



Amazon's initiative transforming a non-contact society - Digital disruption leads the way to stakeholder capitalization

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ARTICLE INFO

Keywords:

Advanced digital fashion
Amazon
Learning orchestration externality
Stakeholder capitalism
Non-contact society

ABSTRACT

Contrary to the decisive role of R&D centered on information and communication technology (ICT) in the digital economy, its excessive expansion has resulted in declining productivity due to the two-faced nature of ICT.

Consequently, the novel concept emerges of innovation that maintains sustainable growth by harnessing the vigor of soft innovation resources (*SIRs*).

Pioneering endeavors can be observed at the forefront of the global ICT leaders. World R&D leader Amazon has been harnessing the power of users that seek *SIRs*. This functions as a virtuous cycle, leading to the transformation of R&D by fusing a unique R&D system with a sophisticated financing system. With this orchestration, Amazon leverages the expectations of a wide range of stakeholders, and takes the initiative of stakeholder capitalism in which stakeholders bet on Amazon's prospecting future.

This paper attempts to elucidate the driving force of this notable accomplishment, taking Amazon's recent challenge in developing advanced digital fashions (*ADFs*) successively as prospecting *SIRs*. Since fashion reflects the change in socio-economic and cultural life, the fashion industry is in the midst of dynamic global change in the digital economy, which necessitates a digital solution.

Based on a co-evolution analysis of the development trajectories of Amazon and the fashion industry, it was demonstrated that Amazon has secured a digital solution by developing *ADFs* successively, and that this success can be attributed to learning orchestration externality. Thus, broad stakeholders' involvement betting on its challenge, expecting the future prospects of Amazon and the fashion industry, can be expected. Non-contact society accelerates this expectation toward on-demand *ADFs* manufacturing.

These findings give rise to suggestions regarding a new concept of R&D and subsequent neo-open innovation in the digital economy.

1. Introduction

Contrary to the decisive role of R&D centered on information and communication technology (ICT) in the digital economy, its excessive expansion has resulted in declining productivity due to the two-faced nature of ICT [1].

Consequently, the novel concept of innovation emerges that maintains sustainable growth while avoiding the dilemma by harnessing the vigor of soft innovation resources (*SIRs*). *SIRs* are latent innovation resources that can be awoken and activated by deploying an ICT-driven disruptive business model with the consolidated challenge for social demand [2].

Pioneering endeavors can be observed at the forefront of the global ICT leaders [3,4]. The world's top R&D firm, Amazon, has been engaging in pioneering innovation and companywide experimentation, thereby enabling it to harness the power of users that seek *SIRs*. This has functioned as a virtuous cycle, leading to the transformation of "routine or periodic alterations" into "significant improvement" during the R&D process, and has explored new *SIRs* successively [5].

This transformation has been enabled by fusing a unique R&D system with a sophisticated financing system centered on cash conversion cycle-driven free cash flow management [6].

With this orchestration, Amazon leverages the expectations of a wide range of stakeholders by satisfying a shift in people's preferences, from

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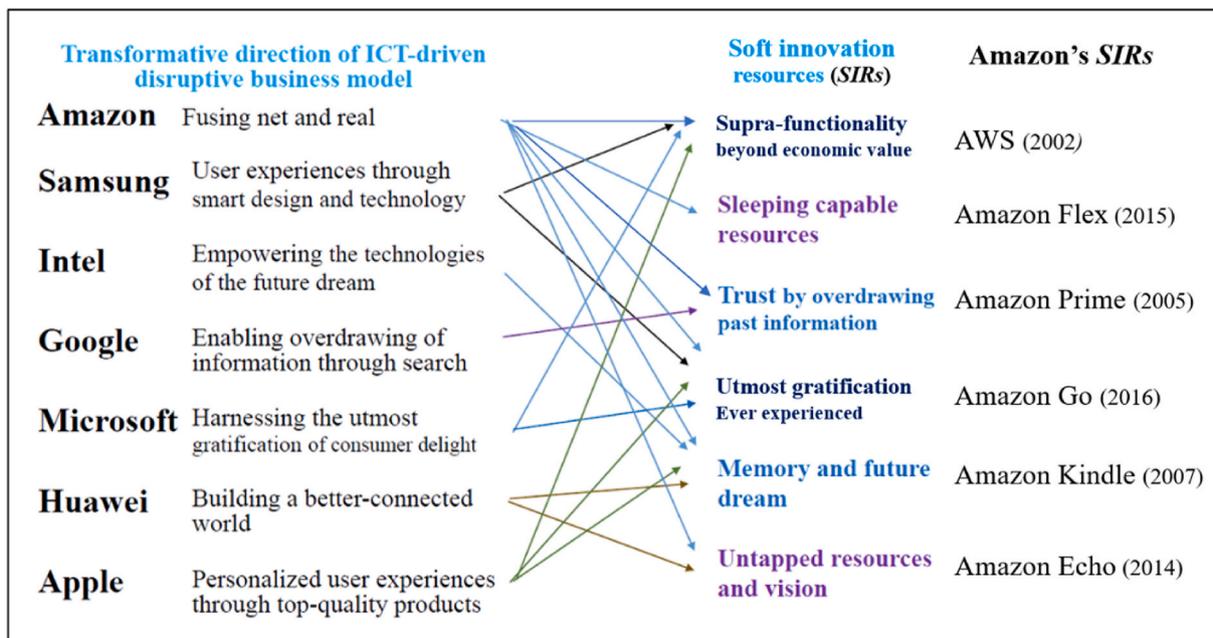


Fig. 1. Soft innovation resources emerged by global ICT leaders, and typical examples in Amazon.

economic functionality to supra-functionality, beyond economic value encompassing socio-cultural, aspirational, tribal, and emotional values [1,7,8].

In this way, Amazon has constructed a virtuous cycle among R&D-driven growth, the satisfaction of the shift in people's preferences to supra-functionality beyond economic value, the advancement of ICT, activation of SIRs, gross R&D (consisting of R&D investment and assimilated SIRs) increase, and well-balanced growth. Consequently, Amazon takes the initiative of stakeholder capitalism in which stakeholders bet on its prospecting future through its aggressive R&D [9]. The orchestration of techno-financing systems enables firms to secure a huge amount of risky investments by inducing an R&D bet from a broad range of stakeholders, which has paved a way to stakeholder capitalization [9].

Fashion reflects the change in aesthetic, economic, political, cultural, and social life [10]. These changes, in turn, change fashion, and apparel boosts this change [11]. Thus, in response to the above shift in people's preferences, the fashion industry has been gaining momentum worldwide [12].

