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# Modeling IoT-Driven Retail Touchpoints: Impact of Smart Shelves and Beacons on Customer Experience, In-Store Purchase Behavior, Churn, CAC, and CLV

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**Abstract—**This paper examines how Internet of Things (IoT) technologies deployed within physical retail stores influence customer experience and long-term customer value. Smart shelves and beacon systems represent two important IoT-enabled touchpoints capable of improving in-store engagement and operational efficiency. Smart shelves enhance product visibility, inventory monitoring, and pricing transparency, while beacon technology delivers location-based promotions and personalized communication through mobile devices. The study proposes an integrated conceptual model linking these technologies with customer experience, in-store purchase behavior, customer churn, customer acquisition cost (CAC), and customer lifetime value (CLV). A quantitative cross-sectional research design using structured survey data from organized retail shoppers is proposed. Structural Equation Modeling (SEM) will be used to test the hypothesised relationships.

**Keywords**—IoT retail, smart shelves, beacon technology, customer experience, customer lifetime value

## 1. Introduction

The retail industry is undergoing a major transformation due to the increasing adoption of Internet of Things (IoT) technologies in physical retail environments such as supermarkets, hypermarkets, and shopping malls. Traditional brick-and-mortar stores are no longer merely places where products are purchased; rather, they are evolving into smart retail environments where connected devices continuously monitor, analyze, and respond to shopper behavior in real time. These intelligent retail systems enable retailers to better understand customer preferences, optimize store operations, and enhance overall shopping experiences. Prior research has highlighted that IoT technologies play an important role in improving both operational efficiency and customer engagement within retail environments [12], [4].

Among the various IoT innovations adopted in modern retail, smart shelves and Bluetooth beacon systems have emerged as two prominent in-store technologies that improve customer interaction and store efficiency. Smart shelves utilize technologies such as RFID tags, weight sensors, and electronic shelf labels to track product movement, maintain optimal inventory levels, and update price information automatically. This capability ensures that products remain visible, available, and correctly priced, thereby improving shopping convenience and reducing the effort customers spend searching for items within the store [7]. At the same time, beacon technology enables retailers to send personalized and location-based notifications directly to shoppers' mobile devices as they move throughout the store. These notifications may include promotional offers, product recommendations, or navigation assistance, which collectively contribute to a more engaging shopping experience [3]. From a consumer behavior perspective, IoT-enabled touchpoints significantly influence how customers perceive and interact with the retail environment. Improved product visibility, personalized promotions, and real-time assistance enhance the overall customer experience, which plays a critical role in shaping purchase decisions and customer satisfaction [9]. A positive in-store experience often leads to increased purchase likelihood and stronger long-term relationships between customers and retailers. Consequently, retailers increasingly recognize that IoT technologies not only support immediate sales but also contribute to broader customer value outcomes such as reduced customer churn, improved customer acquisition cost (CAC) efficiency, and enhanced customer lifetime value (CLV) [4]. Despite these advantages, the growing use of in-store tracking technologies also raises concerns related to data privacy and consumer trust. As retailers collect detailed information regarding customer movements and shopping behavior, consumers are becoming more cautious about how their personal data is collected, stored, and utilized. Prior studies emphasize that transparent data policies, strong security systems, and responsible data management practices are essential for maintaining consumer trust in technology-driven retail environments [11].

Moreover, the integration of advanced analytics and artificial intelligence with IoT technologies further expands the potential of smart retail systems. Data collected through sensors and proximity technologies can be analyzed to generate predictive insights into customer preferences, shopping paths, and demand patterns. Such insights allow retailers to improve store layouts, optimize promotional strategies, and design more personalized shopping experiences [4]. However, despite the increasing adoption of IoT technologies in retail environments, empirical research examining the relationship between IoT-enabled retail touchpoints and long-term customer value metrics—such as churn, CAC, and CLV—remains limited, particularly within organized retail settings. Another factor driving IoT adoption in retail is the growing demand for seamless omnichannel experiences. Modern consumers frequently move between online and offline channels during the shopping journey and expect similar levels of convenience and personalization across platforms. IoT-enabled technologies such as smart shelves and beacon systems help bridge the gap between physical and digital retail environments by integrating real-time data into the store ecosystem [16].

