Customer traces during all trip phases ➔ **large quantity and variety** of **customer-based data** in destinations...
    • Transaction data, CRM data, survey data... [*Data bases]*
    • Navigation & search data, UGC,... [*Web Servers]*
  – ... large data amount remains **unused**

• **Solution:** *Business Intelligence-based knowledge infrastructure for destinations*

• **Business Intelligence** ⇔ **One of 10 technologies changing the world** (MIT Review 2008)
  – BI = {Data Warehousing + Data Mining} ⇔ *Data*: relaxed assumptions of AI ➔ huge in amount
  – Explosive **growth of data flows/collection, storage capacity/computing power, decreasing storage/computing costs** ➔ OS SW for AI Apps (e.g. RapidMiner™)
Knowledge Destination Framework

Knowledge application layer

Customer-oriented knowledge application
- Recommendation services
- Community services
- Location based services

Supplier-oriented knowledge application
- Decentralized access to knowledge bases (OLAP)
- Visualization of DM results

Knowledge generation layer

Customer-based knowledge generation
- Tourists feedback
- Information traces
- Mobility behavior

Supplier-based knowledge generation
- Customer profiles, products, processes, competitors and cooperation partners

Knowledge Destination Architecture

DMIS

Knowledge application layer

Interactive visualization

Knowledge generation layer

Data mining & knowledge generation

Data warehouse

Data extraction (ETL)

Structured data

Unstructured data

BI-based DMIS

Examples for knowledge generation through BI

Web Usage Mining

www.visisitare.se

Clustering ☯ Log files Aug 2008 - Mar 2009 (92,035 user sessions)
- X-Mean Clustering (2 ≤ x ≤ 30) by category change

<table>
<thead>
<tr>
<th>Category</th>
<th>Cluster 1</th>
<th>Cluster 2</th>
<th>Cluster 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Search</td>
<td>8.7% (7,980)</td>
<td>3.1% (2,830)</td>
<td>88.2% (81,143)</td>
</tr>
<tr>
<td>Duration</td>
<td>12.6 min</td>
<td>12.2 min</td>
<td>2.5 min</td>
</tr>
<tr>
<td>Selection</td>
<td>Accommodation (80% a/s 6.4)</td>
<td>Eating (100% a/s 8.4)</td>
<td>To do (28% a/s 0.7)</td>
</tr>
<tr>
<td></td>
<td>Program (29% a/s 1.9)</td>
<td>To do (33% a/s 1.6)</td>
<td>Accommodation (27% a/s 0.5)</td>
</tr>
<tr>
<td></td>
<td>To see (21% a/s 0.8)</td>
<td>To see (9.2% a/s 0.2)</td>
<td></td>
</tr>
<tr>
<td>Actions</td>
<td>Tourism (11.2%)</td>
<td>Brochure (7.6%)</td>
<td>PDF (6.8%)</td>
</tr>
<tr>
<td>Ext. Search</td>
<td>Services (17.5%)</td>
<td>Eating (13.5%)</td>
<td>Services (14%)</td>
</tr>
<tr>
<td></td>
<td>Accommodation (10.5%)</td>
<td>Services (12.5%)</td>
<td>Activities (6.6%)</td>
</tr>
<tr>
<td></td>
<td>Activities (3.1%)</td>
<td>Activities (2.1%)</td>
<td>Accommodation (6%)</td>
</tr>
</tbody>
</table>

Int. Search

<table>
<thead>
<tr>
<th>Category</th>
<th>Cluster 1</th>
<th>Cluster 2</th>
<th>Cluster 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Int. Search</td>
<td>Accommodation (22%)</td>
<td>Accommodation (17.7%)</td>
<td>Accommodation (16%)</td>
</tr>
<tr>
<td>Used after</td>
<td>Skiing (5.5%)</td>
<td>Eating (12%)</td>
<td>Services (10.2%)</td>
</tr>
<tr>
<td></td>
<td>Activities (5.1%)</td>
<td>Skiing (8.1%)</td>
<td>Skiing (8%)</td>
</tr>
<tr>
<td>Parametric</td>
<td>5.1 min</td>
<td>4.3 min</td>
<td>1.5 min</td>
</tr>
<tr>
<td>Used after</td>
<td>21% (a/s 4.4)</td>
<td>19% (a/s 4.9)</td>
<td>6% (a/s 1.9)</td>
</tr>
</tbody>
</table>

BI-based DMIS

Examples for knowledge generation through BI

Explaining cancellation behaviour

\[ \text{Decision tree} \]