However, the contemporary fashion industry is in the midst of global dynamic change in the digital economy [13,14], urging its volatility, velocity, variety, complexity and dynamism [15,16], which necessitate the digital solution. These features have urged Amazon to expect fashion as prospecting SIRs [17].

Given a timely digital solution, the fashion industry could reinforce the above R&D-driven virtuous cycle [18] which, in turn, advances the digital solution leading to co-evolution between them. Thus, broad stakeholders' involvement betting on a higher R&D with the expectation of the future prospects of the industry as well as the company can be expected [9].

To date, while many studies have analyzed the identical features of fashion and the fashion industry (e.g., Refs. [19–23], and also Amazon's R&D system from the viewpoints of technology operation strategy as well as financial management systems (e.g., Refs. [5,6,9,24–26]), no one has analyzed their co-evolutionary advancement leading to further advancement of the digital solution of the fashion industry and Amazon's R&D-driven customer-centric virtuous cycle toward stakeholder capitalism. Dumaine [27] has recently provided a suggestive postulate that the company's strength lies in the "Artificial intelligence (AI) Flywheel" mechanism, which uses vast amounts of data and AI to gain

momentum for growth.

Prompted by Amazon's recent challenge in developing advanced digital fashions (ADFs) successively with aggressive AI-oriented R&D, an empirical co-evolutional analysis of the development trajectories of Amazon's recent seven ADFs and the fashion industry, with special attention to the role of AI advancement, was conducted in this paper. Here, ADF can be defined as a new fast fashion business that leverages digital innovation assets and the learning effects of preceding development.

It was demonstrated that Amazon has succeeded in securing a timely digital solution by developing seven ADFs successively. Advancement of AI and Amazon's enthusiastic efforts to be an AI giant [28] enabled this success. Amazon's business culture as an R&D-based customer-centric company and its subsequent R&D strategy inevitably utilized AI in a unique way, as inducing multiple hierarchy-level functions for approaching human behavior and thoughts by learning from preceding innovations. Such institutional systems have enabled Amazon to enjoy the effects of learning orchestration externalities through the course of its successive development of seven ADFs.

While Amazon has developed its notable business model depending on institutional systems by shifting its driving force from network externality to big data externality, this analysis demonstrated that learning orchestration externality takes a lead in the current digital economy. This inevitably leads to broad stakeholders' involvement betting on its challenge, expecting the future prospects of Amazon and ADFs. Non-contact society after COVID-19 accelerates this trend toward on-demand apparel manufacturing.

An insightful suggestion toward stakeholder capitalism is thus provided.

Organization of this paper is as follows: Section 2 provides an overview of Amazon's endeavor in advanced fashion. Learning orchestration externality emerging in advanced fashion is examined in Section 3. Section 4 analyzes Amazon's endeavor toward stakeholder capitalization. Section 5 summarizes the noteworthy findings, policy suggestions, and future research.

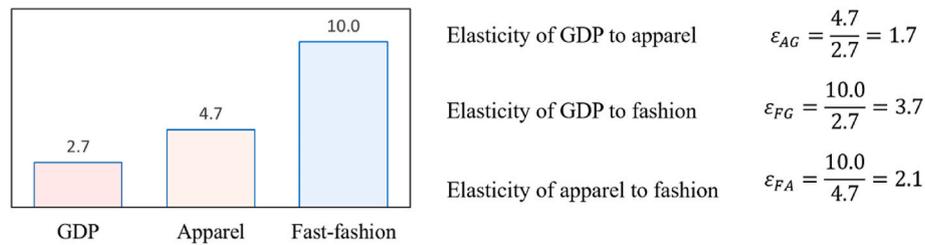


Fig. 2. Comparison of Growth Rate of GDP, Apparel and Fast-fashion in the World. (2011–2015) - % p.a. Sources: Singh [29] based on Market Line and Euro monitor International, and Statista [30].



Fig. 3. Co-evolution between SIRS-induced innovation and advanced digital fashion development in Amazon.

2. Amazon's endeavor to be a digital fashion leader

2.1. Virtuous cycle for customer-centric R&D-driven advancement

Amazon endeavors to make customer-centric R&D-driven advancement as the basis of its business model. With this business model, it has been endeavoring to frontier innovation and companywide experimentation for *growing its empire* and *subsequent big data collection* system.

This leads to notable interaction with users for user-driven innovation based on an architecture of participation, and a high level of assimilation capacity based on rapidly increasing R&D investment [5]. This enables it to harness the power of users who seek SIRS as demonstrated in Fig. 1.

This interaction functions as a virtuous cycle in Amazon, leading to the transformation of “routine or periodic alterations” into “significant improvement” during its R&D process [5].

These systems are considered a source that enables Amazon to deploy a successful neo-open innovation, leading its outstanding accomplishment in both R&D and sales increases by overcoming the dilemma between them. Here, neo-open innovation implies the novel concept of innovation emergence that maintains sustainable growth by avoiding the dilemma of productivity decline through increases in gross R&D, including assimilated SIRS by harnessing their vigor [2].

This deployment has been enabled by fusing a unique R&D system with a sophisticated financing system, centered on cash conversion cycle-driven free cash flow management [6].

With this orchestration, Amazon leverages the expectations of a wide range of stakeholders by providing supra-functionality beyond economic value, and takes the initiative of stakeholder capitalism in which stakeholders bet on its prospecting future through aggressive R&D [9].

Consequently, a notable virtuous cycle has been constructed: *user-driven innovation* → *advancement of the Internet* → *awakening and inducement of SIRS in a marketplace* → *increase in gross R&D (consists of indigenous R&D and assimilated SIRS)* → *solid growth* → *activation of self-propagating function* → *emergence of supra-functionality beyond economic value* → *acceleration of user-driven innovation* [9].

2.2. Challenge to fashion

(1) Lesson from the Bitter Experience

Challenge to fashion can be considered in the same context for Amazon. Fashion can be a strong growth engine as it incorporates a growth nature with high level of income growth elasticity, as demonstrated in Fig. 2.

Amazon has been making extensive efforts to reinforce the above virtuous cycle in terms of acceleration, widening, appealing to stakeholders, and avoiding fragility. The acquisition of Whole Foods in 2017 can be considered aiming at reinforcing this cycle by capturing the growth engine with a brand value of ESG¹ for avoiding the fragility of unsustainable growth derived from technological and financial risks and uncertainties, as well as environmental change in corporate governance [31].