As a result, retailers can create more consistent and integrated customer journeys across multiple touchpoints. From an operational perspective, IoT technologies also contribute to improved inventory management and demand forecasting. Real-time shelf monitoring reduces the likelihood of stockouts and overstocking, both of which directly influence sales performance and customer satisfaction levels. When products remain consistently available and accurately priced, customers are less likely to abandon purchases or switch to competing retailers [7]. Therefore, beyond marketing advantages, IoT infrastructure also enhances store productivity and operational efficiency. Furthermore, the increasing competitive intensity in supermarket, hypermarket, and mall-based retail formats has made customer retention a strategic priority. IoT-driven personalization and in-store engagement tools provide retailers with new opportunities to strengthen emotional connections with shoppers, encourage repeat visits, and improve long-term profitability [13]. By integrating smart shelves, beacon systems, and data-driven analytics, retailers can transform traditional stores into interactive retail ecosystems capable of delivering both operational efficiency and enhanced customer experiences. Therefore, this study proposes a conceptual framework to examine how IoT-enabled retail technologies, specifically smart shelves and beacon systems, influence customer experience, in-store purchase behavior, customer churn, customer acquisition cost (CAC), and customer lifetime value (CLV) in organized retail environments.

## 2. Literature Review

The rapid development of Internet of Things (IoT) technologies has significantly transformed the retail sector, particularly in organized retail formats such as supermarkets, hypermarkets, and shopping malls. IoT-enabled systems allow retailers to collect real-time data, monitor store operations, and enhance customer engagement through connected devices and smart infrastructures. Prior studies indicate that IoT technologies improve retail visibility, operational efficiency, and decision-making capabilities within physical store environments [12]. As a result, retailers increasingly rely on IoT-driven solutions to create intelligent and responsive retail ecosystems.

Among the various IoT innovations used in retail, smart shelves and beacon technologies have emerged as important in-store touchpoints that support both operational efficiency and customer interaction. Smart shelves utilize technologies such as RFID tags, weight sensors, and electronic shelf labels to track product movement, maintain inventory accuracy, and update prices automatically. These systems ensure that products remain available and clearly priced, thereby improving customer convenience and reducing the effort required to locate items in the store. Research suggests that improved product visibility and accurate pricing information enhance consumer confidence and positively influence purchase decisions [4], [7].

Another key IoT technology in retail is beacon-based proximity communication, which uses Bluetooth Low Energy (BLE) signals to transmit location-based messages to shoppers' mobile devices within the store. Beacon technology enables retailers to deliver personalized offers, product recommendations, and navigation assistance based on the shopper's location inside the store. Previous research shows that such proximity-based marketing strategies can increase customer engagement, time spent in the store, and impulse purchasing behavior [3], [15]. By enabling real-time interaction with customers, beacon technologies help retailers deliver more targeted and effective promotional communication.

From the perspective of customer experience, IoT-enabled touchpoints influence both cognitive and emotional responses during the shopping journey. Features such as easy product discovery, personalized promotions, and real-time assistance improve perceived convenience, enjoyment, and overall satisfaction. These experiential benefits play an important role in shaping purchase intentions and long-term customer relationships [9]. Consequently, retailers increasingly view IoT technologies not merely as operational tools but as strategic resources for improving key customer value metrics, including customer churn, customer acquisition cost (CAC), and customer lifetime value (CLV) [4].

Despite the benefits of IoT technologies, the increased use of real-time customer data has also raised concerns regarding privacy and data security. Retailers collect detailed behavioral and location-based information through sensors, mobile applications, and proximity technologies. If customers perceive that their data is being misused or collected without transparency, their trust in the retailer may decline. Prior research emphasizes the importance of responsible data practices, transparency, and informed customer consent in maintaining trust in technology-enabled retail environments [11].

The integration of artificial intelligence (AI) with IoT technologies, often referred to as AIoT, has further expanded the capabilities of smart retail systems. AI-powered analytics enable retailers to process large volumes of sensor-generated data and derive insights into customer preferences, demand patterns, and shopping behavior. These insights help retailers design more targeted marketing strategies, optimize store layouts, and improve resource allocation [2]. As a result, AIoT technologies are increasingly viewed as a key driver of intelligent retail transformation.