C.4.5 Algorithm (accuracy 94%, $R^2 = 0.23$)

Target marketing to prevent cancellation

- **Node 2**: Days to arrival > 42 days (2.4 ↑)
- **Node 7**: Booking ski pass < 1 day (3.1↑)
- **Node 12**: First year of arrival > 2009 (8 ↑)

BI-based DMIS

Examples for knowledge generation through BI

Explaining tourist arrivals

BI-based DMIS

Examples for knowledge generation through BI

\[ Y_{jt} = \beta_0 + \beta_1 \text{GDP}_j + \beta_2 \text{EX}_5\text{EX}_j + \beta_3 \text{EX}_A\text{EX}_j + \beta_4 \text{Jet Fuel} + \beta_5 \text{Advertising}_i + \beta_6 \text{Advertising}_{(j-\text{i})} + \beta_7 \text{Online}_j + \beta_8 \text{WorldChampionship} + \beta_9 \text{Winter} + \beta_{10} \text{Y}_{(j-\text{i})} + e, \]

**Table 5. Summary of estimated coefficients of Åre destination’s major sending countries.**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Denmark</th>
<th>Russia</th>
<th>Norway</th>
<th>UK</th>
<th>Finland</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP</td>
<td>14.882</td>
<td>41.015</td>
<td>17.412</td>
<td>5.830</td>
<td>-3.814</td>
</tr>
<tr>
<td>EX_s</td>
<td>1.681*</td>
<td>10.482</td>
<td>-.0141</td>
<td>-.001</td>
<td>.090</td>
</tr>
<tr>
<td>EX_A</td>
<td>-99.483*</td>
<td>-43.907</td>
<td>.0174</td>
<td>.071</td>
<td>-3.79*</td>
</tr>
<tr>
<td>Advertising_{(j-\text{i})}</td>
<td>2.748</td>
<td>53.401*</td>
<td>10.814*</td>
<td>-2.071</td>
<td>-24.129*</td>
</tr>
<tr>
<td>Advertising_{(j-k)}</td>
<td>3.582</td>
<td>82.573*</td>
<td>11.480*</td>
<td>1.232</td>
<td>-</td>
</tr>
<tr>
<td>Online</td>
<td>33.612</td>
<td>-114.582*</td>
<td>33.276</td>
<td>10.031</td>
<td>272.888*</td>
</tr>
<tr>
<td>WorldChampionship</td>
<td>-4940.242*</td>
<td>-3298.392</td>
<td>-5590.943*</td>
<td>-1029.890</td>
<td>-16754.219*</td>
</tr>
<tr>
<td>Winter</td>
<td>6984.531*</td>
<td>3537.121*</td>
<td>4357.733*</td>
<td>907.501*</td>
<td>1283.411</td>
</tr>
<tr>
<td>Y_{(j-\text{i})}</td>
<td>-.0401*</td>
<td>-.210*</td>
<td>.031</td>
<td>.443*</td>
<td>.201</td>
</tr>
</tbody>
</table>

**Model Statistics**

F-statistics: 67.292, 8.456, 8.794, 44.753, 19.188
Prob. (F-statistics): .000, .000, .000, .000, .000
Durbin-Watson: 1.712, 2.168, 1.907, 2.382, 2.001
R^2: .932, .628, .645, .901, .779

Note: *Significance level < .05;
Lag-periods for the lagged advertising variables Advertising_{(j-\text{i})} and Advertising_{(j-k)}: Denmark (i = 3; k = 6), UK (i = 3; k = 6); Norway (i = 6; k = 10); Russia (i = 1; k = 9); Finland (i = 9).
Lag-periods for the lagged dependent variable Y_{(j-\text{i})}: Denmark (i = 11), UK (i = 12); Norway (i = 10); Russia (i = 10); Finland (i = 9).

DMIS Prototype

Website statistics

<table>
<thead>
<tr>
<th>indicator</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>total visits (sessions)</td>
<td>28802</td>
</tr>
<tr>
<td>unique visitors</td>
<td>16058</td>
</tr>
<tr>
<td>total page views</td>
<td>87372</td>
</tr>
<tr>
<td>average pages per visit</td>
<td>3.034</td>
</tr>
<tr>
<td>average visit time in seconds (session length)</td>
<td>87.665</td>
</tr>
<tr>
<td>average time on single page in seconds</td>
<td>26.292</td>
</tr>
</tbody>
</table>

