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# Connected Stores, Connected Brands, Connected Consumers, Connected Goods: On Business Model Ecosystems in Internet of Packaging

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Received 26 July 2019; Accepted 08 January 2020

Published 03 February 2020

## **Abstract**

This paper investigates and discusses roles, initiatives, and potentials for the business model ecosystem to enter business model innovation triggered by digital wireless technologies and capabilities of the Internet of Packaging-enabled smart interactive packaging. This paper develops an overview of the Internet of Packaging technology, wireless digital capabilities, business model innovation, and business model ecosystem in connection to the investigated phenomenon. In this paper, the digital transformation from passive to network-connected enhanced packaging is considered as an accelerator for business model innovation that creates and delivers the value proposition to a wide-ranging business model ecosystem including internal and external participants. Therefore, the governance of the overall business model ecosystem should efficiently reinforce each separate business model, as well as ensure safe and reliable data mobility in the IoP digital infrastructure regarding unique secure digital identifiers.

**Keywords:** Internet of packaging, consumer experience, retail, business model innovation, business model ecosystem.

*Journal of NBICT, Vol. 1, 77–94.*

doi: 10.13052/nbjict1902-097X.2020.004

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## 1 Introduction

Today consumers are largely inspired to purchase via digital media and digitally created brands. Therefore, brands are becoming dependent on customer loyalty maintained in digital universes. Due to brand-moderated social media platforms for brand communication and consumer engagement, consumers are enrolled not only as shoppers but also as retailers, influencers, followers, and other value-added service providers that can digitally interact with brands in real-time [1]. However, the potential of digital brand–consumer interaction is not fully exploited for physical products in stores. Simultaneously, goods remain passive throughout the entire supply chain, where manual registration or indirect data extraction to settle the current status of the item is still needed. Nevertheless, the rapid development of new computing and communication technologies, the establishment of wireless networks, and the growth of the Internet have enabled the digital transformation from physical passive to digital network-connected goods through their packaging [2, 3].

Generally, traditional packaging has always served as means of containment, protection, convenience, and communication [4]. However, the recent advances in printed electronics (PE), augmented reality (AR), conductive inks, and IoT have led to the improvement of the primary communication function and thereby to the emergence of IoP-enabled smart interactive packaging [5]. Consequently, the latter can extend the traditional communication aspects [3] and trigger a conversation between the product/brand and consumer at several interfaces [6]. Also, the design of Internet of Packaging (IoP) is multi-purpose with aims ranging from customer engagement to supply chain support. As a result, IoP provides an interactive dimension between brands, retailers and consumers – core participants of the business model ecosystem (BME). IoP enables the collaboration between diverse businesses to design innovative technological solutions for new value creation and thus drive business model innovation (BMI) [2]. Furthermore, due to the abundant amount of data generated by joint digital capabilities, IoP is able to expand the value proposition for a broader range of stakeholders that originates beyond the primary core actors [7, 8].

Therefore, this research aims to investigate which secondary BME participants IoP-enabled smart interactive packaging might benefit as well in connection to the Consumer Packaged Goods (CPG) industry. The paper examines and discusses roles, initiatives, potentials, and guidelines for the BME to enter BMI accelerated by digital wireless technologies of smart interactive packaging. First, an independent literature review was performed to