In addition to AI integration, emerging technologies such as augmented reality (AR) are also being incorporated into smart retail environments. AR applications enable interactive product visualization, virtual demonstrations, and enhanced store navigation, which improve the experiential aspects of shopping [6]. However, the successful implementation of these technologies depends on effective system integration and strong privacy protection mechanisms.

Recent studies also highlight the importance of omnichannel integration in maximizing the benefits of IoT-enabled retail technologies. Modern consumers frequently move between online and offline channels during their shopping journey and expect consistent experiences across platforms. Smart shelves, beacon systems, and mobile applications help connect physical stores with digital retail ecosystems by enabling seamless data integration and personalized interactions [16]. This integration helps retailers create more consistent and convenient customer journeys.

Another important research area focuses on real-time analytics and promotional efficiency. IoT-generated data enables retailers to adjust promotional strategies dynamically based on customer location, browsing behavior, and dwell time. Studies show that such context-aware promotions are more effective than traditional mass promotions, leading to higher conversion rates and increased basket sizes [4]. Consequently, beacon-based micro-targeting can also improve marketing efficiency by reducing promotional waste and optimizing customer acquisition cost (CAC).

Customer retention has also become a critical issue in competitive retail markets. Previous research suggests that improved customer experience and perceived personalization can significantly reduce customer switching behavior

[9]. IoT-enabled retail technologies enhance store convenience and engagement, which can contribute to improved customer retention and reduced churn.

From the perspective of customer lifetime value (CLV), intelligent retail technologies may influence both purchase frequency and spending levels. The CLV framework suggests that firms can enhance long-term profitability by strengthening customer relationships, encouraging repeat purchases, and increasing share of wallet [8]. Smart shelves improve product discovery and availability, while beacon technologies encourage repeat visits through personalized engagement strategies.

Although research on IoT in retail continues to expand, empirical studies that directly connect IoT-driven in-store technologies with long-term customer value outcomes such as churn, CAC, and CLV remain limited, particularly in organized retail environments. This gap highlights the need for integrated research frameworks that examine how IoT-enabled retail touchpoints influence both customer experience and long-term customer economics.

## 3. Research Objectives

1. To examine the impact of smart shelf effectiveness on customer experience in organized retail environments.

2. To analyze the influence of beacon technology on customer experience.

3. To investigate the relationship between customer experience and in-store purchase behavior.

4. To assess the effect of customer experience on customer churn.

5. To evaluate the impact of in-store purchase behavior on customer lifetime value (CLV).

6. To examine the influence of customer experience on customer acquisition cost (CAC).

## 4. Proposed conceptual model

The conceptual model proposes that smart shelf effectiveness and beacon effectiveness enhance customer experience in retail.

Improved experience influences purchase behavior while reducing churn and customer acquisition cost. Increased purchase behavior ultimately improves customer lifetime value. The conceptual framework is shown in Figure 8.1. 1.

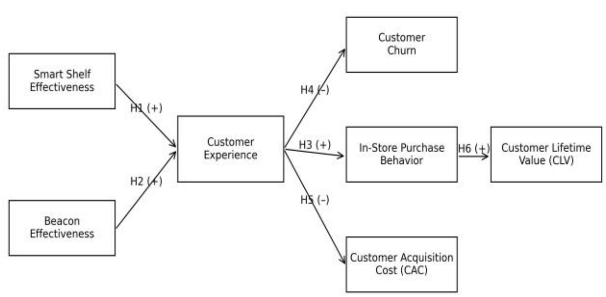


Fig. 8.1: Conceptual model of IoT-driven retail touchpoints and customer value outcomes

## 5. Hypotheses

H1: Smart shelf effectiveness positively influences customer experience.

H2: Beacon effectiveness positively influences customer experience.

H3: Customer experience positively influences in-store purchase behavior.

H4: Customer experience negatively influences customer churn.

H5: Customer experience negatively influences customer acquisition cost (CAC).

H6: In-store purchase behavior positively influences customer lifetime value (CLV).