Details on clicks and sessions

Clicks by
- Day in week
- Item
- Day time
- Hours of the day
- Day in week
- Weekend
- Week
- Season
- Quarter
- Month
- Year
- Country
- City
- URI
- Referral website

Visits (sessions) by
- Hours of the day
- Day time
- Day in week
- Weekend
- Week
- Season
- Quarter
- Month
- Year
- Country
- City
- Referral website
- Referral type
DMIS Prototype

- Booking
  - Skistar
  - Tott

- Web Navigation
  - DMO
    - Tott
  - Copperhill

- Feedback
  - DMO surveys (Winter/Sommer)
  - eCRST (Customer Registration)
  - UGC (User Generated Content)
  - Copperhill
  - Tott

- Cross-process and cross-partner analyses
- Process-specific but cross-partner analyses
- Process- and partner-specific (data source specific) analyses
e-Customer Registration & Survey Tool

- Customer profile
- Information about visit
- Ad-hoc feedback

Survey registration

- Type of accommodation
  - Hotel
  - Camping
  - Rented cottage
  - Own cottage
  - Rented apartment
  - Own apartment
  - Accommodation owned by relatives or friends
  - Other

- Accommodation area
  - Åre village
  - Björnen
  - Tegelfjäll
  - Duvet
  - Other

- Date of arrival
- Date of departure

- Number of adults in your travel group
- Gender

- Number of children in your travel group
- Year of birth

- Country of residence

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VI BEHÖVER DIN HJÄLP!

REGISTRERA DIG på Åres gästundersökningspanel genom att besöka denna webbsida. Dina erfarenheter och uppfattningar om ditt besök är mycket viktiga för Åres utveckling.

Du kan vinnas fins priser!

www.are360.com/survey
Cold beds
Text data mining → opinion mining (polarity)

1) Document selection ⇔ Are hotels on leading review portals

<table>
<thead>
<tr>
<th></th>
<th>No. of Hotels</th>
<th>No. of e-reviews</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tripadvisor.com</td>
<td>10</td>
<td>248</td>
</tr>
<tr>
<td>Booking.com</td>
<td>17</td>
<td>1193</td>
</tr>
</tbody>
</table>

2) Document Processing

- Extract review texts from HTML documents
- Remove reviews with no text, filter English texts only
- Generate single statements

<table>
<thead>
<tr>
<th></th>
<th>No. of reviews</th>
<th>No. of statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>tripadvisor.com</td>
<td>127</td>
<td>1296</td>
</tr>
<tr>
<td>booking.com</td>
<td>81</td>
<td>220</td>
</tr>
<tr>
<td>Total</td>
<td>208</td>
<td>1516</td>
</tr>
</tbody>
</table>

DMIS Prototype

3) Mining

**Machine Learning** (*Naïve Bayes, SVM, k-NN*) ⇔ **Dictionary-Based**

- **Property recognition** ⇔ 100 training data/method, 7 classes
- **Subjectivity recognition** ⇔ 300 training data/method, 6,800 opinion words (Liu 2008)
- **Sentiment recognition** ⇔ 250 training data/method; 2,000 pos., 4,800 neg. words

4) Evaluation

<table>
<thead>
<tr>
<th>Method</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Property recognition</strong></td>
<td></td>
</tr>
<tr>
<td>SVM (with POS tagging)</td>
<td>72.36%</td>
</tr>
<tr>
<td>Naïve Bayes (with POS tagging)</td>
<td>49.72%</td>
</tr>
<tr>
<td>k-NN (with k = 8)</td>
<td>57.08%</td>
</tr>
<tr>
<td>Dictionary-based</td>
<td>71.28%</td>
</tr>
<tr>
<td><strong>Subjectivity recognition</strong></td>
<td></td>
</tr>
<tr>
<td>SVM</td>
<td>65.50%</td>
</tr>
<tr>
<td>Naïve Bayes</td>
<td>60.67%</td>
</tr>
<tr>
<td>k-NN (with k = 5)</td>
<td>55.50%</td>
</tr>
<tr>
<td>Dictionary-based</td>
<td>82.63%</td>
</tr>
<tr>
<td><strong>Sentiment recognition</strong></td>
<td></td>
</tr>
<tr>
<td>SVM (with bigrams)</td>
<td>76.80%</td>
</tr>
<tr>
<td>Naïve Bayes (with trigrams)</td>
<td>69.80%</td>
</tr>
<tr>
<td>k-NN (with k = 8)</td>
<td>69.60%</td>
</tr>
<tr>
<td>Dictionary-based</td>
<td>71.28%</td>
</tr>
</tbody>
</table>