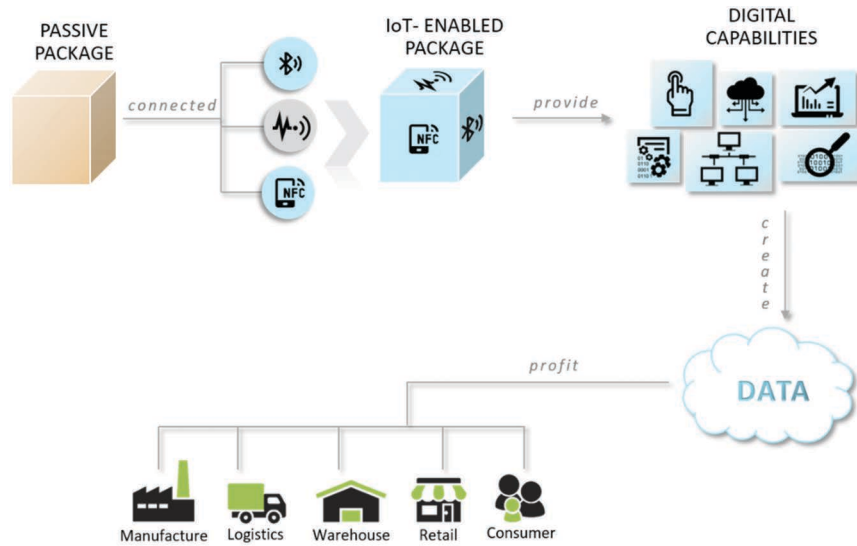


Figure 1 Digital transformation of packaging.

develop an overview of the concept of IoP, wireless digital capabilities, BMI, and BME and value chain. The connection of each subject to one another is illustrated in Figure 1. Second, empirical research was carried out to present study cases from several industrial and institutional stakeholders regarding network-enabled smart interactive packaging and CPG applications. Finally, the theory and empirical cases were merged to discuss how IoP-enabled smart interactive packaging with a wide range of wireless digital capabilities could engage other participants and thereby expand the overall BME.

## 2 Theoretical Background

### 2.1 Internet of Packaging (IoP)

Reference [9] states that digital innovation combines digital and physical components in the context of novel product creation, but it does not involve the action of human beings, whereas digital artifacts defined by [10] are: “objects created by and composed of digital technology and the outcome of coordinated human action.” Consequently, enabling technologies such as IoT and PE are further referred to as digital innovation, while smart interactive packaging as a digital artifact. The main distinction between physical artifacts, i.e. traditional passive packaging, and digital artifacts, i.e. smart

interactive packaging, is that the latter ones are intentionally incomplete, unfinished technologies that are continuously being improved, updated, and perpetually in the making [11]. As a result, IoT reliance on digitization makes traditional packaging programmable, addressable, sensible, and, most importantly, communicable and thus enables the development of innovative properties and innovation in products and services [9]. This technology is able to open new perspectives on how the general packaging definition can be understood and bring a new expression of the IoP into existence.

Since IoT allows packaging to embrace the digital transformation and become network-connected [5], it highly increases the design freedom for new applications. Contrary to IoT that connects vast amounts of everyday items to the internet [12], IoP targets a more particular range of objects and thus links physical passive CPG packaging to a network through embedded, laminated, or printed electronics, smart sensors, and tags. The latter can collect and exchange data for providing immediate access to information about the physical world and objects in it [12]. Due to digital capabilities of incorporated smart devices into packaging design, a package can detect, trace, communicate, and apply scientific logic to facilitate decision making for diverse participants [13].

## **2.2 Wireless Communication Systems for Packaging**

Once digital data has been detected, collected, or traced, it has to be obtained from connected communication devices to cloud computing systems in the middleware layer for further analysis and assessment [14]. Therefore, IoT follows networks and protocols to transmit gathered data [15]. Currently, smart interactive packaging employs several wireless communication systems:

- UHF Radio Frequency Identification (RFID) passive, semi-passive, and active tags with Gen2 standard based on automatic identification technology and widely used for smart warehouse, logistics, and real-time industrial location and surveillance operations [16]. An RFID tag embedded into packaging improves the way the data is handled since it can be altered and renewed wirelessly [17].
- 8.2 MHz RF Electronic Article Surveillance (EAS) tags with several signaling schemes that impart a reading indication once the package goes through the reader at the checkpoint [5]. Thus, EAS tags are utilized mainly in retail for antitheft alarms.
- Close-range Near Field Communication (NFC) tags ensure secure and efficient data exchange between devices based on electromagnetic principles [18]. In general, IoT combines diverse telecommunication

technologies like Global System for Mobile Communications (GSM), NFC, Bluetooth Low Energy (BLE), Wireless Local Area Network (WLAN), Global Positioning System (GPS), and sensor networks together with SIM card technology [14]. Consequently, NFC enables communication between devices and employs a mobile phone as a reader to transmit the read data to a central infrastructure [14]. Since SIM cards can store NFC data and various authentication credentials, this technology is utilized for identification and anti-counterfeiting practices for retailing.

