Space management in a DIY store analysing consumer shopping paths with data-tracking devices

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Abstract

Purpose – Space management is an essential part of successful retailing. Good space management requires accurate data about consumer behaviour. Traditionally, these data have been collected through panel interviews, camera tracking and in-store observation. Their nature is subjective to a greater or lesser extent. Modern technology makes it possible also to use more objective methods, such as the wireless local network (WLAN) and the radio frequency identification (RFID). This paper seeks to examine the possibilities WLAN provides for facilities management studies.

Design/methodology/approach – The empirical data were collected from 866 consumer shopping paths in a large do-it-yourself (DIY) store using WLAN technology. The data have been analysed with GIS tools.

Findings – The results show that WLAN has great potential for accurate and objective data collection processes and modelling. This method creates more objective results than traditional consumer tracking methods.

Research limitations/implications – Only a small amount of previous research has been done and the relevant amount of source material was very limited. This study gives new methodological viewpoints. This is also the main limitation of this study. More empirical data and analysis are definitely needed in order to achieve more reliability and validity.

Practical implications – This paper gives direct advice in the form of pros/cons for retailers in the usage of WLAN in the consumer tracking process.

Originality/value – Similar research methods have been utilised only a few times before and only in the grocery retailing industry. This is the first time a DIY store has been analysed.

Keywords Consumer behaviour, Wireless, DIY stores

Paper type Research paper

Introduction

A retail store is a dynamic and continuously changing complex. However, there are a few unchanging variables. One is the sales area where the actual retailing process is ongoing. This is also true in a do-it-yourself (DIY) shopping unit. Each store, for a given retailer, typically has a fixed number of square metres to use. If the space of one section, category or segment is to be increased, the space of another has to be reduced. Space management is a significant factor in a successful store (Soars, 2003). A good store from the space planning perspective is one where visibility and accessibility of products is maximised. In other words, an effective store typically places products along the common customer routes and in the visible range in a way that makes the customer consider buying (Underhill, 1999). The question then becomes "how can the retailer establish where their customers really walk and spend their time?"

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The advantages of effective space management for a store are an increase in the ease of store operations, sales volumes, turnover and yield on tied equity. It is important for the convenience of the consumer's shopping process, that he/she encounters or finds the desired products and product categories easily and in a logical order. The advantages of space management for a consumer are, e.g. the ease of finding products, decrease in the amount of out-of-stock products and the improvement in the freshness of products due to fast product circulation (e.g. Needel, 1998; Broniarczyk *et al.*, 1998; Sang Yong and Staelin, 1999).

Consumers' buying behaviour has been studied for many years with in-store videos and interviews (Underhill, 1999). However, according to Larson *et al.* (2005) the results of these studies are limited to general recommendations aimed only at increasing the convenience of the customers. Only a few studies with large datasets have been conducted on the customer's complete shopping paths to date. Until now this has not been possible with traditional data collecting methods (Sorensen, 2003; Larson *et al.*, 2005).

The purpose of this study is to explore the benefits and limitations of wireless local area networks (WLAN) as a data collecting method of customer traffic within the space management context. The main focus is on collecting customer traffic data with the help of the WLAN and to analyse it with different models using geographical information systems (GIS). The research questions are therefore:

(1) Can technology be used in an objective way to analyse large customer traffic datasets from a large DIY unit?

(2) From the space management point-of-view, what kind of consumer shopping path models can be developed from these datasets?

The empirical data of the study has been collected in a large, modern DIY unit located in Scandinavia. The store belongs to a large DIY chain. The study has been limited to a single store over a period of two weeks in August 2006.

Literature review

The consumer buying behaviour process inside the store has been studied for several decades. There have been attempts to research such behaviour in many different ways. Five different data collecting methods are briefly discussed: radio frequency identification (RFID), camera tracking, in-store observation, in-store interviewing and wireless local area network (WLAN).

Radio frequency identification

RFID is a common name for technologies that use radio waves to identify individual products. RFID consists of a reader and tags. A RFID tag is an object that can be attached to or incorporated into a product, animal, or person for the purpose of identification using radio waves. Chip-based RFID tags contain silicon chips and antennas. Passive tags require no internal power source, whereas active tags require a power source (e.g. Jones *et al.*, 2004). In addition to retail warehouses, the RFID technology is being used in health care, libraries and following the luggage (Juban and Wyld, 2004). RFID has also been used to track the shopping paths of customers in a store. Sorensen (2003) researched over 200,000 shopping paths in a supermarket. According to him, the number of the studied shopping paths in earlier studies has been a few hundred at its biggest. He estimates being the first, who has studied tens of thousands shopping paths in detail. In Sorensen's research the customers' shopping trolley or basket was tracked with a small tag placed at the bottom of the trolley/basket. RFID tags and trackers have, though, a relatively short operational range (only up to a few metres with passive tags) and therefore their usability in large stores are limited. Active RFID tags may have a operational range of up to 15 metres (Anderson, 2004), but high costs per unit limit their usability.

