THE ACQUISITION OF CONSUMER BEHAVIOUR DATA USING INTEGRATED INDOOR POSITIONING SYSTEMS

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Abstract: In this article, the authors have introduced trends in developing technologies used for analysing consumer behaviour and supporting marketing actions in retail networks focusing on using data in marketing information systems. The authors have proposed a developed model of a system which integrates separate technology groups such as POS, computer video analysis, social media data and the indoor navigation system based on beacon and radio tomography in one consistent solution in order to achieve the synergy effect in the area of customer behaviour analysis and behavioural targeting. The model can be developed by other technologies which gather unique data about customers.

Keywords: Customer behaviour, IoT, Big Data.

1. Introduction

Research on the subject of consumer behaviour is one of the key marketing aspects of scientific work of recent years. The developing knowledge of the above-mentioned aspect allows to use tools of behavioural targeting which are becoming increasingly significant on today's market of growing competition and customer network markets. This phenomenon is accompanied by a rapid technological development providing a possibility of wider usage of customer data in the decision-making process. On today's market, there are more and more new systems focused on gathering, processing, and analysing customer data. A major trend is the attempt to increase sales by using IoT solutions intended for a comprehensive study of customer behaviour.

2. Customer behaviour in theory

"Customer behaviour" is a complex concept which results in the lack of a one single definition of this term in publications and literature. The definition can vary depending on the context or scientific field in which it is used. However, considering this aspect in marketing sense, Schiffmann & Kanuk's definition can be used according to which consumer behaviour consists in actions linked to searching, buying, using, and evaluating goods and services, which have capability to fulfil needs (Schiffman, and Kanuk, 1984). According to Hansen, this term is understood as a set of activities and customer perception that consist of successive stages: preparing, choosing the product, and consuming (Hanse, 1972). Customer behaviour is also defined as activities and decisions taken before acquiring, using, and administering the goods and services (Engel, Blackwell, and Miliard, 1993).

The commonly known classical model of the purchase decision-making process includes the following stages (Trejderowski, 2009):

- identifying the problem,
- acquiring information,
- assessment of possible variants,
- the decision to purchase,
- behaviour after the purchase.

It is possible to monitor and analyse consumer behaviour at each above-mentioned stage using information systems in case of consumers who use information technologies during the processes of fulfilling the decisions about the purchase. This allows analysing customer behaviour continuously which is the basis of marketing information systems. In further parts of the article, solutions for acquiring customer behaviour data will be presented. One of the key purposes of the solutions is to collect information on customer behaviour in order to take such actions to convince him or her to buy a product or service. Each of the defined stages of purchase decision-making is a potential source of customer behaviour data.

3. Marketing information system in the aspects of consumer analysis

The marketing system can be understood as a system in which marketing data is formally gathered, stored, analysed, and distributed to managers in accordance with their informational needs on a regular basis (Jobber, 1997).

The following functions are identified as fundamental in the marketing systems (Marciniak, 2011):

1. Collecting data,
2. Storing collected data resources,
3. Processing the data – in the way required by the decision-making staff,
4. Sharing the processed data with the managers.

The analysis of collected data is the main task of the Marketing Information Systems. The usefulness of these systems in reacting to changes and marketing decision-making is closely related to the amount of customer data and their differentiation. According to this conjuncture the number of systems providing possibilities of gathering, storing, and analysing customer data is increasing rapidly. A trend of integrating IT systems supporting varied business areas is becoming more and more noticeable in the last years. Nevertheless, the imperfect systems with limited capabilities of integrating are not able to deliver comprehensive information about consumer behaviour and decision-making process (Marciniak, 2011). The quality of the data on consumer behaviour can be improved by collecting information from multiple sources. The decision-making processes could be more effective if consumer behaviour data are acquired from many sources which provides the possibility of a multidimensional analysis. As a result, the strategic and operational marketing management could be adjusted to the collected information. According to the results of research done by the authors, there is a lack of one, single application that would provide comprehensive information to support the decision-making process. This kind of system provides the following features (Marciniak, 2011):

- planning marketing activities,
- creating a marketing budget,
- customer relationship management,
- implementation of loyalty programs,
- management of brand value,
- keeping a calendar of events,
- customer service,
- evaluation of the effectiveness of the marketing activities,
- organising processes and resources in marketing (human, financial, information),
- supporting search engine optimisation,
- multivariate analysis of customer information based on monitoring activity on-line,
- multidimensional analysis of segmentation and selection of target market.