- Lightweight bendable smart temperature, humidity, moisture, and other sensors embedded to packaging can measure, collect, and store data that afterwards can be transmitted to the database by RFID and NFC technologies. For instance, the combination of a temperature sensor and an RFID tag can improve the monitoring functions during transportation and storage in terms of the freshness status of packaged products [5].

Furthermore, intelligent identification of packed products can be supported by other positioning and image recognition systems, like QR codes, barcodes, beacons, augmented reality, and others that can trigger an instant entry to data [15]. Consequently, due to a wide range of wireless digital capabilities, smart interactive packaging enables reciprocal actions and thereby creates two-way communication between every supply chain participant and the package [19].

### **2.3 Business Model Innovation**

A business model (BM) is a conceptual tool with a number of elements and their relationships that express the firm's logic to create, deliver, capture, and commercialize value [2, 20]. In fact, a BM forms a sort of conceptual bridge, The Business Triangle, between Business Strategy, Business Organization, and Information and Communication Technology [20]. According to the authors, business models are subject to external pressure, e.g. competitive forces, social and technological changes, customer opinion, etc., and therefore they are constantly changing. Therefore, if a business aims to deliver benefits to customers, it has to find the new organized way to do so and capture a portion of the value it delivers with respect to changes in (i) social and (ii) technological environment [2]. On the one hand, changes in the social environment refer to a customer demand and behavior. Thus, it is essential for the enterprise to look into what are the target customers groups, what do they want, how they want it, and what they are willing to pay for it, i.e.,

identify value proposition [2, 21]. On the other hand, the business adopts new technologies through their business models [22], and thus the technology innovation is a significant part of value creation.

The growth of the Internet, the rapid development of new communication and computer technologies, and the establishment of global wireless networks and protocols have induced CPG businesses' transformations, and new ways of creating and delivering value have emerged [2]. Consequently, digital wireless capabilities provided by smart interactive packaging extend the traditional communication aspects [3] and potentially further expand communication by triggering a conversation between the package and consumer at several user interface touch points [5, 6]. Therefore, smart interactive packaging, as a digital artifact, can facilitate innovation [10] that induces the change of existing BMs and thereby contributes to BMI.

## **2.4 Business Model Ecosystem**

Reference [21] describes a BM as an instrument that includes links between traditional elements in the company and those outside that are parts of the overall mechanism for delivering products and services. In general, a business ecosystem refers to an economic community of interacting organizations and individuals with the key logic of the reciprocal relationships among companies and the surrounding business environments to enable the commercialization of products [23]. According to the author, in order to retain the business ecosystem, an effective value capture mechanism, i.e. monetization, has to be established. Therefore, despite the fact that the innovation itself is remarkable, it has to offer a compelling value proposition to users and set up profitable business systems. The perceived value should not only be related to the individual customer but also to every participant in organizational systems, networks, etc. in the business model value chain.

Regarding smart interactive packaging, the growth of the Internet has not only formed new ways of providing information services but also allowed businesses to have access to an abundant amount of information [2]. Furthermore, the digital transformation from traditional passive packaging to network-connected interactive packaging provides new digital capabilities that generate useful data for business ecosystems. Consequently, the IoP is potentially enabling and offering a compelling preeminent value proposition to a wide-ranging BME with brand-owners, retailers, and consumers as critical center-points. The graphical illustration of the digital transformation of packaging and its influence on BME is given in Figure 1.

### **3 Empirical Positions**

IoP emerges over a range of CPG markets. This technology is based on the collaboration of diverse businesses that aims to create joint digital capabilities and contribute to BMI. As a result, numerous firms have been started to develop novel B2B technologies to embrace the existing BM of CPG companies. Brief descriptions of collected empirical cases from the current packaging industry are given below.