Cameras and machine recognition

By tracking the customer with a camera, the shopping paths can be studied with fair easiness (Dodd *et al.*, 1998). The gained information helps to plan product categories and customer rotation, and gives information on how long the customer stays in store and which offers or other messages he/she responses to. Phillips and Bradlow (1991) wrote how the in-store customer behaviour has been mainly studied using manual recording techniques. With this technique, the customer can be tracked around a store. Also product handling, verbal contact with the store staff and display viewing can be added to the study. It is also almost impossible to get an inclusive picture of customer behaviour throughout the whole store. The labour-intensiveness makes the technique very time consuming and difficult to obtain large sample sizes.

In a standard camera tracking survey the store is first inspected and the camera locations are selected. Trial photographs are taken to check each location. The optimum number of cameras is a compromise between the smallest possible number of cameras to minimise the amount of time spent analysing the film but having enough cameras for the adequate coverage of the store. Each camera takes one photograph once every minute (e.g. Newman *et al.*, 2002). Analysing the material is the most labour-intensive part in the camera tracking study. However, machine recognition technology has developed during past few years and therefore in the future it probably increases the effectiveness and reliability of the material analysis.

In-store observation

It is possible to observe and follow the customers also from inside the store, while they are shopping. It is very uncommon that the customer notices that he or she is being watched. A template of the store layout, on which all entrance and exit areas, tills, gondolas and special product displays have been marked, can be used in the observation and tracking. In addition, it is possible to add the specific product categories, which are being researched. When the shopper enters the store, his or hers shopping path is marked on an individual template to show where the customer stopped looking, to browse or to purchase and so on. Also the day of the week, time of the day and length of the time spend in-store are all recorded with observable characteristics of the customer. In addition, time spent at a specific location or display in store can be recorded. The individual tracking forms can be processed for analysis by computer (Johnson, 1999).

In-store interviewing

Another possible technique for collecting data on consumer behaviour in-store is interviewing the customers as they leave the store. This kind of memory-based technique, can lead to a high inaccuracy in the results. However, this technique makes it possible to collect a very inclusive picture of the customers' shopping experience (Phillips and Bradlow, 1991). A significant problem in using interviews is that it relies on the reliability of self-reporting, which is invariably inaccurate (i.e. what they say they did and what they actually did).

Wireless local area networks

People and machines can be tracked with the help of wireless local area network. Already existing wireless networks enable fast installation both indoors and outdoors. WLAN tracking system consists of a network and electronic devices, which are connected to the network. These electronic devices can be, e.g. electronic tags, which are being tracked. This technology has been used among others in healthcare centres and both mine and tunnel constructions (Martikainen, 2006).

The features of the different collecting methods are represented in Table I. WLAN and RFID are viewed as one collecting method because of their similar features.

WLAN and RFID are very similar as data collecting methods but quite dissimilar in their technical qualities. RFID is an identifying technology and not a location technology (Schwartz, 2004). When using RFID, readers must be put in the store as densely as the tag is to be recognized (i.e. if the tag is to be recognized within a two-meter radius then the readers should be placed every two meters). This is why RFID as a location technology is difficult to move from one place to another.

RFID technology has been used as the technological platform in a research by Larson *et al.* (2005). They analysed the customer routes of an American grocery market. In their study, attention was not paid to the customer's actual purchases or to