Studying capabilities of marketing decision supporting systems it is noticeable that IT solutions do not provide the possibility of gathering and analysing data on a large group of consumer activities. It is a result of the existing obstacles in collecting multi-source data, including social media activities and consumer behaviour during the shopping process. A significant identified difficulty is analysing unstructured data as well as drawing conclusions useful in making marketing decisions. Looking more broadly at this issue, it can

be stated that there is a need of a possibility to integrate applications, social media data, and point of sales systems into one complex system. It is because currently systems operate in disconnection making it impossible to take a quick action in response to changes and trends in consumer behaviour. Commonly used applications like CRMs have significant deficiencies in functionality which is the reason for small utility of provided information.

4. Big Data analysis in terms of consumer behaviour

Due to the ongoing process of the digitisation of all human activities, data sets are growing rapidly. Organisations enter a new stage of development which provides tools and capabilities to gather, process, and analyse huge amounts of data. New possibilities are sources of information useful in the decision-making process. Massive amounts of data, widely known as a Big Data, are used to find trends and patterns in order to achieve a market advantage.

The following features describe Big Data analysis (Płoszajski, 2013):

- Variety – Big Data are collected from multiple sources like PCs, mobile phones, sensors, and many other devices. They occur in many forms, including text, pictures, behaviour data, or even interactions on websites and social networks;
- Velocity – Big Data are obtained constantly and in real time which provides a possibility of immediate response for the organisations;
- Volume – diversified sources of data as well as millions of users at one time make the Big Data grow rapidly. This provides terabytes of data that can be analysed.

What distinguishes the Big Data from traditional analysis is simultaneous processing of different types of data. Processing large data sets creates value by making them transparent and accessible at any time (Pawełoszek, and Wieczorkowski, 2015).

As of now, focus group interviews and survey are the main source of information on consumer behaviour and purchasing decisions. Along with the technological progress, new opportunities of gathering and processing of consumer behaviour data emerge. Technology of indoor navigation and positioning system becomes a rich source of diverse consumer data.

5. Indoor navigation system in the light of consumer behaviour

The commonly known concept of the Internet of Things assumes that in the future all of the daily necessities will be equipped with microcontrollers, which will allow interaction with users and other systems, combining all the elements in a network. The Internet of Things can

be characterised as a set of linked physical objects which are simultaneously a part of the business processes (Haller, Karnouskos, and Schroth, 2009).

The IoT concept provides the possibility of technology implementation in every part of human life and automation of all human activities. The IoT allows for introducing technology that works and interacts in real time and ensure dynamic development of companies (Murthy, and Kumar, 2015). Indoor positioning systems are considered as a part of the Internet of Things' concept and they can be widely used in malls in order to improve the purchasing process. Most of these solutions are based on a network of connected sensors called beacons distributed in the building. Beacon infrastructure can be used by a mobile application to localise the user and then determine the optimum path to the selected destination, e.g. a specific store. More sophisticated solutions based on the analysis of location are able to recommend products for a specific user and inform him or her about ongoing special offers and discounts. Such functionalities activate the user, which is the key achievement of indoor positioning systems (Karunarathna et al., 2014).

Heat maps used in stores are a tool that allows for a comprehensive study of consumer behaviour. Their essence is a graphic presentation of those store parts (shelves, product, arrangement elements) which enjoy the greatest customer interest. Heat maps are created by an analysis of the intensity of people's movement in specific areas of the shop. The more often a place is visited by customers, the colour of this area on the heat map is darker.

High accuracy of heat maps allows store managers to analyse a wide range of data on consumer behaviour and purchasing process. They are able to identify the most popular products, the most often selected path, order of viewed products, and also areas that are the least visited (Larson, Bradlow, and Fader, 2005). Moreover, collected data on popularity of particular areas of the shop allows for identifying the most popular product. This knowledge is helpful in the optimisation process of the trade offer and better selection of the merchandise. Being aware of customer preferences is necessary in order to achieve a market advantage (Ailawadi et al., 2006).