#### **3.1 WaterIO Smart Cap**

WaterIO developed the Smart Cap technology that employs smart capacity sensors that are embedded into the lid and thereby are able to measure the volume of the liquid in the bottle. Then, data collected through such sensors is transmitted to the cloud for further analysis. This developed technology for various verticals is a great illustration of how IoP connects consumers with CPG brands and products via packaging. Firstly, the technology benefits consumers and can (i) measure the product usage, e.g. liquid capacity in the bottle; (ii) inform the user in various ways such as reminders on the app to stay hydrated, re-order washing liquid, or take medicines; and (iii) build a personal profile and report the usage history and typical habits on the app or cloud. Secondly, Smart Cap also creates preeminent value for a firm to improve its business model and link every actor in the business ecosystem to provide more customized, personalized, and efficient services. For example, once smart capacity sensors estimate that the product is about to run out, the WaterIO app will send an offer with a fixed-term discount code at the nearest shop ([water-io.com](http://water-io.com)).

#### **3.2 Mypack<sup>®</sup> Connect**

Mypack<sup>®</sup> Connect has presented a software IoT-enabled solution for CPG packaging to ensure better consumer engagement. Mypack<sup>®</sup> built solution is as intermediate between augmented reality and NFC technologies, i.e. it combines the capabilities of both techniques. Since it is based on image recognition technology, experiences are created by assigning the traditional packaging visuals as front-side layout to various digital content as videos, images, URLs, etc. in the provided software platform. Once the user scans the packaging front side with a mobile phone, he/she is automatically redirected to particular digital content. Contrary to NFC tags and QR codes,

this technology does not require any additional incorporated electronics and graphic design changes of the package (mypackconnect.com).

### **3.3 Thinfilm OpenSense™ and SpeedTap™**

Thinfilm provides highly scalable printed electronics solutions by employing printed NFC tags for various consumer and industrial packaging applications. The company has designed OpenSense™ and SpeedTap™ NFC technologies. The former contains a dual-ID tag with an incorporated opening sensor. Therefore, it is mainly deployed for preventing unauthorized refills and facilitating authentication to combat counterfeiting and gray market diversion. Furthermore, although the factory's seal will be broken after the purchase, the OpenSense™ tag remains still active not only to prolong the interaction between package, product, and consumers but also for analytic purposes. The latter, SpeedTap™, is a single-ID technology that enables instant identification of a product for track & trace and marketing practices (thinfilmnfc.com).

### **3.4 Thinfilm Smart Label**

Regarding supply chain operations, Thinfilm developed a smart label for temperature threshold detection that can accumulate information and then wirelessly transfer data to the CNECT™ Cloud. All electronic components and sensing devices, such as temperature threshold indicator, crystal clear display, touch button, stand-alone power supply and wiring, are utilized by printed electronics. Thus, a thin flexible smart label can be integrated into packages of different shapes and curvatures. This technology creates both (i) a supply chain audit trail with critical information such as date, time, and location of the package by monitoring the surroundings; and (ii) registration of accidents throughout the supply chain. It is a profitable solution for distributors, logistics providers, and retailers working with temperature-sensitive products (thinfilmnfc.com).

### **3.5 Saralon GmbH Light Emitting Devices**

Saralon GmbH produces a wide range of printed electronic devices and elements for packaging applications, like LED lights, illuminated displays, EC displays, circuits, batteries, inverters, sensors, and capacitive touch pads. Saralon GmbH has developed four main technology categories: SaralLight®, SaralIllum®, SaralOLED®, and SaralSecurity®. The first three are usually



applied for high markup product packaging with light emitting capability. For instance, SaralLight<sup>®</sup> and SaralOLED<sup>®</sup> include either SMD LEDs or OLEDs, whereas SaralIllum<sup>®</sup> is based on printed electroluminescent inks. SaralSecurity<sup>®</sup> is applied for electronically secure packaging with printed batteries, antennas, and EC displays. The developed solutions are aiming for consumer engagement, marketing and PoS/Instore communication, anti-counterfeiting and brand protection (saralon.com).