Table I.
Features of different data-collecting methods

	Advantages	Disadvantages
RFID/WLAN	Possibility to track the customer, shopping cart or basket very accurately Possibility for a very large dataset Collecting data requires very little or no work force	Memory limitations when the collected dataset is very large Possible technical disturbance and problems before and during the data collection Possible labour-intensity when setting up the system Setting up the system can be expensive but the actual collecting of the data is not
Camera tracking	Possible to study also other customer behaviour features besides the shopping paths An easy way to get a mediocre picture of the customer traffic	Labour-intensive Large datasets almost impossible to collect and analyse Accurate shopping paths almost impossible to find out especially in large stores
In-store observation	Possibility to study consumer behaviour in detail	Labour-intensive Large datasets almost impossible to collect and analyse
In-store interviewing	Possibility for an inclusive picture of customer's shopping experience	Relies on self-reporting, which makes the results inaccurate Labour-intensive

different sales tactics of the store. A RFID tag had been placed at the bottom of every shopping trolley and was located at intervals of five seconds. Locating RFID readers had been placed throughout the store. Larson *et al.* (2005) did valuable work especially on changing the routes of different lengths to a comparable format. They analysed the data by the grouping algorithm developed by them. It made the handling of the big spatial information possible quantitatively. In the study 27,000 shopping paths were collected. The tracking of the route was stopped when the customer pushed the trolley through the cash desk area. Every third route was analysed. The customer routes varied between two minutes and two hours. One customer could be located as many as 1,500 times.

Data collection

For this study, WLAN was chosen as the data collecting method. It was chosen because the tracking system's easy installation in a large store, the possibility of collecting large datasets, the objectivity of the collecting method, the possibility to track customer with less than one meter accuracy, and the portability of the tracking system to other stores in the chain,

The data of this study was collected in a modern DIY store in Scandinavia. The dataset was collected by locating a tag carried by the shopping customer. The tags were tracked using a system measuring signal strengths. The tags sent continuous signal and the actual location was calculated by a server using triangular network algorithms.

The store of this study has more than 20 departments. There are four services points and an information desk in the store. There is also a small cafeteria located in connection with the main entrance. The store has a total of 5,100 square metres of selling space. A detailed plan can be seen in Figure 1.

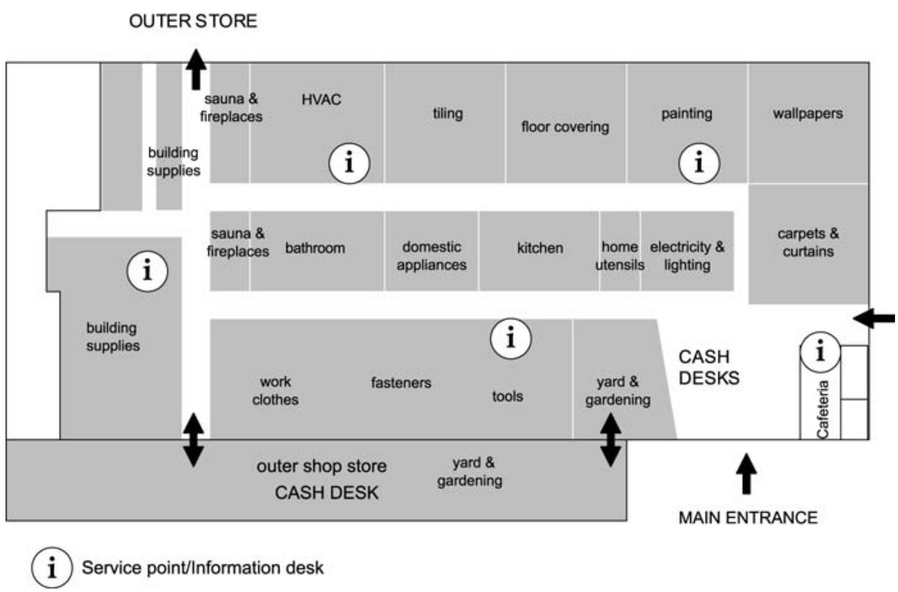

Figure 1.
Departments of the store

A total of 30 tags were used over a period of two weeks in August 2006. Data was collected from four to six hours per day. The customer routes were located every day with variance between mornings and evenings so that after the collecting period tracked shopping paths could be found from nearly all opening hours from different days of the week. The store was open on weekdays from 7 O'Clock in the morning to 8 O'Clock in the evening. On Saturdays the store was open from 9 am to 3 pm. The data was collected neither during the first opening hour of the morning, nor during the last opening hour of the evening. The sample size of the study was 866. An average of 72 shopping paths was located during one day. The number of the tracked shopping paths per day varies between 60 to 93.