## 6. Research Methodology

### 6.1 Research Design

This study adopts a quantitative, cross-sectional research design to examine the impact of IoT-driven retail touchpoints on customer experience and customer value outcomes in organized retail environments such as supermarkets, hypermarkets, and shopping malls. A quantitative approach is appropriate because the research aims to measure relationships among well-defined constructs and test theory-driven hypotheses using statistical techniques [1]. The cross-sectional design enables the collection of consumer perceptions at a single point in time, which is commonly applied in marketing and consumer behavior research [10].

The study follows a hypothesis-testing framework using structured survey data collected from retail shoppers who have experienced IoT-enabled technologies such as smart shelves or beacon-based in-store interactions. A deductive research approach is employed to empirically validate the proposed conceptual model and test the relationships among the constructs specified in hypotheses H1–H6 [14]. To analyze the relationships among multiple latent variables simultaneously, Structural Equation Modeling (SEM) is used. SEM is widely recommended for testing complex causal models involving multiple dependent relationships and mediating constructs in marketing and retail research [5].

### 6.2 Target Population

The target population for this study consists of adult consumers (18 years and above) who shop in organized retail stores and are exposed to IoT-enabled retail technologies such as smart shelves and beacon-based communication systems. The study focuses on customers visiting organized retail environments including shopping malls, supermarkets, and hypermarkets, where the adoption of smart retail technologies is more prevalent.

The geographical scope of the study primarily includes urban retail settings, where digital retail infrastructure and technology-enabled shopping experiences are more widely implemented. Previous research suggests that organized retail environments provide a suitable context for studying IoT-enabled consumer interactions and technology adoption within physical stores [12].

### 6.3 Sampling Technique

This study employs a non-probability convenience sampling technique, in which respondents are selected based on their accessibility and prior exposure to IoT-enabled retail environments. Convenience sampling is widely used in retail and consumer behavior research where obtaining a complete sampling frame is difficult and the primary objective is theory testing rather than population generalization [10], [14].

Data collection will be conducted using mall-intercept surveys and online questionnaires, enabling efficient access to shoppers who have experienced technology-enabled retail environments. This approach is commonly adopted in retail studies that investigate in-store customer experience and technology-driven consumer interactions.

### 6.4 Sample Size

An adequate sample size is required to ensure reliable estimation and statistical power when applying Structural Equation Modeling (SEM). Methodological guidelines suggest that SEM studies should have a minimum sample size of 150 respondents, while larger samples improve model stability and accuracy. Based on the Krejcie–Morgan sampling guidelines, the preferred sample size for this study ranges between 260 and 375 respondents, which is considered sufficient for robust SEM analysis.

### 6.5 Measurement Scale

The constructs used in this study were measured using multi-item scales adapted from prior literature. All items were measured using a five-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree. The measurement items and their sources are presented in Table 8.1.

Table 8.1: Constructs and Measurement Items

| Construct | Code | Questionnaire Item | Source |
|---|---|---|---|
| **Smart Shelf Effectiveness** | SS1 | Smart shelves make it easier to locate products in the store. | [12] |
| | SS2 | Smart shelves improve product availability information. | [12] |
| | SS3 | Price information on smart shelves is clear and helpful. | [4] |
| | SS4 | Smart shelves enhance my in-store shopping convenience. | [13] |
| **Beacon Effectiveness** | BE1 | I receive useful in-store notifications through beacon technology. | [3] |
| | BE2 | Beacon messages are relevant to my shopping needs. | [15] |
| | BE3 | Beacon alerts improve my in-store navigation. | [4] |
| | BE4 | Beacon-based offers enhance my shopping experience. | [15] |
| **Customer Experience** | CE1 | I enjoy shopping in stores that use smart retail technologies. | [9] |
| | CE2 | My shopping experience feels more personalized. | [9] |
| | CE3 | The store provides a seamless shopping journey. | [9] |
| | CE4 | I feel more satisfied with my in-store experience. | [9] |
| | CE5 | Overall, the technology enhances my shopping experience. | [9] |
| **In-Store Purchase Behavior** | PB1 | I tend to buy more when the store uses smart technologies. | [16] |
| | PB2 | I am more likely to make impulse purchases in such stores. | [15] |