In addition, Amazon develops a broad area of SIRS, as demonstrated in Fig. 1. These SIRS include what Amazon's user-driven innovation awoke and induced, such as (i) a shift in preferences towards supra-functionality (e.g., AWS in 2002), (ii) sleeping resources (e.g., Amazon Flex in 2015), (iii) drawing upon past information and fostering trust (e.g., Amazon Prime in 2005), (iv) providing the most gratification ever experienced (e.g., Amazon Go in 2016), (v) memory and future dreams (e.g., Amazon Kindle in 2007), and (vi) untapped resources and vision (e.g., Amazon Echo in 2014). These are corresponding to people's preferences shift, and Amazon's success in overcoming the dilemma between R&D expansion and sustainable growth can be attributed to assimilation of these resources as reviewed earlier.

Fashion advances all of these SIRS, which, in turn, leads to further advancement of the fashion industry. Thus, Amazon endeavours co-evolution between SIRS development and fashion advancement, as illustrated in Fig. 3.

¹ Whole Foods has taken a pioneering initiative in balanced ESG strategy: Environment-Social-Governance.

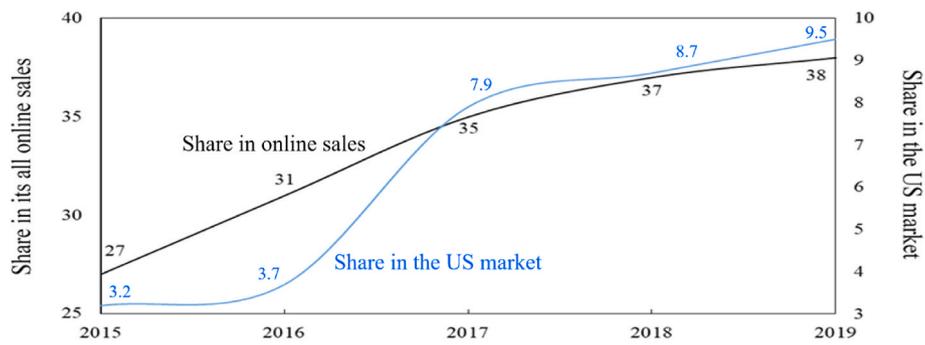


Fig. 4. Trends in Amazon’s apparel sales share (2015–2019): %. Sources: Statista [33]; Keyes [34]; Richter [35]; Wichser et al. [36]; Pymnts [37].

Thus, Amazon has been expanding the fashion-driven apparel business, which is a highly profitable category for Amazon. Fig. 4 demonstrates the increasing share of apparel sales on Amazon in all of its online sales as well as in the US market. Amazon has jumped to the second-largest seller of apparel in the US, with 7.9% share after Walmart (8.6%) in 2017, from 3.7% share in 2016. Apparel, including footwear, is now Amazon’s most bought category in 2018–2019, up from fourth place in 2017–2018, surpassing books, beauty, and electronics. Amazon quietly became the leading apparel retailer in the US in 2019 [32].

With this jumping inertia of apparel, taking into account the strong growth engine of fashion, which incorporates a growth nature with a high level of income growth elasticity as reviewed in Fig. 2, Amazon became keen to move beyond selling apparel as traditional value. It started fashion-driven apparel focusing on higher-value categories.

This was not Amazon’s first attempt at breaking into the luxury fashion market. It tried a similar move in 2012, but was not successful.

Part of the problem was the e-commerce brand’s image. Despite conquering most of retail and selling a lot of clothes, Amazon has consistently struggled to sell fashion. Its quest to dominate fashion has faced several historical obstacles, as customers have not trusted buying apparel online out of a desire to try on the items first; additionally, Amazon was perceived as an uncool brand seller that will not satisfy customers’ desire to try before buying the item.

(2) The New Platform

Based on such bitter experience, Amazon re-started the fashion challenge, focusing on shedding its image to a cool brand.

It acquired the global television rights to The Lord of the Rings (a series of three epic fantasy adventure films) in 2017, committing to a multi-season television series. This was an attempt to capture young affluent consumers’ passion, as acquiring a hot digitally native vertical brand would be essential for shedding its uncool label.

Successively, by making full utilization of digital technologies, such as artificial intelligence (AI), the Internet of things (IoT), virtual reality (VR), augmented reality (AR), and mobile devices, Amazon introduced several innovations designed to turbocharge its fashion-driven apparel business by making full utilization of its strength in the big data collection system, user-driven innovation, and advanced logistics system.

Consequently, Amazon’s share of fashion shoppers jumped from 50% in 2017 to 61% in 2018 [17]. Amazon can further increase its apparel market share if it diversifies the apparel business from selling basic and functional apparel to trendy styles [38].

2.3. The inducing role of the fashion industry toward stakeholder capitalism

The fashion industry is a demanding industry, part social and part cultural phenomenon.

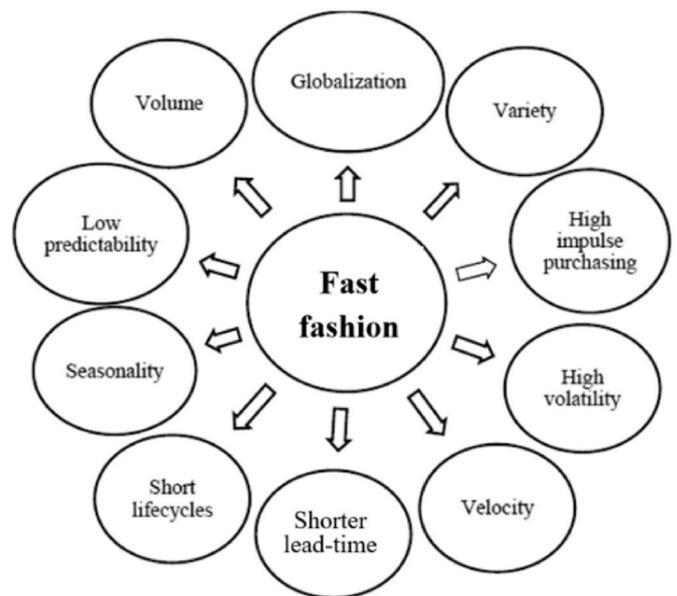


Fig. 5. Key features of the fashion industry in the digital economy. Source: Authors’ elaboration based on Ciarniene et al. [10].

Advancement of the digital economy increases demands in this industry by accelerating a shift in customer’s preferences, from economic functionality to supra-functionality beyond economic value, and accelerates subsequent identical features of the industry such as volatility, velocity, variety, complexity and dynamism, as reviewed in Fig. 5 [10].

At the same time, this advancement provides the fashion industry with a new solution, a digital solution. In addition, it causes the emergence of new environments, shifting to a sharing economy and a circular economy, which urge the fashion industry to change to a disruptive business model.