A scanning circuit located the tag at intervals of ten seconds. The customer received the tag immediately at the entrance area of the shop. The customer was given instructions to keep the tag with him/her during the whole shopping trip and to give it to the nearest cash desk when leaving the store. If there were several people in the shopper group, the same person was required to carry the tag at all times. When the customer was given the tag, the identification number of the tag, time, gender and age of the customer, and the size of the group were recorded. The customer was not asked directly any information. Instead the background information is an estimation of the research assistant, who collected them. Research assistant's personal beliefs and attitudes could have affected the observations. This is a weakness in this study. In other words, the background data is subjective whilst the shopping path data is objective. The age was approximated and there were four different groups. These groups were 18 to 30 years, 30 to 45 years, 45 to 60 years and over 60 years. A typical customer in this study was 30 to 45 years old, male and shopping alone.

Accepting the tag was entirely voluntary. By accepting the tag, the customer gave permission to track his/her shopping paths in the store. The majority of the customers to whom the tag was offered to, chose to take it. On average one fifth of customers refused it. The number of the customer to whom the tag was offered to, the number of customers who refused it, and their relative proportion can be seen in Table II.

Analysis

The dataset of this study was analysed with different methods to those used by Larson *et al.* (2005) in their study. The whole sample of the study was analysed by modelling with the help of spreadsheets, statistical software and GIS software. The GIS software was particularly used in the graphic representation process. The models represented here concentrated on studying the customer traffic as a whole instead of explaining individual shopping paths. In the following figures customer traffic has been analysed with 130 different customer routes, according to the previously presented four different models.

In the first model all the locations are marked on the base plan of the store as pixels (Figure 2). In this way detailed data can be obtained about which parts of the store the customers move in. The location accuracy is less than half a metre at best using this method. The weakness of this pixel model is that the map cannot resolve between coincident paths, if there have been more shoppers in one pixel. In particular, the amount of the locations in smaller aisles cannot be easily verified from this kind of figure.

Time	Week 1						Week 2						Σ
	Thursday	Friday	Saturday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Monday	Tuesday	Wednesday	
Were offered the tagging device	79	79	107	80	85	90	99	110	100	88	82	83	1,082
Refused tagging device	10	19	25	16	17	21	25	17	24	19	10	13	216
Proportion of refusers (%)	12.7	24.1	23.4	20.0	20.0	23.3	25.3	15.5	24.0	21.6	12.2	15.7	20.0

Table II.
Proportion of refusers

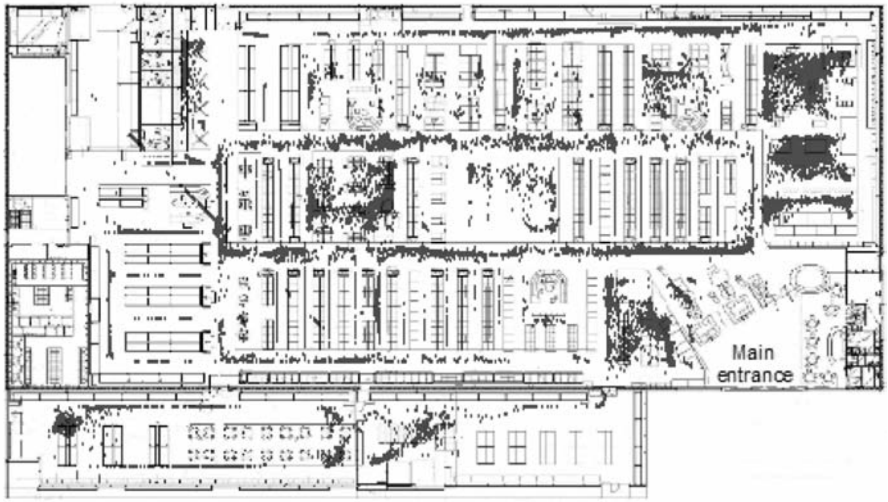

Figure 2.
Pixel model

In the second model, the large square model (Figure 3), the base plan of the store is divided into 21 squares in the horizontal direction and into 11 squares in the vertical direction. This way 219 different squares locations were formed to the base plan. A total of 182 of these squares included tracked customer locations. The rest 37 squares are located in areas, which were inaccessible to the customers, in the cafeteria or near the entrance doors. The area of one square is about 25 square metres in reality. The disadvantage of this model is the large size of the squares. This is why the location