### DMIS Prototype

**The destination management information system in tourism**

<table>
<thead>
<tr>
<th>Date</th>
<th>Source</th>
<th>Hotel Name</th>
<th>Feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>February, 2013</td>
<td>tripadvisor.com</td>
<td>Tott Hotell</td>
<td>This is a perfect hotel both with or without kids. We arrived on a Saturday morning, parked outside minutes. The after ski at Fjellgården nearby is tremendous and downtown Åre is just a walk or a shuttle. I stayed for a 4 day ski week end. I had a family room, a bit pricy but very comfortable and convenient. I truly speak English and I was told to book by internet very useful. Hotel is at 5 min walk from the village. Restaurant and bars are good and serve international cuisine. Yes, a place to recommend, not for romantic week end but, definitely yes for the ski.</td>
</tr>
<tr>
<td>February, 2013</td>
<td>tripadvisor.com</td>
<td>Tott Hotell</td>
<td>I’ve been there during company conference - it’s probably a great spot for skiers. I’m not one of the regulars but I really enjoyed the stay. Rooms quality was quite good; service has some problems talking in English (I’ll try again next time) but the disadvantage of this place (excl breakfasts) - it was cold so many times that I started to thing about the cold meals!</td>
</tr>
<tr>
<td>February, 2013</td>
<td>tripadvisor.com</td>
<td>Tott Hotell</td>
<td>The situation is perfect. Rooms are ok, small kitchenette was nice surprise. The spa is very nice for those who want to relax. The hotel staff was very helpful. I’ll stay here next time.</td>
</tr>
<tr>
<td>February, 2013</td>
<td>tripadvisor.com</td>
<td>Holiday Club Hotell</td>
<td>Excellent resort with plenty of options for wintersports. Holiday club excellent for families as it is close to the slopes and sauna complex to chill out, sports bar and reception bar rather characterless. Large general area and an indoor link to shopping mall. Food excellent quality and choice. Good service to meeting rooms. Room was fold out bed with curtain - great for sharing. Views from rooms better on higher floors. Storjӓr are arriving my room was not available ans sent away - kinder to offer somewhere for luggage and enl</td>
</tr>
</tbody>
</table>

**UGC | Dashboard | OLAP reviews | OLAP statements | choose another data pool here:**

- Data -

**Select**
DMIS Prototype
DMIS Prototype

![DMIS Prototype Image]

**Table: Average Feedback Value of Review Statements**

<table>
<thead>
<tr>
<th>Items</th>
<th>Copperhill Mountain Lodge</th>
<th>Diplomat Årehotel</th>
<th>Fjällgården Hotel</th>
<th>Holiday Club Hotel</th>
<th>Karolinen Hotel</th>
<th>STF Hotel</th>
<th>Are Bed &amp; Breakfast</th>
<th>Are Continental Inn</th>
<th>Granen &amp; Residences, Hotel</th>
<th>Mårtensliens Gård</th>
<th>AGO Mitt &amp; Park</th>
<th>Are</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food/Breakfast</td>
<td>0.478</td>
<td>0.704</td>
<td>1</td>
<td>0.565</td>
<td>0</td>
<td>0.500</td>
<td>0.667</td>
<td>1</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Location</td>
<td>0.841</td>
<td>0.938</td>
<td>0.556</td>
<td>0.772</td>
<td>1</td>
<td>0.909</td>
<td>0.933</td>
<td>1</td>
<td>0.667</td>
<td>0</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Mixed</td>
<td>0.576</td>
<td>0.633</td>
<td>0.667</td>
<td>0.722</td>
<td>1</td>
<td>0.625</td>
<td>0.895</td>
<td>1</td>
<td>0.625</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Rooms</td>
<td>0.524</td>
<td>0.500</td>
<td>0</td>
<td>0.429</td>
<td>0.333</td>
<td>0.333</td>
<td>0.227</td>
<td>?</td>
<td>0.111</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Service/Personnel</td>
<td>0.522</td>
<td>0.750</td>
<td>0</td>
<td>0.562</td>
<td>?</td>
<td>0.500</td>
<td>0.750</td>
<td>1</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Wellness</td>
<td>0.950</td>
<td>0.778</td>
<td>?</td>
<td>0.917</td>
<td>?</td>
<td>?</td>
<td>0.857</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
</tbody>
</table>

Select: 

- UGC
- Dashboard
- OLAP reviews
- OLAP statements
- Choose another data pool here: - Data - [select]
DMIS Prototype