The above reviews on Amazon’s fashion challenge, new streams in the digital economy as digital innovation, shifts to sharing and circular economies, and their impacts on the fashion industry suggest that Amazon’s apparel strategy has transformed into a disruptive business model, as typically demonstrated by the successive introduction of such new innovative fashion models as Prime Wardrobe, AI Algo. Fashion designer, Echo Look, AR Mirror, Personal Shopper, Style Snap, and The Drop.

Such examples are crystals of SIRs, at the core of Amazon’s sophisticated virtuous cycle between gross R&D expansion, growth increase, supra-functionality creation, activation of user-driven innovation, advancement of the Internet, and further SIRs emergence. This cycle has enabled Amazon in shedding its uncool label from its fashion challenge, thereby allowing it to pour its business assets into the fashion industry and to

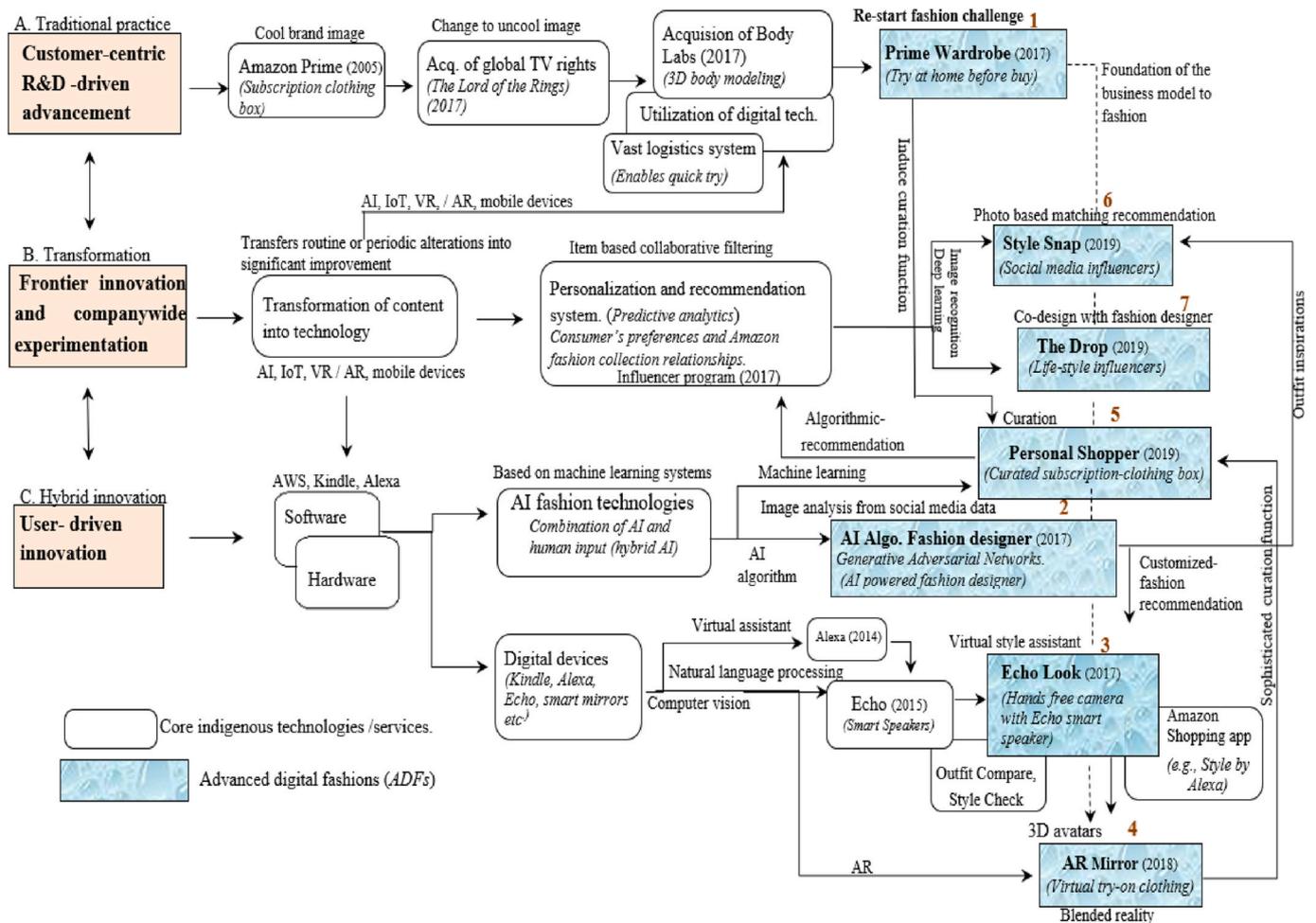


Fig. 6. Amazon's orchestration strategy in emerging advanced digital fashion.

lead disruptive innovation.

A fundamental feature of fashion as a popular aesthetic expression indigenous to human life triggered this cycle. Since this feature is the basis of all of SIRs as illustrated in Fig. 3, this co-evolutional dynamism between the development of Amazon and the advancement of fashion provides insightful suggestions toward stakeholder capitalization.

Another aspect that draws attention toward stakeholder capitalization is the fundamental nature of the fashion industry. Multiple stakeholders are involved in the value chain, ranging from procurement of materials, manufacturing, marketing, and consumption. These stakeholders bet to enhance the future prospects of the company.

3. Learning orchestration externality emerging disruptive fashion

3.1. Orchestration Strategy in Emerging Advanced Digital Fashion

As reviewed in the preceding section, a basic principle for Amazon in conducting its R&D endeavor as an R&D-driven company can be highlighted as follows:

(i) Customer-centric R&D-driven advancement

Amazon endeavors to make customer-centric R&D-driven advancement as the basis of its business model.

(ii) Frontier innovation and companywide experimentation

It has been endeavoring to frontier innovation and companywide experimentation for growing its empire and subsequent big data collection system.

(iii) User-driven innovation

It demonstrates notable interaction with users for user-driven innovation based on an architecture of participation, and a high level of assimilation capacity based on rapidly increasing R&D investment.

Amazon has been deploying orchestration strategy in endeavoring innovation by effectively utilizing the learning effects of similar challenges conducted in each respective area above the three pillars, which can be defined as learning by orchestration. Its endeavor in developing advanced digital fashions (ADFs) can be considered the typical case, as illustrated in Fig. 6.

In line with this orchestration strategy, Amazon has emerged such ADFs successively as Prime Wardrobe (2017), AI Algo. Fashion designer (2017), Echo Look (2017), AR Mirror (2018), Personal Shopper (2019), Style Snap (2019), and The Drop (2019).