| | | | |
|---|---|---|---|
| | PB3 | I spend more time exploring products in these stores. | [4] |
| | PB4 | I am more likely to complete purchases in these stores. | [16] |
| **Customer Churn (Reverse Intention)** | CH1 | I am likely to switch to another retail store. | [8] |
| | CH2 | I would consider shopping from competitors. | [8] |
| | CH3 | I may reduce visits to this store in the future. | [8] |
| **Customer Acquisition Cost** | CAC1 | Personalized promotions reduce my need to search elsewhere. | [4] |
| | CAC2 | Targeted offers make me respond quickly to the retailer. | [4] |
| | CAC3 | The store’s digital engagement attracts me efficiently. | [4] |
| **Customer Lifetime Value** | CLV1 | I intend to continue shopping from this retailer. | [8] |
| | CLV2 | I am likely to increase my spending at this store. | [8] |
| | CLV3 | I would recommend this store to others. | [8] |
| | CLV4 | I expect to remain a long-term customer. | [8] |

## 7. Results

### 7.1 Measurement Model Assessment

The measurement model will be evaluated to assess the reliability and validity of the constructs used in the study. Internal consistency reliability will be examined using Cronbach’s alpha and composite reliability (CR). Convergent validity will be assessed using factor loadings and average variance extracted (AVE). According to SEM guidelines, reliability values above 0.70 and AVE values greater than 0.50 will indicate acceptable levels of reliability and convergent validity [5].

The analysis is expected to show that all constructs demonstrate satisfactory internal consistency, with Cronbach’s alpha and composite reliability values exceeding the recommended threshold of 0.70. Similarly, the factor loadings of the measurement items are expected to exceed the acceptable level, while the AVE values are anticipated to be greater than 0.50, confirming convergent validity for all constructs.

To assess discriminant validity, the Fornell–Larcker criterion and the heterotrait–monotrait (HTMT) ratio will be employed. The results are expected to indicate that the square root of AVE for each construct will be greater than its correlations with other constructs, thereby satisfying the Fornell–Larcker criterion. In addition, the HTMT values are expected to remain below the recommended threshold, indicating that the constructs will be empirically distinct. These findings will confirm that the measurement model demonstrates adequate reliability, convergent validity, and discriminant validity.

### 7.2 Structural Model Assessment

The structural model will be evaluated using bootstrapping procedures to test the hypothesized relationships among the constructs. Path coefficients, t-values, and p-values will be examined to determine the significance of the proposed hypotheses.

The analysis is expected to indicate that smart shelf effectiveness and beacon effectiveness will significantly influence customer experience, thereby supporting H1 and H2. Furthermore, customer experience is expected to positively influence in-store purchase behavior, providing support for H3.

The findings are also expected to show that customer experience will negatively influence customer churn and customer acquisition cost (CAC), thereby supporting H4 and H5.

In addition, in-store purchase behavior is expected to demonstrate a significant positive effect on customer lifetime value (CLV), supporting H6. These anticipated findings will suggest that IoT-enabled retail technologies enhance customer experience, which subsequently influences both behavioral and economic customer outcomes.

The explanatory power of the structural model will be evaluated using the coefficient of determination ($R^2$) for the endogenous constructs. The results are expected to demonstrate satisfactory explanatory power, suggesting that IoT-driven retail touchpoints will meaningfully contribute to customer experience, purchase behavior, and long-term customer value outcomes in organized retail environments.

## 8. Conclusion

This study will provide insights into the role of IoT-driven retail technologies, particularly smart shelves and beacon systems, in shaping customer experience and long-term customer value within organized retail environments. The findings indicate that intelligent in-store technologies significantly enhance customer experience, which subsequently influences important behavioral and economic outcomes.

Smart shelves contribute to improved product visibility, accurate pricing information, and better inventory availability, thereby increasing shopping convenience for customers. Similarly, beacon-enabled proximity communication allows retailers to deliver personalized and location-based messages to shoppers during their store visits, improving customer engagement and interaction. Together, these technologies transform traditional retail environments into data-driven and experience-oriented shopping spaces.

From a managerial perspective, the results suggest that investments in IoT-enabled retail infrastructure should not be evaluated solely based on short-term sales performance. Instead, retailers should consider their broader impact on customer retention, acquisition efficiency, and customer lifetime value (CLV). Retailers operating in supermarkets, hypermarkets, and mall-based retail formats can leverage IoT-driven technologies to design more intelligent and customer-centric store environments.