With this knowledge, a store manager is able to optimise the arrangement of the shop in order to match the identified profile of its customer. It provides a possibility to maximise sales profitability. A properly optimised scheme of the shop improves product display and activates customers to choose a longer path between shelves which creates an additional opportunity to sell other products.

An important advantage of heat maps, considering present indoor navigation solutions, is a lack of necessity to use the mobile application by users and connect to the beacon infrastructure in order to create the heat map. Currently, heat maps may be generated using data collected in many ways. However, considering the retail networks' characteristics, the most proper technology is radio tomography.

Dudh and Pitambare, presented the benefits of implementing the solution highlighting the area of consumer behaviour analysis, operational analysis, and opportunities to improve profitability.

Table 1.
Benefits of implementing indoor navigation and positioning

Customer Analytics	Operational Analytics	Revenue Improvement
– Identify and trigger real time offers. – Identify and offer various loyalty programs. – Identify personalized alerts and high-value rewards. – Redeem rewards. – Identify customized coupons. – Optimized in-store customer experience. – Purchase a product in real time in-store via a mobile device. – Pay without the need to join a checkout queue.	– Engage with customers in real time using their mobile phone and an app Follow-up with the shopper after the shopping experience to provide additional information or receive offers based on the beacons they were near during their store visit. – Optimize store layouts and product placement based on navigational patterns. Optimize website, merchandising zones on desktop and mobile. – Help customers locate items in-store. – Offer better in-store customer service. – Inventory planning. – Fraud detection: Loss prevention – both internal and external. – Improve Store traffic patterns to eliminate choke points.	– Empower sales associates. – Improve business processes and generate more revenue. – Identify peak traffic times, checkout line length, number of associates presently in-store and product location. – Improve campaign management.

Note: Adapted from: "Location Based and Contextual Services Using Bluetooth Beacons: New Way to Enhance Customer Experience" by N.A. Dudhane, and S.T. Pitambare. Appeared in *Lecture Notes on Information Theory*, *3*(1), 2015.

Despite the fact that indoor navigation using beacon technology provides a wide range of information, the implementation of this kind of systems and data acquisition using them has a number of limitations and drawbacks. The authors of the publication have analysed many potential solutions based on beacon technology. Based on user feedback and own observations, the authors identified several difficulties which appear in the process of implementing and using this kind of solution. The first important limitation is the necessity to use the mobile application in order to obtain data on consumer behaviour. A great part of users do not have the required knowledge to use the mobile application during the process of daily shopping. Another obstacle in collecting consumer behaviour data is the necessity for continuous use of the mobile application. Marketing campaigns implemented by shopping centres do not involve users for a permanent use of the mobile application. The research carried out by the authors through focused interviews with the application users shows that despite the fact that users install the application, they do not become its regular users. Along with the process of getting to know the building of the shopping centre, the mobile application

and its main feature of indoor navigation loses its meaning to them. A significant risk of a common use of the discussed solutions by consumers is the fact that the application collects a wide range of particular user data. Referring to it, customers are reluctant to share their personal information.

The above-mentioned limitations can be marginalised due to the technological progress, increasing consumer awareness, or increasing the quality of the marketing campaigns. The number of people using mobile devices is growing constantly. It is estimated that in 2016 31% of the population were active users of mobile phones. It is nearly 2.3 billion people who use mobile devices ("Free 2016 Global", 2016). One of the main objectives of the marketing campaigns should be adapting customers to use the application. The indoor navigation application should work smoothly in the background. Moreover, the system should be linked to a loyalty program of a particular store making the application a form of an integrated loyalty program. This approach will allow for attracting new customers and encouraging them to keep using the application while shopping. It will have a significant effect on the process of collecting consumer behaviour data during visits in shopping malls. Analysing the risk of sharing personal data, the mobile application should allow the user to specify the range of data collected by the system and then analysed.

However, solutions based on beacon technology may be replaced or supplemented by such technologies as: retail video analytics and radio tomography.