Functionality and effects of learning orchestration externalities of each respective seven ADFs are demonstrated as follows:

(1) Prime Wardrobe (2017)

This triggered Amazon's re-start of the fashion challenge. This attempted to change Amazon's image from the uncool brand of just selling, to building trust and credibility [34,39]. This enables customers to try several items at home before purchase, and thereby satisfies their

demand for touching and feeling the apparel before purchase [40].

Amazon started from acquiring the global television rights to *The Lord of the Rings* (a series of three epic fantasy adventure films) in 2017, committing to a multi-season television series [41]. This was an attempt to capture young affluent consumers' passion, as acquiring a hot digitally native vertical brand would be essential for shedding its uncool label.

In parallel, Amazon attempted to reinforce its technology and distribution base for improving its competitive advantages in the fashion industry. Acquisition of Body Labs (2017) empowered 3D body modeling [42]. Incorporating the advanced digital innovation such as AI, particularly machine learning, IoT, VR/AR and mobile devices initiated through the transformation of content into technology, contributed to enhancing competitiveness. A vast logistics system enabled customers' quick try.

Thus, **Prime Wardrobe** succeeded in Amazon's re-start in the fashion business by shedding its uncool brand image.

Furthermore, this constructed the foundation of the business model by which to understand customers' needs on product and style preferences, as well as measurement of personal data. In addition, this induced an innovative business with a curation function: Personal Shopper (2019).

(2) AI Algo. Fashion designer (2017)

While **Prime Wardrobe** allowed customers to try several (given) items on at home before purchase, their potential desires would extend beyond these items.

To gain dominance in the fashion sector, Amazon aimed at providing customer-centric fashion solutions to each customer individually. To achieve this goal, Amazon used human designers as well as AI-based methods, such as machine learning and deep learning, by which to understand consumers' preferences, especially from social media data, and hence developed particular algorithms that have an ability to identify fashion trends through visuals appearing on the web [43,44].

AI Algo. Fashion designer provides new items by copying all possible fashion trends analyzed by human designers and AI, particularly by machine learning and deep learning.

Amazon's R&D team at Lab126 in the USA has developed an algorithm that learns about a particular fashion style from images, and then generates new items in similar styles from scratch. This uses machine and deep learning-based Generative Adversarial Networks (GAN), wherein two neural networks compete with each other [45].

By using this algorithm, Amazon is able to keep an eye on fashion trends by identifying and analyzing fashion-related images on the web. This revolutionary algorithm has the ability to design styles by itself. This algorithm also indicates that AI-powered fashion technologies can take over human designers, and the future fashion industry could possibly be more dependent on scientific/mathematical methods in the fashion design process [46].

Amazon has taken the lead in providing this breakthrough development, wherein algorithms find fashion inspiration from the Internet, analyze visuals and images to find fashion trends, and then generate similar styles from scratch without any human input. Amazon has provided the long-awaited solution that machines can design fashion without human supervision. However, these algorithms are continuously learning from data, and are not yet capable enough in producing the best results for each customer without human supervision [45].

This algorithm empowers Amazon's other imagery-based forthcoming fashion technologies such as **Echo Look** (2017) and its derivatives, with similar features such as **Style by Alexa**, either by using images taken for them or by providing customized fashion recommendations through them. It is also leveraged to induce **Style Snap** (2019) by advancing outfit inspirations from customers' provided photos function.

(3) Echo Look (2017)

While **AI Algo. Fashion designer** has satisfied customers' demand to try before purchase, they are still curious and want to see themselves wearing selected outfits before purchasing. Therefore, for these highly fashion-conscious customers, Amazon introduced a new device incorporating a personal style assistant.

By incorporating the hands-free camera and style assistant function, **Echo Look** captures images and short videos of customers wearing the outfits. This functionality can be attributed to smart speakers in **Echo**, which emerged in 2015 [47].

Before the launch of **Echo Look**, Amazon introduced **Outfit Compare**, a mobile feature by which customers can share the images of two outfits if recommendation is needed from Amazon's fashion team [48]. Amazon then further enhanced this software to be used for the hardware device. The technology behind the hands-free camera is computer vision [49]. It comprises a corresponding app., i.e., **Style Check**, for a second opinion on outfits. Users upload two photos, and **Style Check** provides the ratings. **Style Check's** fashion advice service is based on machine learning and human fashion designers [50].

Algorithms and human designers provide the final recommendations based on uploaded images. **Echo Look** collects more contextual consumer preference data, such as their body structures and buying habits, etc. The visual data enhance the skills of machine learning algorithms in designing and recommending customized outfits for each customer individually, leading to dependence on statistical and deep learning. Customized recommendations have significantly improved consumer trust in Amazon's fashion endeavors.

Echo Look has transformed **Alexa** from virtual assistant to virtual fashion assistant. It contributed not only to the selling of apparel through **Alexa** but it also trained **Alexa** in becoming a style advisor, which represents Amazon's innovative way of applying AI to fashion.

Its functionality has been transferred to the mobile-based "Style by Alexa" app., available at the Amazon Shopping app. [51].

While **Echo Look** has satisfied customers in gaining style assistant function, its outfit display was behind a possible idealistic one and has remained a "display-less device." This deficit has induced **AR Mirror** (2018) to complement this deficit, although functionality is not the same but comparable [52]. Thus, **Echo Look** laid the foundations for further user-driven innovations in a digital fashion [53].

(4) AR Mirror (2018)

While **Echo Look** has solved the customer's concerns about their looks in selected outfits, they expected more, such as real-time customized recommendations, instead of uploading photos on corresponding apps. for fashion advice. This motivated Amazon's patented **AR Mirror** for real-time fashion visualization.

AR Mirror uses virtual clothing with an augmented reality (AR) function and mirrors to recommend styles to customers. Superimposing virtual outfits on a customer's reflection in a mirror, it also creates virtual backgrounds at the same time if outfits are for a specific purpose/destination. The mirror shows virtual clothing overlaid onto the potential buyer's body and also shows virtual backgrounds, so that customers envision their outfits for specific destinations [54].

Customers view themselves in a blended reality environment, whereas AR technology provides virtual try-on fashion in customers' preferred virtual locations [55]. The device consists of a camera, projectors and a screen. A camera at the top of the mirror tracks the user's body and then a screen behind the reflective panel works with projectors to illuminate the picture [56]. Also, computer vision-based **Body Labs** (acquired in 2017) software is used to create human-like 3D avatars for outfit modeling. Its unique features include sizing of the human body, sizing of outfits, and putting them together in a virtual environment.

