

Consumer responses to shelf-out-of-stocks and implications for retail ordering systems

*Karel van Donselaar and Tom van Woensel
Eindhoven University of Technology
The Netherlands*

Research questions

1. How do consumers behave when their preferred product is out of stock?
2. How to incorporate knowledge on consumer buying behaviour in Automated Store Ordering systems?

Research environment

- 3 supermarkets from major Dutch retailer
- data gathered during 7 days
- selected product type: bread
bread is fresh in supermarket for 1 day only ->
trade-off between customer service and waste



Research methodology

Data were gathered by 12 students via:

- Interviews
 - Over 3000 customers
 - Both personal characteristics and buying behaviour
- Performance measurement
 - Shelf-availability per SKU during the day
 - Waste

Customer data

- Personal characteristics, e.g.
 - Gender
 - Family size
 - Estimated age
- Buying behaviour, e.g.
 - Regular/incidental customer
 - Preferred bread,
 - Out of stock-behaviour (substitute, come back later, buy elsewhere)
 - Alternative bread (real or hypothetical)

Results data analyses

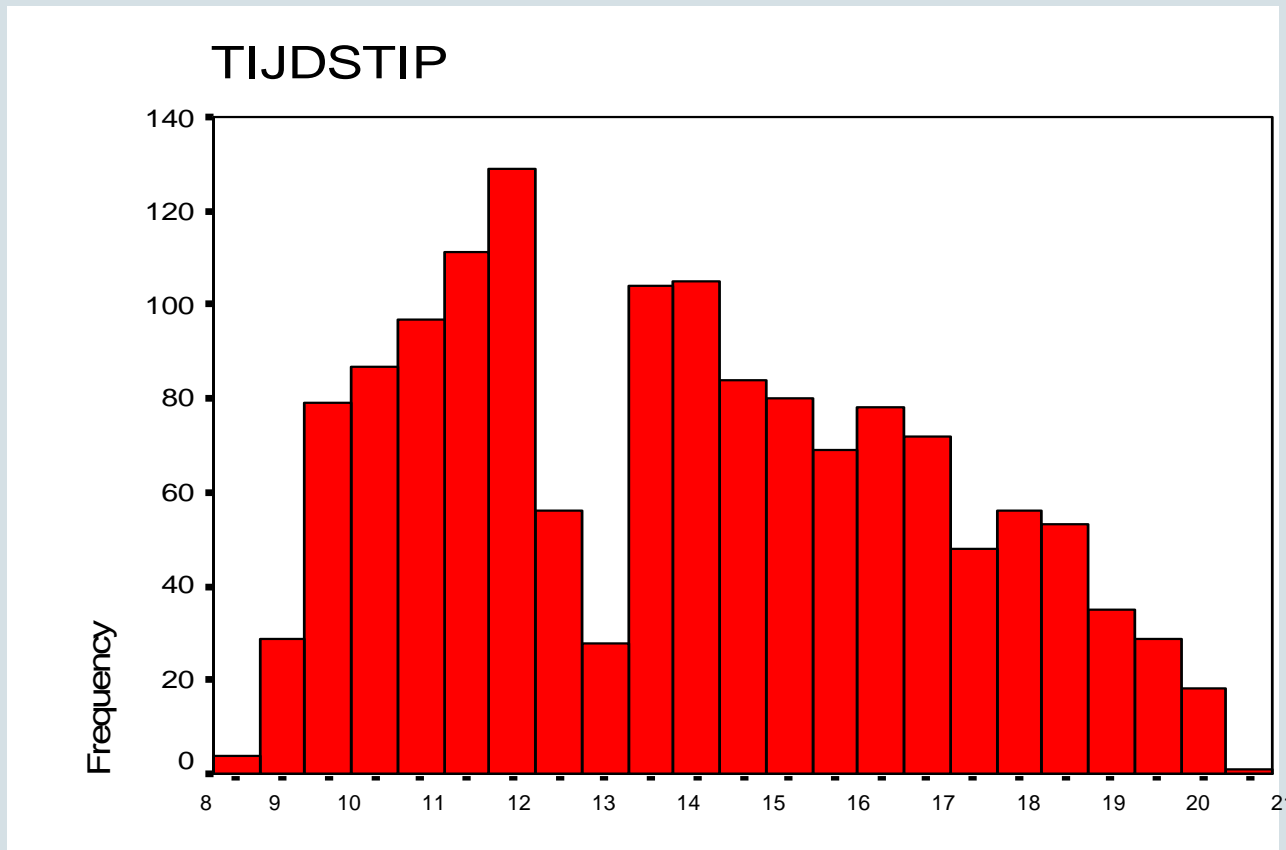
Data analysis on product-characteristic-level i.o. SKU-level, since:

1. Most customers reply in these terms
2. The number of SKU's for bread (~ 100) is too large to accurately estimate substitution probability from SKU i to SKU j

Some results:

- Number of bread customers through the day
- Willingness to substitute
 - Dependent on supermarket
 - Dependent on product characteristics
- Asymmetry in substitution behaviour
- ...

Number of bread customers through the day



Substitution behaviour (1)

	Store 1	Store 2	Store 3
Buy elsewhere	12%	8%	7%
Later	13%	4%	11%
Substitution	75%	88%	82%

Conclusions:

Willingness to substitute is very large and differs per supermarket.
 Still, even for bread 7-12% of customers facing a stock-out may go to the competitor!

Substitution behaviour (2)

In case of substitution, the customer gives different weights to different product characteristics.