6. Retail video analytics

The application of computer vision technologies is widely used in a retail data analysis. Video analytics can provide managers more insightful business intelligence. Gathering information from computer vision system allows for enhancing customer experience, optimising store performance, reducing operational costs and in the effect – higher profitability (Connell et al., 2013).

The figure below (Figure 1) shows logical steps of the algorithm which allows for recognising consumer activities.

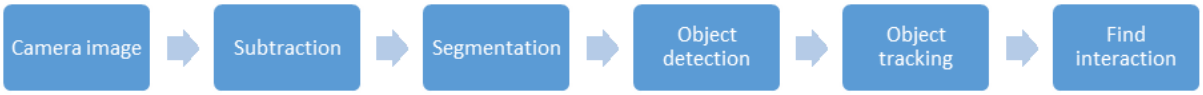

Figure 1. Logical steps of the implemented algorithm. Adapted from: "Shopper analytics: A customer activity recognition system using a distributed RGB-D camera network" by D. Liciotti et al. Copyright 2014 by Springer.

Advances in computer vision and data analysis promise much higher business value than the traditional customer survey. The main advantage of these technologies is unique activity recognition. For example video analytics can detect customers' interest in a product or recognise actions such as grabbing or reaching the products (Popa et al., 2011). The system based on video analytics implements a function which can provide many unique indicators like the number of products picked up, relocated on the shelf, touched products, duration of interactions, average interaction time, or the number of interactions for product and category (Liciotti et al., 2014). Gathering and interpreting data from these solutions is a supplement of a model of the system for customer behaviour analysis.

7. Radiotomography

Radio Tomographic Imaging is a method of localising and imaging objects in the area covered by a wireless radio network. The principle of operation of this method is sending and receiving a radio signal by nodes. Nodes are located in a way that provides full covering of a particular area. The transmitted signal encounters obstacles and then reflects returning to respective nodes. Knowing the delay of the sent signal, it is possible to specify the position of the obstacle (Wilson, and Patwari, 2010).