Customers can virtually try on clothes in the comfort of their homes before they purchase. Amazon would get more in-depth customer data, such as 3D visual measurements of body shapes through depth-sensing-cameras in the device [57]. This improves customers' shopping

experience by allowing Amazon to produce customized outfits, and it prevents accumulating large fashion inventories. It also prevents customers' physical store visits.

The successive development of advanced digital fashions, such as **Prime Wardrobe** and **AI Algo. Fashion designer** with the copy-all-possible-fashion-trends function, **Echo Look** with the personal style assistant function, and **AR Mirror** with a real-time customized recommendation function, has enabled Amazon to accumulate sophisticated curation ability, which satisfies customer-centric business [58].

(5) Personal Shopper (2019)

Prime Wardrobe has initiated foundations of the business model to disruptive fashion, and a series of successive advanced digital fashions have provided customers with sophisticated curation services.

However, the more choices customers have, the harder it is for them to decide, and, in turn, the less likely they are to purchase. Moreover, customers are more prone to feel remorse after choosing among a plethora of options. In addition, customers' preferences are rapidly changing. They do not want to spend time on building their style profiles and to wait for the curation process until products are shipped. They expect immediate real-time solutions. Subscription boxes can be the solution to indecisiveness and regret, as they curate products according to a customer's personal preferences, which also simplifies the process. Furthermore, letting customers apply personalization become the center of the retailer-customer relationship in a way that encourages extreme loyalty.

Personal Shopper, based on machine learning, provides the subscription-based, personalized curated clothing box by understanding every customer's unique needs, whether it is taste, style preferences, size, cost or even psyche. New clothes, decided on a real-time basis, are directly shipped to the customer's door. The styling fee is charged on top of the Prime membership fee [59].

Its preceding service was based on the traditional browsing of the Internet. Its counterpart had two major elements: Prime membership, and try at home before purchase. The sophisticated curation function went a step further in providing customized fashion for a set monthly fee. Customers first build their style profiles through a questionnaire, then AI algorithms, particularly machine learning, and human designers use the style profiles for curation [60]. Finally, customers can choose eight curated items at once, and then the subscription box is shipped to them with an option to pay only for the items they keep [61].

Without the expert's opinion, buying fashion online does not necessarily represent actual products that satisfy customers' needs [62]. However, **Personal Shopper** service has eliminated such issues, because customers communicate with designers throughout the curation process [61]. Customers are able to see final products before home delivery, while enjoying free shipping.

This can largely be attributed to the abovementioned sophisticated curation ability accumulated through a series of advanced digital fashion development [58]. The advancement of machine learning has enabled the construction of personalized data.

The prerequisite questionnaire provided important customers' preference data, such as size, color, and style. This allowed customers to develop personal relationships with Amazon designers through a feedback system. This relationship and style profile allowed Amazon to track the customized fashion needs of all customers individually. It improved customer loyalty, provided convenience, comfort, and the customized fashion aided in shedding its uncool image [63].

Since **Personal Shopper** has provided Amazon with a direct contact with customers, Amazon collects an enormous amount of customer data regarding their preferences. It also improved its algorithmic fashion recommendation system.

(6) Style Snap (2019)

In the preceding advanced digital fashions, curation was conducted by using the questionnaire. However, some customers like a fashionable outfit but cannot express the style or need in an immediate response about its availability. They are less expressive or do not use voice or text for fashion recommendation. In addition, the prerequisite questionnaire provides customers with preference data and indicates that customers are familiar with their required styles.

A fashion recommendation feature based on using visuals using can solve these problems [64]. **Style Snap** satisfies this, by providing photo-based matching recommendations in real-time.

The feature is for customers who were inspired by a style elsewhere, such as in a street, shop, or social media; they upload a picture, selfie, or screenshot of it and receive matching recommendations in real-time. In addition, recommended fashion products come with price, brand, ratings and reviews, thus enabling customers to filter products according to their preferences [65,66].

Style Snap is based on deep learning and computer vision that are continuously learning from data and images. It empowers Amazon's influencers program introduced in 2017 by enabling social media fashion influencers to recommend Amazon fashion products for a set commission [67].

Style Snap creates a visual shopping experience. Amazon's vast fashion inventory is available at its marketplace, to identify similar fashion images; this service uses image recognition of a subset of computer vision and deep learning methods [68]. By using these methods, this service provides the best possible results that match with customers' needs. It is a deep learning-based fashion search tool in which neural networks have developed an ability to remember fashion images from large data sets, and to learn new features at the same time with new data. This ultimately enables **Style Snap** to process large data and to find the best possible matches [65].

While **Style Snap** triggered a dependence on external resources for recommending similar styles, it continues to recommend fashion only from Amazon's fashion inventory [66]. It induced fashion influencers to develop their followers on social media further.

(7) The Drop (2019)

To further harness influencers' fashion designs by incorporating external resources such as street style trends by using machine learning, Amazon introduced **The Drop**, which enables social media influencers to present their fashion collection for a limited time on Amazon's Marketplace [69].

While **Style Snap** triggered the enabling of social media influencers to recommend visual-based fashion inspirations to Amazon customers, **The Drop** is a step further, allowing renowned lifestyle influencers and designers on social media to co-design fashion with Amazon's designers. Limited edition street style fashions, designed by influencers exclusively for Amazon, are available at Amazon's Marketplace for 30 h [70].

The Drop collection goes live after every few weeks, every time a new influencer brings a new collection. Fashion influencers who compete on fashion-related reality TV shows bring their collections to **The Drop**. Fashion competition TV series such as "Project Run Way" and Amazon's own show, "Making the Cut," aired at Amazon Prime Video are prominent examples.

As billions of users consume social media channels (YouTube, Snapchat, Facebook, etc.), a new entertainment is formed. Amazon capitalized this segment by merging entertainment, social media-content, and fashion. Influencers, designers and Amazon co-create fashion together. This provides Amazon with valuable data from external fashion professionals, and familiarizes Amazon's fashion algorithms and human designers with worldwide fashion trends.