### **3.6 Other Digital Technologies**

In addition, the industry has also presented a broad range of other digital technologies to improve the existing ones related to packaging. For instance, ScanTrust enhances the traditional QR technology by ensuring highly secure supply chain traceability to combat counterfeiting (scantrust.com). Meanwhile, Kezzler presented the anti-counterfeiting solution Kezzlercode<sup>®</sup> for NFC applications for brand protection (kezzler.com). Furthermore, Digimarc introduced Digimarc Barcode<sup>®</sup> as an improved version of the traditional barcode that can contain more data than the UPC does and can provide access to diverse digital content (digimarc.com). A summary of each empirical case is given in Table 1.

## **4 Analysis and Discussion**

Smart interactive packaging is driven by advanced communication systems combining several enabling technologies from different providers. For instance, printed electronics utilizes conductive inks, nanomaterials, and parts of conventional electronics to manufacture smart sensors that further can be linked to a network by IoT. Consequently, IoP induces the collaboration of diverse businesses with the aim to create joint digital capabilities to design innovative technological solutions for a novel value proposition for consumers and thereby trigger BMI [7]. Furthermore, IoP is able to extend the value proposition and delivery for a broader range of stakeholders, i.e. data generated by joint cooperation can benefit internal, external, implicit, and explicit actors of BME. Reference [7] refers to such joint value as a complementary innovation created by the collaboration of internal company-specific platforms and external industry-wide platforms. Although the primary core business of CPG BME is brand-owners, retailers, and consumers, IoP can enable and profit other companies, organizations, and communities that originate beyond the confines of the primary actors [7, 8].

**Table 1** Summary of empirical cases

Digital Technology	Corporate Role	Enabling Components	Primary Purposes	Primary Engaged Environment
WaterIO Smart Cap	Smart lid for bottles	Capacity sensors, IoT	Consumption analytics for more customized services	At home (consumers)
Mypack <sup>®</sup> Connect	Digital graphics for packaging	Image recognition and tracking	Attract attention	In-store (consumers), at home (consumers)
Thinfilm OpenSense <sup>™</sup> SpeedTap <sup>™</sup>	Smart tags for packaging	NFC, dual-ID, single-ID, opening sensor	Refill fraud, anti-counterfeiting, authentication and identification, track & trace	In-store (retailers, consumers), at home (consumers), supply chain
Thinfilm Smart sensors	Smart labels for packaging	Temperature indicator, display, touch sensors	Supply chain audit trail, accident registration	Supply chain
Saralon Saralight <sup>®</sup> SaralOLED <sup>®</sup> Saralllu <sup>®</sup>	Light emitting devices for high value product's packaging	Printed LEDs, OLEDs, battery, touch sensors, electroluminescent ink	Attract attention on the shelf	In-store (consumers)
Saralon SaralSecurity <sup>®</sup>	Security system for packaging	Printed displays, sensors, batteries, antennas	Anti-counterfeiting, track & trace, authentication	Supply chain, in-store (retailers)

#### 4.1 Potentials of BME Regarding Consumer Engagement

The examined cases can provide potentials of BMI and set the circumstances for secondary stakeholders of BME. In a context of a primary internal platform, WaterIO Smart Cap technology can generate data that advantages both consumers, in forms such as reminders to use, re-order, or throw out the product, and brands, to understand product usage, features that engage consumers the most, and others. Likewise, Thinfilm OpenSense<sup>™</sup> and Mypack<sup>®</sup>

Connect are able to collect data of consumer engagement in connection to the scan & tap frequency, app downloads, video views, demographic spread, and others. As a result, based on retrieved real-time and historical data, the system builds dashboards to analyze consumer behavior further and provide more customized and personalized services.

In terms of consumer engagement, the overall process involves an ecosystem of external stakeholders such as consumer behavior and consumer satisfaction analysts, environmental services, consumer communities, health services, and others.