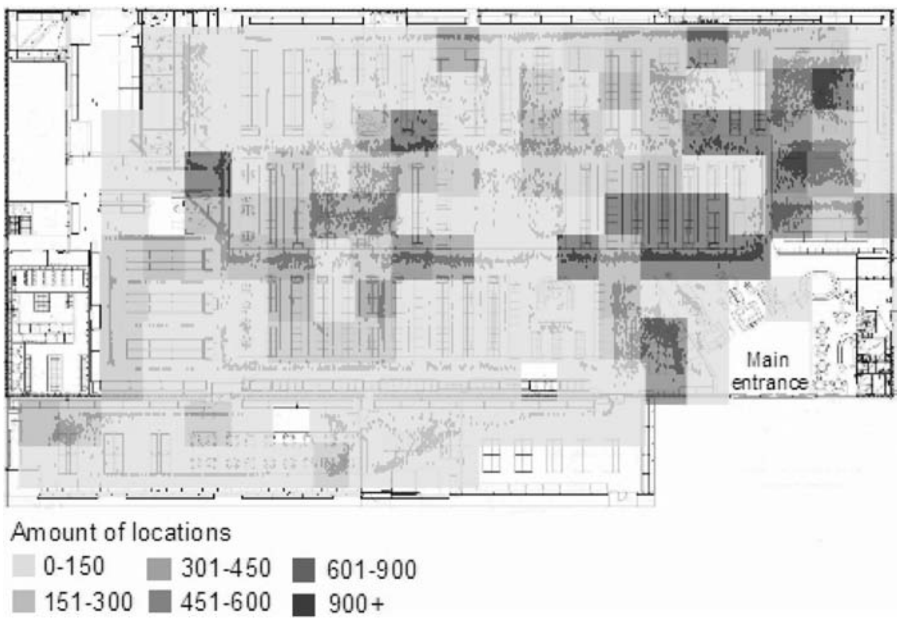

Figure 3.
Large square model

points from the pixel model have been added to the same base plan. Combining the large squares and the exact customer traffic locations, the whole figure gives a better overview of the customer traffic. The clear advantage of this model is that from it is easy to see where the customers spend their time in the store.

The third and fourth models are similar to the large square model. In these models, the base plan is also divided into squares but the squares are smaller than in the second model. In the medium square model the base plan of the store is divided into 42 squares in the horizontal direction and 23 squares in the vertical direction (Figure 4). All together 906 squares are formed in the base plan from which 520 squares include tracked locations. The amount of squares without tracked locations is fairly large because, for example large gondolas etc., store furniture takes up the whole square making it inaccessible to the customers. The area of one square of the third model is approximately 6 square metres in reality. In the fourth model, the small square model (Figure 5), the used squares are the smallest. In the model the base plan of the store is divided into 105 squares in the horizontal direction and 56 squares in the vertical direction forming over 5,000 squares on the base plan. One square equals about one square meter in reality. Although the information provided by the picture is more accurate than in the second or third model, the picture seems to be in a way chaotic.

Discussion

Space management needs objective information about consumer behaviour. An excellent picture of the customer traffic can be obtained when collecting the data with the wireless local area network and analysing with spreadsheet and geographical information systems. As seen in this study, it is possible to analyse the customer traffic datasets in several different ways.