The customer prefers to hold on to the following product characteristics (in decreasing order):

- *white/brown bread*
- *whole-meal bread/wheat*
- *light/dark bread*
- *bread with/without seeds*

Substitution behaviour (3)



The willingness to substitute may be asymmetric:
e.g. customers are more willing to change from
white to brown bread than vice versa

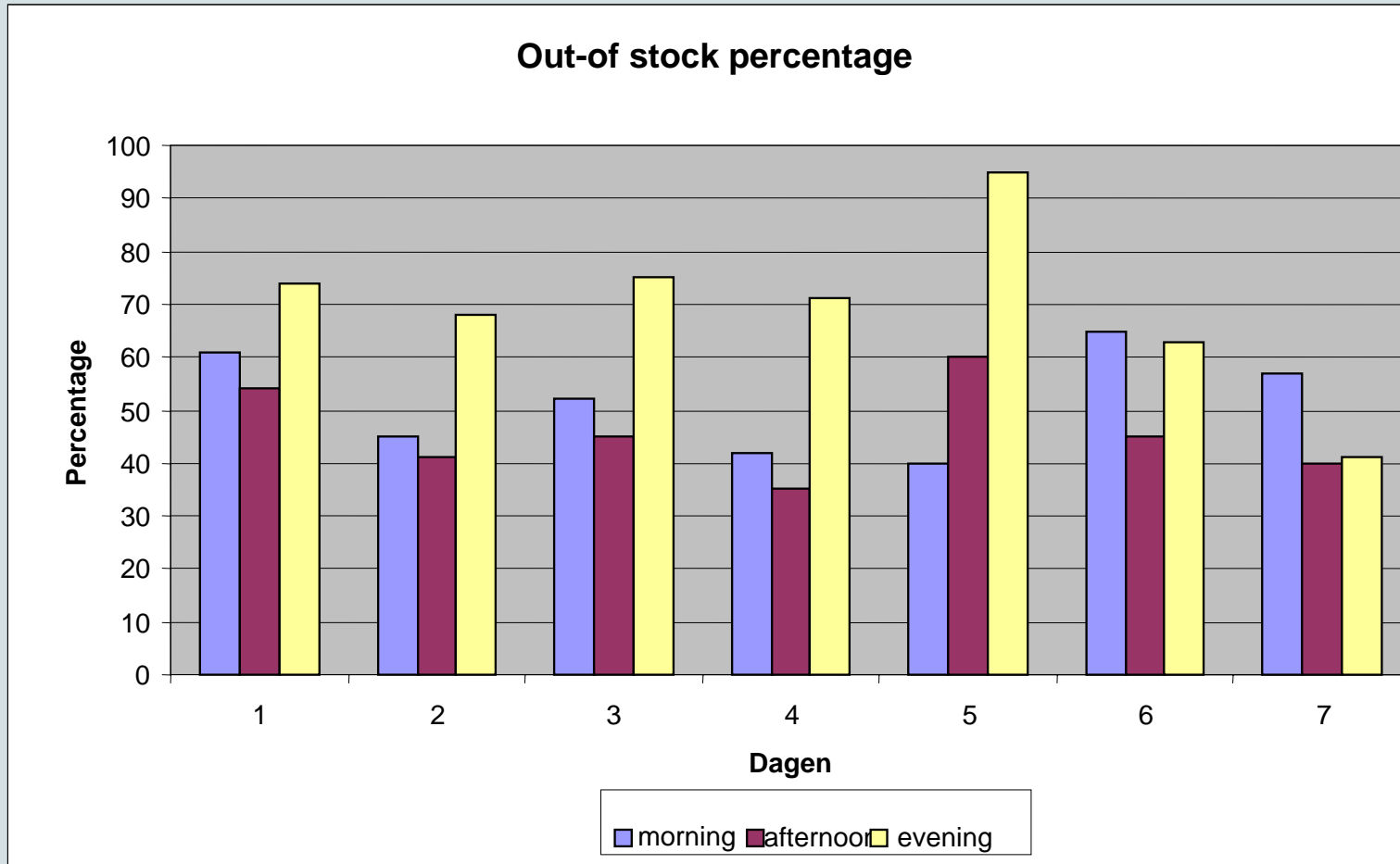
Performance measurement

Shelf availability and waste are strongly influenced by:

- The timing of the initial filling of the shelf and later replenishments
- The consistency of the assortment in the day-to-day ordering process
- The experience of the person who orders the bread

Improvement opportunity:

a decision support system for the daily ordering of the bread, which takes into account the customers' substitution behaviour.



Relevant literature

Multi-item newsboy problem with substitution:

Mahajan and Van Ryzin compare 3 potential algorithms:

- Pooled newsboy (simple, based on total number of bread)
- Independent newsboy (simple, based on orderlevel/SKU)
- Gradient algorithm (more complex)

Improvement opportunities:

- use intermediate aggregation level
- use substitution-asymmetry to differentiate target service levels
- allocate total white bread to individual SKU's based on expected demand (which can be derived from registration of o.o.s.-timing)

Conclusions

- For bread consumers are often willing to substitute. This willingness may differ per supermarket.
- Still 7-12% of the customers may (in case of a stock-out) decide to buy their bread elsewhere
- Shelf availability is strongly influenced by refilling and ordering processes
- Ordering may be improved by using knowledge on consumer buying behaviour (e.g. the product characteristic which is most essential to the consumer may determine the aggregation level in the ordering process)
- Registration of the time a SKU goes out-of-stock provides valuable input for the ordering decision at SKU-level