Furthermore, the WaterIO smart cap is able to measure how much of the product is left in a bottle. Therefore, when the product is about to end, the system will send an offer with a fixed-term discount at the nearest market. Consequently, IoP in a detergent bottle forms a BME between packaging manufacturers, fluid washing agents' brands, supermarkets, and to some extent even waste management industries, water, electricity, and sewage services.

#### **4.2 Potentials of BME Regarding Supply Chain Support**

IoP-enabled smart interactive packaging also expands the BME by improving the supply chain processes. Thinfilm developed real-time location tracking RFID and NFC systems to facilitate logistics operations, whereas smart pressure, temperature, and shock sensors register accidents during transportation and handling that allows supply chain participants to re-evaluate the most efficient means of transportation and the best conditions for it. Furthermore, RFID, NFC, and IoT capabilities to wirelessly accumulate, store, and transfer data highly benefit warehouse operations [24]. The relevant and critical data about each item can be easily accessed with a minimized amount of effort. As a result, these digital capabilities not only reduce the amount of damage and loss of the production during logistics but also improve employees' work efficiency, support collaboration and communication among them, and reduce the major bottlenecks and the risk of workplace accidents in the warehouse. In order to accomplish such goals, the information flow between internal and external platforms, particularly logistics, ICT, and data information service providers, has to be well-maintained.

Since the potentials of IoP BME are abundant, the number of presumable participants in the ecosystem is increasingly expanding. Therefore, it is critical to manage and govern the growth of internal company platforms and accompanying external ecosystems. The ecosystem governance should

reinforce the separate business models of each participant by sustaining their incentives to invest in joint value complementary innovations [7]. For instance, to meet the fundamentals of monetization in advertising, the consumer of a WaterIO-enabled bottle might be engaged by the promotion of healthy lifestyle organizations that provide nutrition coaching and analysis, fitness programs, sportswear and equipment, supplements and vitamins, and others. The retrieved and analyzed data of consumers' behavior from smart interactive packaging can form a basis for improving targeted advertising.

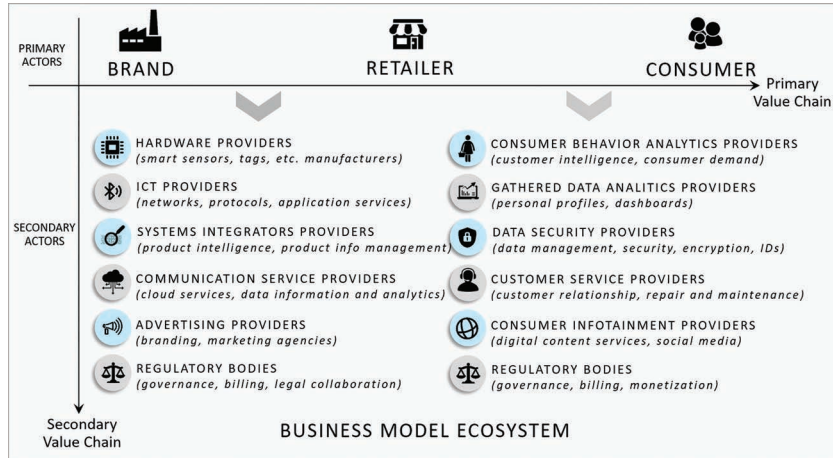
### **4.3 The Concern of Unique and Secure IDs**

In order to retain an effective governance of the IoP business ecosystem, the value capture has to be established not only in connection with the economic effectiveness but also in terms of security, privacy, and reliability relating to the management of customer data sharing, data encryption technologies, data ownership in collaborative clouds, enforcement of data privacy regulators, and the overall digital infrastructure [14]. The heterogeneity and high mobility of “connected things” in the IoP digital infrastructure add complexity to the overall BME for guaranteeing trust, privacy, and security of consumers and their data. First and foremost, it raises various matters in the system design in connecting IoP-enabled packaging with internal actors, i.e. the brands, retailers and consumers, and external industry actors by using IDs.