Cross-process and cross-partner analyses

Process-specific but cross-partner analyses

Process- and partner-specific (data source specific) analyses
### Frequently viewed product areas on websites

<table>
<thead>
<tr>
<th>Group by attribute</th>
<th>Total bookings</th>
<th>Total clicks</th>
<th>Total feedback, answers</th>
<th>Total sessions</th>
<th>Average booking price in SEK</th>
<th>Average number of persons per booking</th>
<th>Average time between booking and arrival in days</th>
<th>Average stay duration per booking</th>
<th>Average time spent on single webpage in seconds</th>
<th>Average visit time on websites in seconds</th>
<th>Average pages visited on websites</th>
<th>Average feedback value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finland</td>
<td>3155</td>
<td>4543</td>
<td>1039</td>
<td>893</td>
<td>7852.046</td>
<td>4.386</td>
<td>95.536</td>
<td>6.160</td>
<td>16.915</td>
<td>100.814</td>
<td>5.087</td>
<td>0.812</td>
</tr>
<tr>
<td>France</td>
<td>25</td>
<td>2923</td>
<td>12</td>
<td>739</td>
<td>4616</td>
<td>3.040</td>
<td>38.318</td>
<td>5.042</td>
<td>19.187</td>
<td>82.978</td>
<td>3.955</td>
<td>0.715</td>
</tr>
<tr>
<td>Germany</td>
<td>105</td>
<td>3268</td>
<td>150</td>
<td>665</td>
<td>5307.040</td>
<td>3.155</td>
<td>124.426</td>
<td>6.644</td>
<td>13.377</td>
<td>82.701</td>
<td>4.914</td>
<td>0.837</td>
</tr>
<tr>
<td>Spain</td>
<td>13</td>
<td>1096</td>
<td>0</td>
<td>305</td>
<td>4776.231</td>
<td>3.231</td>
<td>35.385</td>
<td>3.846</td>
<td>13.889</td>
<td>64.287</td>
<td>3.593</td>
<td>0</td>
</tr>
<tr>
<td>Sweden</td>
<td>50073</td>
<td>162942</td>
<td>36880</td>
<td>39139</td>
<td>5023.956</td>
<td>3.860</td>
<td>83.014</td>
<td>5.498</td>
<td>17.407</td>
<td>84.981</td>
<td>4.163</td>
<td>0.773</td>
</tr>
<tr>
<td>Switzerland</td>
<td>48</td>
<td>1398</td>
<td>0</td>
<td>292</td>
<td>4282.787</td>
<td>3.149</td>
<td>51.023</td>
<td>4.957</td>
<td>14.687</td>
<td>84.761</td>
<td>4.788</td>
<td>0</td>
</tr>
<tr>
<td>Hungary</td>
<td>2</td>
<td>82</td>
<td>0</td>
<td>33</td>
<td>1480</td>
<td>2</td>
<td>61.500</td>
<td>1</td>
<td>15.917</td>
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Conclusion

- **Step towards BI-based Knowledge Destination**
  - Knowledge *generation* ⇔ customer processes **Web Navigation**, Booking, Feedback
  - Knowledge *application* ⇔ DMIS Cockpit **Dashboard, OLAP**
    - **Data mining** in future version (Clustering, Classification, Prediction)

- **Major project outcome**
  - Performance Indicators ⇔ Multi-Dimensional Destination Data Model
  - Architectural DMIS Framework ⇔ Testable Prototype
Outlook

**DMIS II Project**: Enhanced experience quality & dynamic need fulfilment through **Real-Time Business Intelligence** during **on-site** phase (ERUF Halland Region 2016-2017)

**M-CRM Apps**
Promising experience opportunities in RT (crowd situation, mood at POIs,...)

**Enhanced DMIS**
RT service recovery, RT insights in supply shortages, query redistribution in SBN,...

**Knowledge application layer**
- Customer-oriented knowledge application
  - Recommendation services
  - Community services
  - Location based services

**Knowledge generation layer**
- Supplier-oriented knowledge application
  - De-centralized access to knowledge bases (OLAP)
  - Visualization of DM results

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**Customer-based knowledge generation**
- Tourists feedback
- Information traces
- Mobility behavior

**Supplier-based knowledge generation**
- Product profiles, suppliers (web-sites), availability (booking engines)
- Cooperation (market basket)

**RT customer data**
QR Codes POIS, Ad-hoc feedback,...

**Digital Destination Eco System**
Thank you!
References