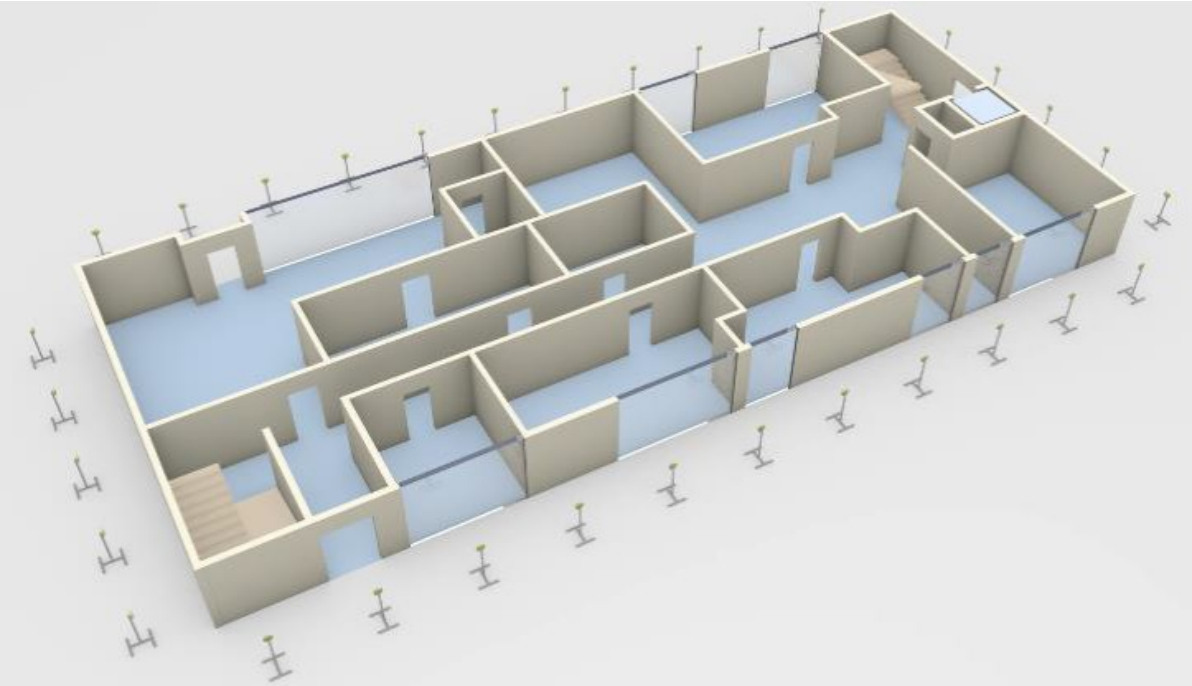

Figure 2. A model of the object with a sensor on the outside. Adapted from: "Concept of detection system to localize inside closed area by radio tomographic imaging" by T. Rymarczyk et al. Appeared in *Informatics Control Measurement in Economy and Environment Protection*, *7*, 2017.

Using the Radio Tomographic Imaging it is possible to maintain a continuous analysis of people's movement, even those who do not use the mobile application to connect with the beacon system. Such conditions make the RTI an excellent method of gathering data that can be used in generating heat maps.

8. The model of integrated system

The complexity of the data obtained from the group of IT solutions allows for making a multi-faceted analysis of consumer behaviour in the real time. In the following figure the authors have presented the key groups of data from different systems, which can be gathered and analysed in the context of consumer behaviour.

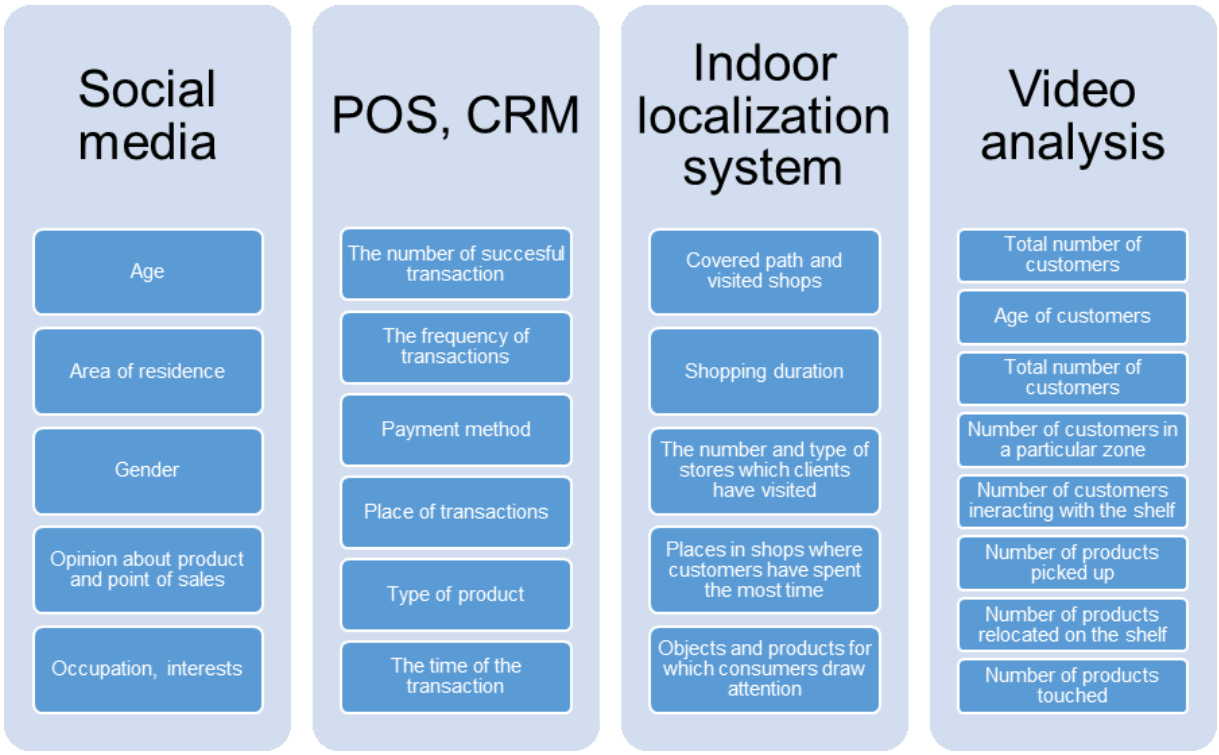

Figure 3. Key types of data usable for analysis of consumer behaviour. Own study based on system analysis.