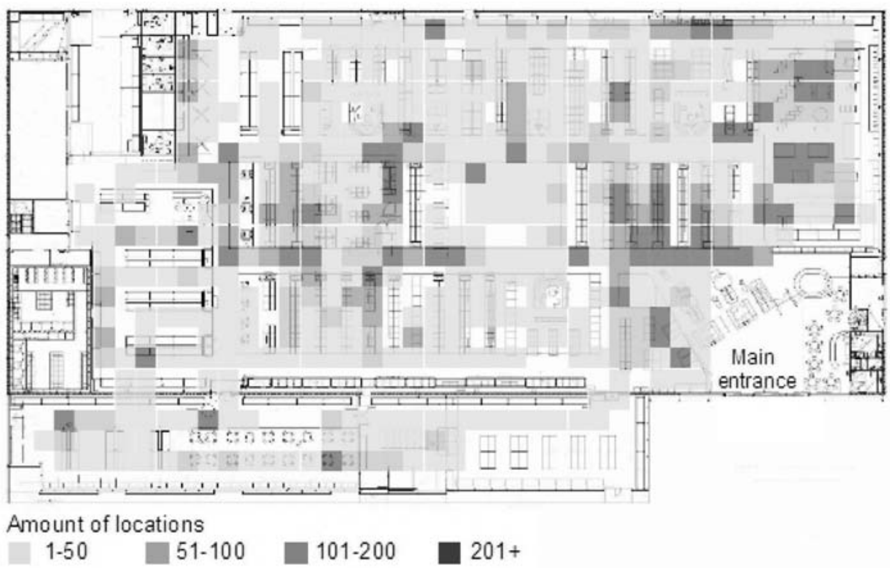

Figure 4.
Medium square model

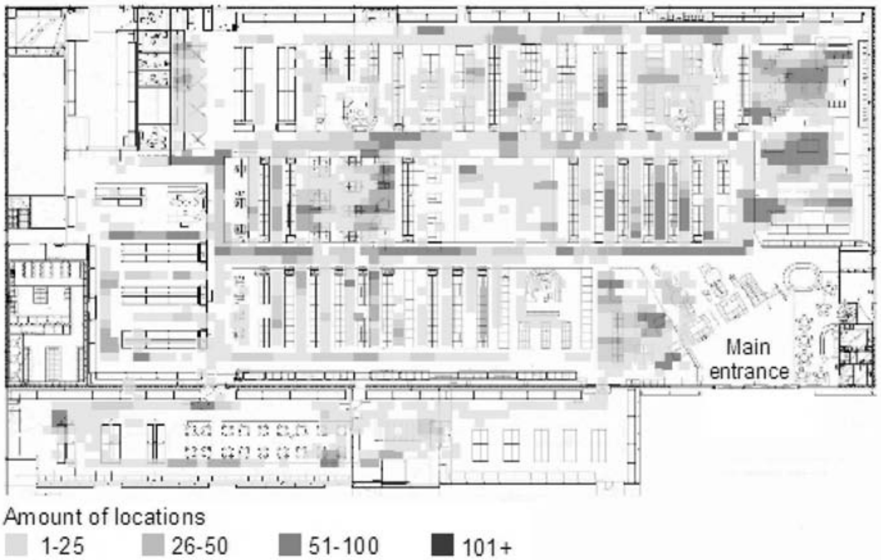

Figure 5.
Small square model

When different consumer data collecting methods are used, the quality of the data can be undermined in two different ways. When collecting the data, the customers may alter their behaviour, when knowing that they are being tracked. This may be a reflection of the Hawthorne effect. The Hawthorne effect refers to a phenomenon of observing workers' behaviour or their performance and changing it temporarily (Roethlisberger and Dickson, 1939). The second possible weakness is caused by the data collector. When the data collector is a human, the personal beliefs and attitudes can affect the observations. In other words, the observations are subjective. The subjectivity can appear when observations are collected or when they are interpreted. But when the data collecting is done automatically, it becomes objective.

Companies engaged in the use of new marketing and research methods in order to monitor customer behaviour should be aware of any potential public concerns and be seen to adhere rigorously to ethical practice (Kirkup and Carrigan, 2000). Different models are best suited in different situations since they have their own advantages and disadvantages. By using only the pixel model, wrong conclusions can be drawn from the customer traffic. On the other hand, the weakness of the large square model is the fact that the used squares have a rather big size. Together the pixel and the large square models give a good overview of the customer traffic. The medium square model and the small square model give more exact information about the customer traffic but for an overview they are somewhat vague. They are more suitable when analysing the different departments or sections of the store.

Because the research area analysing the consumer's behaviour with modern technology is a very new field of research, there is only a small amount of existing research done and the relevant amount of source material was very limited. Especially about processing the customer traffic in a store, source material was almost impossible to find. Studies, which have been made in the field of the retail business, have been clearly emphasised to the perishables business. There is only a limited amount of material concerning DIY trade. Therefore this study gives new methodological viewpoints. This is also the main limitation of this study. More empirical data and analysis is definitely needed in order to achieve more reliability and validity.

Because in a DIY store a similar study has not been carried out earlier, very many technical problems had to be solved. The sample size of the study is sufficient that robustness is ensured in the study.

In this study, attention was paid to the reliability during the whole research process. In the store there were only a few areas in which there were no locations. These areas are the cash desk area and the outer corner on the side of the main entrance in the outer shop store. The absence of location points (i.e. that were not detected or to which the system was blind) can possibly be explained by the fact that the local area network has not covered the area in question. The second alternative to the missing locations is the fact that there have continuously been many active tags simultaneously side by side in the area. This has possibly caused disturbance to the location system. Therefore attention should be paid also to technological issues. Larson *et al.* (2005) have developed a research frame and performed a study very near this study. The results of their study were generalised. Also in this study external validity comes true. In this study the sample size is big. This marks off the random results. Thanks to the random sampling, the data of the study represents the target population well. The data collecting method can be considered objective and the location exactness of the data collecting method sufficient for reliable information.

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