Social media fashion influencers have developed higher trust and credibility among users. Due to their specific content on social media, they have large followings, which makes them nontraditional celebrities [71]. Many brands use them for influencer marketing

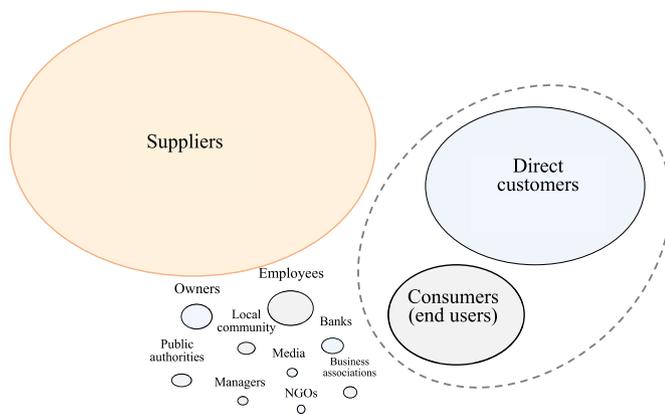


Fig. 7. Relative importance of stakeholders in the Swedish fashion industry. Source: Authors' elaboration based on Pedersen et al. [73].

campaigns on social media. The combination of the attractive clothes and extremely limited release makes the hype exciting and makes customers feel like they achieved something very exclusive [72]. Influencers share their experiences with users who influence their preferences. It provides a real-time shopping experience as every collection goes live and is available for less than 30 h on Amazon Marketplace.

With **The Drop**'s continued success, it is likely that the influencer collaborations will continue to grow in size, scope and even category. Influencers are successful at driving a quick response from their followers. In Amazon's influencer program, which emerged in 2017, social media stars can create a page, recommend products they like on Amazon, and earn commission on sales. Influencers are able to leverage their expertise and charisma to be salespeople for products not necessarily their own. Additionally, they leverage different channels, including social media, blogs, videos, webinars, email lists and columns to market to the potential audience.

Thus, *ADF* has explored a new business model utilizing external innovation resources by co-designing with external designers. This corresponds to neo-open innovation, which is the novel concept of innovation emergence that maintains sustainable growth by avoiding the dilemma between R&D expansion and productivity decline by

Table 1
Learning orchestration of advanced digital fashion emergence in Amazon.

Advanced Digital Fashion	Functionality	Lessons from preceding innovation	Assets obtained that transferred to/motivated followers	Core function of AI
1. Prime Wardrobe (2017)	Enables customers to try several items at home before purchase.	3D body modeling AI (ML), IoT, VR/AR, mobile devices	Foundation of the business model to understand customers' need and style preferences.	ML
2. AI Algo.Fashion designer (2017)	Provides new items by copying all possible fashion trends.	ML and DL based Generative Adversarial Networks (GAN)	Prospect of machines' capability to design fashion without human supervision.	ML, DL
3. Echo Look (2017)	Captures images and short videos of customers wearing the outfits.	Echo, Outfit Compare (share photos), Style Check (second opinion)	Enhanced the skills of ML algorithms in designing and recommending customized outfits.	ML, CV, SL, DL
4. AR Mirror (2018)	Provides real-time customized recommendation by using virtual clothing.	CV-based Body Labs software	Trained Alexa to become a style assistant Accumulated in-depth customer's data, such as 3D visual measurements of body shapes and sophisticated curation ability.	CV, AR, VR
5. Personal Shopper (2019)	Provides the subscription-based personalized curated clothing box.	sophisticated curation ability accumulated through series of <i>ADFs</i> development	Secured big customer data on their preferences and improved algorithmic fashion recommendation system thereby. Improved customer loyalty and provided convenience, comfort, and customized fashion.	ML
6. Style Snap (2019)	Provides photo-based matching recommendations in real time.	Influencer program.	Enabled to process large data and find best possible matches	CV, DL
7. The Drop (2019)	Allows renowned life-style influencers to co-design with Amazon's designers.	Social media fashion influencers	Explored a new business model utilizing external innovation resources by co-designing with external designers.	ML

ML: machine learning; CV: computer vision, SL: statistical learning, DL: deep learning. AR: augmented reality, VR: virtual reality.

harnessing the vigor of *SIRs*, as reviewed in sub-section 2.1. *ADFs* can be expected to play a prominent role as *SIRs*.

In addition, **The Drop** merges broad influencers' channels including entertainment, social media, blogs, videos, webinars, email lists and columns, and fashion. Through this process, broad stakeholders— not only Amazon and its direct customers but also broad external influencers including entertainment, social media, and designers— enjoy higher services corresponding to growth in size, scope and category. The scope of stakeholders involved is much broader and balanced than that of traditional stakeholders' involvement in the fashion industry, as demonstrated in Fig. 7 [73].

This provides Amazon with valuable data, information and flavor from external fashion professionals and fashion lovers, and familiarizes Amazon's fashion algorithms and designers with worldwide fashion trends.

This effect can be defined as the effect of learning orchestration externality.

3.2. Learning orchestration externality

(1) Learning Orchestration

These analyses demonstrate that Amazon has emerged a series of *ADFs* successively by deploying an orchestration strategy in endeavoring new innovation by effectively learning from preceding innovation, as summarized in Table 1.

Table 1 demonstrates that advancement of AI through its multi-hierarchical functions, such as machine learning, computer vision, statistical learning, and deep learning, as well as technologies utilizing these functions, such as AR and VR, played a leading role in this orchestration.

(2) Pivotal Role of AI

AI plays a pivotal role in the digital solution to the historical demand of the fashion industry, as illustrated in Fig. 8 [74].

AI incorporates such unique characteristics as inducing multiple hierarchy-level functions for approaching human behavior and thoughts, as illustrated in Fig. 9. This inducement depends largely on learning from preceding innovations.