The integration of data collected from many sources is essential in order to increase the accuracy of forecasting and accelerate the decision-making process. Data from multiple-source systems will allow mangers to define new patterns of consumer behaviour and assess perception of the purchasing process from the consumer point of view.

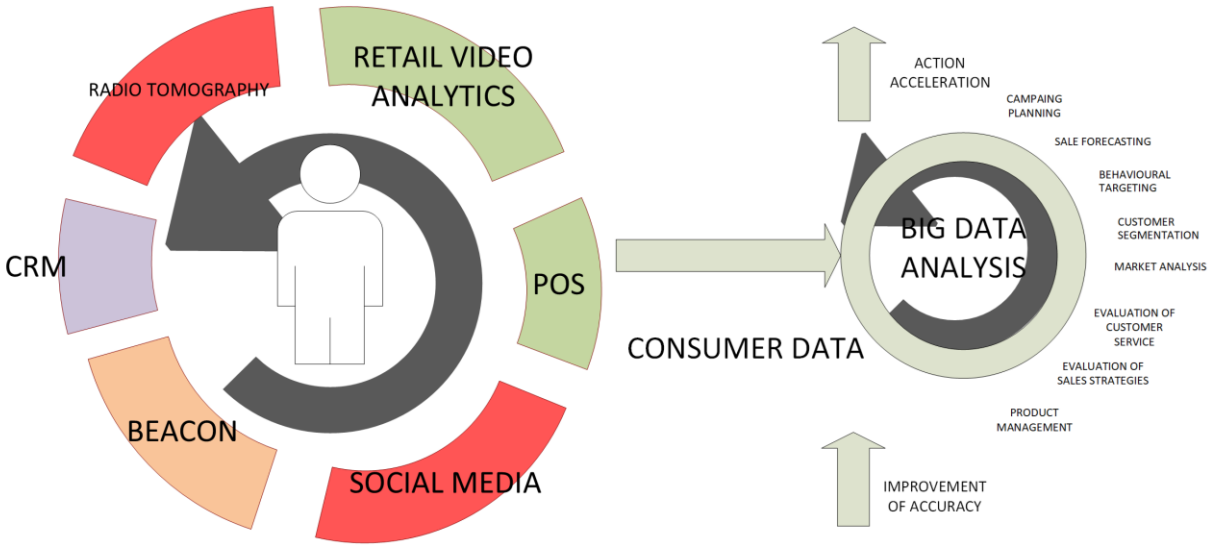

Figure 4. Key types of data usable for analysis of consumer behaviour. Own study.

Consumer behaviour is a major factor in the process of marketing decision-making. The implementation of this model in the MkIS would allow managers to respond more quickly to changes in the external environment and increase the precision and validity of decisions taken in the area of marketing. Ultimately, the combination of data from loyalty systems, social media, the indoor navigation system, Radio Tomography Imaging, video analysis, and CRM can improve the quality and efficiency of the decision-making process. The model should be analysed in two dimensions – as a tool for decision-making at the tactical and strategic level, which covers the segments of customer groups, affecting the decision fields such as budgeting, modelling of the sales process, sales forecasting, analysing market changes, as well as a system for defining the needs of the individual customer. The information obtained from a hybrid system may allow to indicate the place of optimisation of marketing communication and support the analysis of an individual consumer's needs. Moreover, deploying the model should also improve tools of customer segmentation. As a consequence, it would be possible to choose a better type of advertisement in the behavioural targeting process by messages and signals tailored to specific individuals.

9. Conclusion

There is a need to develop an application which integrates data from multiple systems in order to create a multi-dimensional analysis system of consumer behaviour in the real time. Computer video analysis allows for gathering unique information about consumers. An interesting solution is using radio tomography for in-building navigation and positioning objects in order to generate heat maps. The integration makes opportunity for a multi-dimensional analysis of the needs and reactions of consumers, ultimately it improves accuracy

in behavioural targeting. The system will increase effectiveness of product positioning and will reduce costs of market research. As a result, the implementation of the model of the purchasing process and adapting the product offer to current needs of consumers will be optimised. An increase in profitability of retail networks will be the end result of the implementation.

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