For wireless design, the potential IDs must be solved with ID tag emulation and anti-collision identifiers, although still retaining open elements for associating goods with consumers and other relevant stakeholders through the value chain. The Thinfilm CNECT<sup>TM</sup> platform has started to utilize blockchain ledger technology services as a potential security feature empowering participants of the BME to authenticate and verify products, track and register time, location, price, and parties involved, and other significant data when goods move throughout the supply chain [25]. ScanTrust, Digimarc Barcode, and Kezzlercode are the first preeminent steps into a virtual representation of unique secure digital IDs that can be employed in the blockchain infrastructure.

## **5 Conclusion**

IoP-connected smart interactive packaging is able to accelerate BMI through joint complementary innovation created by the entire BME including the core business and accompanying external stakeholders. Regarding collected



**Figure 2** Graphical illustration of potential secondary BME participants efficiently engaged by IoP-enabled smart interactive packaging of CPG products.

empirical data of currently commercialized smart interactive packaging applications, the potential primary and secondary value chains of IoP BME internal and external actors are proposed in Figure 2. The primary core business value chain consists of brand-owners, retailers, and consumers, whereas the secondary employs a broader range of stakeholders that are as intermediators between the core business actors, as seen from the illustration. However, each distinct IoP-connected enhanced packaging application has the feasibility to attract and involve stakeholders from different industries associated with the application's primary purposes. For instance, WaterIO consumers might be potentially engaged with a health style industry at the consumers' engagement level, whereas the Thinfilm smart label might involve waste management and environmental services at the supply chain support level.

Furthermore, IoP-generated data handling expands the traditional one-way information process flow in the value chain from the producer to the consumer, i.e. smart interactive packaging enables reciprocal actions between brand, retailer, and consumer. Even though the packaging has been purchased and reaches the final user, it still remains active and generates data that later is transmitted back to the retailer or the brand-owner and analyzed for the further product improvement.

In addition, the governance of the overall business model ecosystem should efficiently reinforce each participant's business model, as well as

ensure safe and reliable data mobility in the IoP BME digital infrastructure with the support of unique secure digital identifiers. Therefore, the BME and BMI will be dependent on the actual ID design. IoP is expected to leverage between physical and digital business environments, enabling the BME in order to engage with the fullest range of competencies, technologies and new BMIs stemming from the opportunities created from wireless communication systems.

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## Biographies



**Justina Lydekaitytė** is a Ph.D. student at Aarhus University in the Department of Business Development and Technology at Aarhus University. Her doctoral research investigates the potential and capabilities of enabling communication technologies that can be applied to consumer cardboard packaging to enhance consumers' experiences and packed products' functionalities. She takes a multidisciplinary approach that encompasses the fields of technology, engineering, business development and social science. She is a member of EngTech (Engineering & Technology) interdisciplinary research group in the same department, where she is enrolled as a PhD student. She holds a master's degree in Engineering (Technology-based Business Development) from Aarhus University, Denmark, that investigated a conceptual improvement of LEGO<sup>®</sup> product cardboard packaging by incorporating a printed Near Field Communication tag to enhance the engagement-based interaction between the consumer and the product. Justina has published and presented papers and book chapters together with the Association for Computing Machinery, Wireless World Research Forum, Nordic Retail and Wholesale Association, and IGI Global.





**Torben Tambo** is MSc in Information Systems from Technical University of Denmark, 1989, and is now engaged as associate professor at Department of Business Development and Technology, Aarhus University and head of studies for MSc in Technology-based Business Development. Research interests include enterprise architecture, information systems, retailing, energy and supply chain management. Torben has previously published with *Journal of Enterprise Architecture*, *Sustainability*, *Journal of Manufacturing Technology Management*, *Journal of Economic Dynamics and Control*, *Journal of Industrial Engineering and Management*, *International Public Policy Review*, and *Journal of Retailing & Consumer Services* and several book chapters. Torben has participated in research programmes on distributed health care, future energy system business modelling, and network-based smart packaging.