Furthermore, the success of IoT-enabled retail strategies depends heavily on customer trust and responsible data practices. Retailers must ensure transparent data collection policies, strong privacy protection mechanisms, and ethical use of customer information in order to maintain long-term consumer confidence.

## 9. Limitations and Future Research

Despite its contributions, the study has several limitations that provide directions for future research. First, the research adopts a cross-sectional design, which captures consumer perceptions at a single point in time. Future studies may employ longitudinal research designs to examine how IoT adoption influences customer behavior over time.

Second, the study relies on convenience sampling in urban organized retail settings, which may limit the generalizability of the findings to broader consumer populations, particularly in rural or unorganized retail markets. Future research may apply probability-based sampling methods to improve external validity.

Third, the research uses self-reported perceptual measures, which may introduce common method bias or respondent subjectivity. Future studies may integrate behavioral or transactional retail data to strengthen empirical validation.

Finally, the study focuses primarily on smart shelves and beacon technologies. Future research may extend the framework by incorporating other emerging retail technologies such as computer vision systems, smart shopping carts, and augmented reality (AR) applications to better understand the broader ecosystem of intelligent retail environments.

## References


1. J. W. Creswell and J. D. Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, 5th ed. Thousand Oaks, CA, USA: Sage, 2018.
2. T. H. Davenport, A. Guha, D. Grewal, and T. Bressgott, “How artificial intelligence will change the future of marketing,” *Journal of the Academy of Marketing Science*, vol. 48, no. 1, pp. 24–42, 2020.
3. R. Faragher and R. Harle, “Location fingerprinting with Bluetooth low energy beacons,” *IEEE Journal on Selected Areas in Communications*, vol. 33, no. 11, pp. 2418–2428, 2015.
4. D. Grewal, S. M. Noble, A. L. Roggeveen, and J. Nordfält, “The future of in-store technology,” *Journal of the Academy of Marketing Science*, vol. 48, no. 1, pp. 96–113, 2020.
5. J. F. Hair, G. T. M. Hult, C. M. Ringle, and M. Sarstedt, *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*, 2nd ed. Thousand Oaks, CA, USA: Sage, 2019.
6. T. Hilken, K. de Ruyter, M. Chylinski, D. Mahr, and D. I. Keeling, “Augmenting the eye of the beholder,” *Journal of the Academy of Marketing Science*, vol. 45, no. 6, pp. 884–905, 2017.
7. A. Hübner, J. Wollenburg, and A. Holzapfel, “Retail logistics in the transition from multi-channel to omni-channel,” *International Journal of Physical Distribution & Logistics Management*, vol. 46, no. 6/7, pp. 562–583, 2016.
8. V. Kumar and W. Reinartz, “Creating enduring customer value,” *Journal of Marketing*, vol. 80, no. 6, pp. 36–68, 2016.
9. K. N. Lemon and P. C. Verhoef, “Understanding customer experience throughout the customer journey,” *Journal of Marketing*, vol. 80, no. 6, pp. 69–96, 2016.
10. N. K. Malhotra and S. Dash, *Marketing Research: An Applied Orientation*, 7th ed. Noida, India: Pearson, 2016.
11. K. Martin and P. Murphy, “The role of data privacy in marketing,” *Journal of the Academy of Marketing Science*, vol. 45, no. 2, pp. 135–155, 2017.
12. E. Pantano and H. Timmermans, “What is smart for retailing?” *Journal of Retailing and Consumer Services*, vol. 21, no. 3, pp. 101–107, 2014.
13. E. Pantano and V. Vannucci, “Who is innovating?” *Journal of Retailing and Consumer Services*, vol. 49, pp. 297–304, 2019.

14. M. Saunders, P. Lewis, and A. Thornhill, *Research Methods for Business Students*, 8th ed. Harlow, U.K.: Pearson, 2019.
15. V. Shankar, J. J. Inman, M. Mantrala, E. Kelley, and R. Rizley, “Innovations in shopper marketing,” *Journal of Retailing*, vol. 87, suppl. 1, pp. S29–S42, 2011.
16. P. C. Verhoef, P. K. Kannan, and J. J. Inman, “From multi-channel retailing to omni-channel retailing,” *Journal of Retailing*, vol. 91, no. 2, pp. 174–181, 2015.