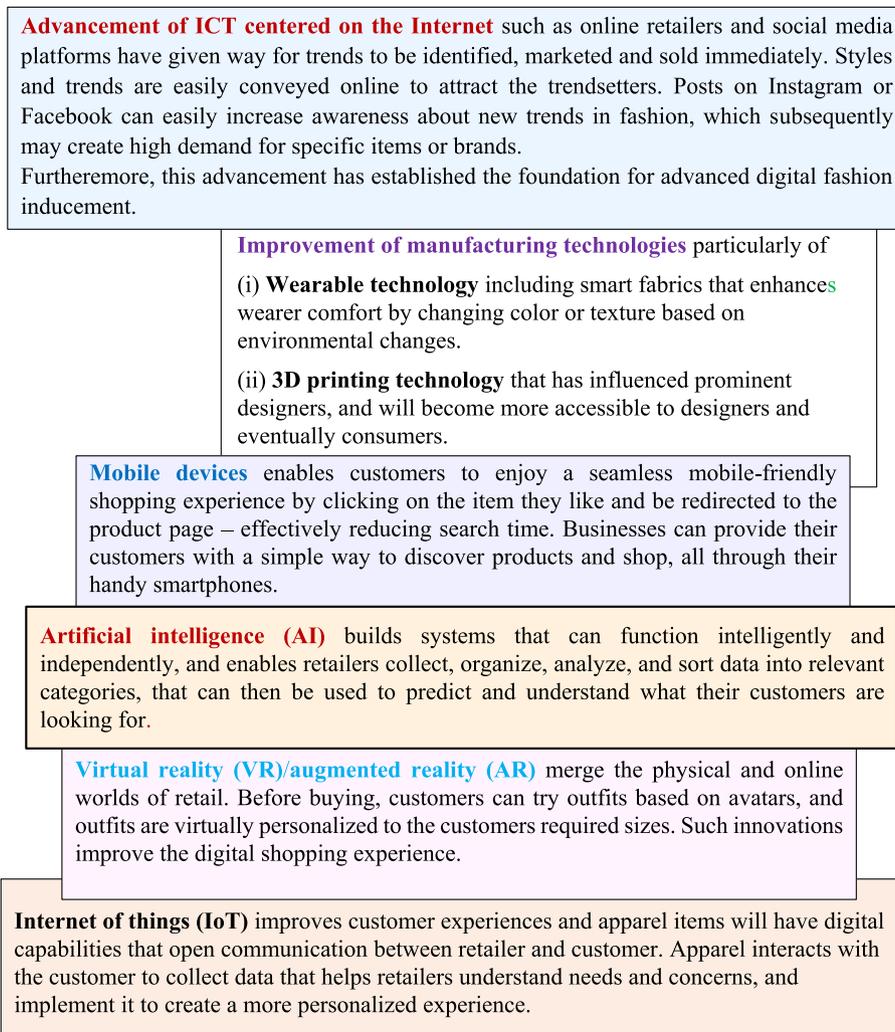


Fig. 8. Pivotal role of artificial intelligence for digital solution to the fashion industry.

AI attempts to mimic human behavior, equipped with a program that can sense, reason, and adapt by learning images and patterns of human behavior, thereby building systems that can function intelligently and independently that make the computer do things requiring intelligence. Currently, AI can be recognized as the main sub-domain of computer science [75,76].

AI techniques in fashion analyze and process big data to understand the needs, design products and services for each customer, i.e., customization and personalization [77]. The techniques are aimed at mimicking human behaviors that move, see, speak and listen, read and write, recognize objects, and remember. AI has been growing by developing its functions through multi-hierarchical learning as follows.

Symbolic learning is symbolic-based image processing. Humans can understand their environment and move therein. This is the field of robotics that can mimic the human behaviors of walking, running, sitting, etc. Humans can see and process what they see Ref. [78]. This is a part of computer vision that allows computers to analyze and process images and videos to identify fashion trends.

Machine learning is used for the development of algorithms that allow computers to learn by themselves from the data. It makes software more precise in making classification and prediction. For example, in the fashion industry, it is used to understand different features of images by classifying them in providing accurate recommendations and predictions [79].

Statistical learning is used for classification in **speech recognition** and **natural language processing**. While the former is used to

recognize speaking and listening, the latter is used to extract useful insights from large unstructured data as reading and writing [78].

Deep learning is a subset of machine learning. It uses a convolution neural network for recognizing objects, and a recurrent neural network for remembering [80]. This learning allows Amazon to determine which products a customer is likely to purchase, based on customer's purchase history.

(3) Amazon's Endeavor to be an AI Giant

It was in 2014 when Jeff Bezos was advised by Srikanth Thirumalai, former IBM computer scientist, of the latest notable advances in AI. While Amazon had realized a potential significance of AI, at that time it had yet to significantly tap into the advances in AI and was falling behind Google, Apple, Facebook, and Microsoft for AI dependence. It took a lot of debates to transform Amazon from an AI wannabe into a formidable power [28].

Echo is Amazon's key innovation. It is an AI-based smart speaker powered by the Alexa voice platform. The trickiest part of the Echo was speech recognition. While building a machine-learning system that could understand and respond to conversational queries in noisy conditions required massive amounts of data, Amazon did not have an industrial-strength system in place for applying machine learning to product development. However, Amazon had incorporated all necessary pieces, such as an unparalleled cloud service, data centers loaded with graphics processing units (GPUs) to crunch machine-learning

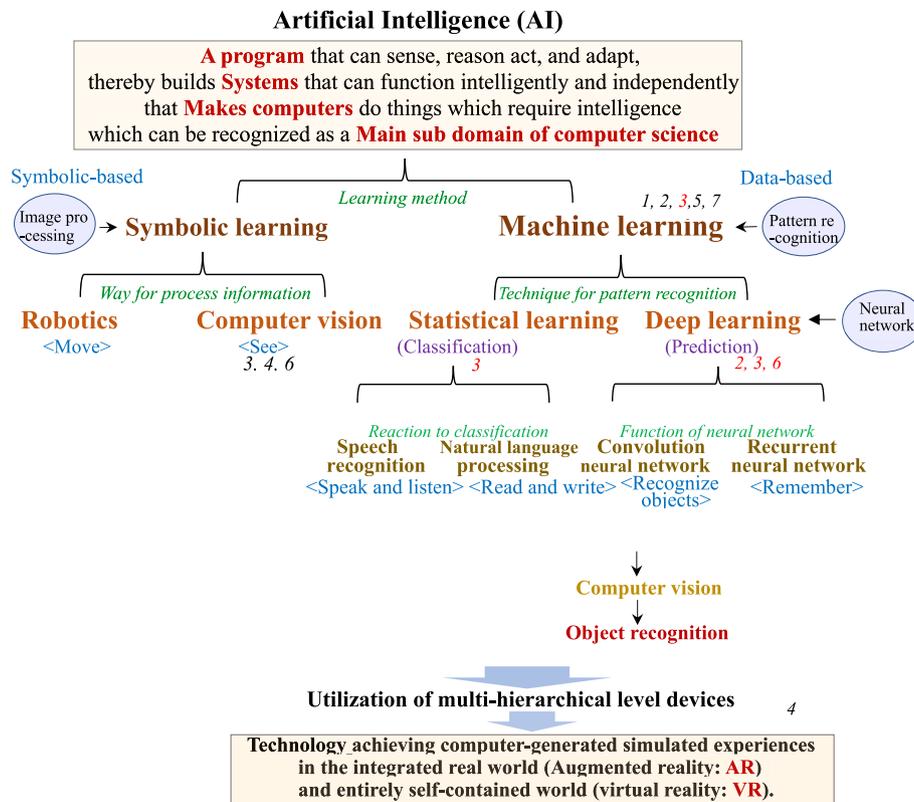


Fig. 9. Hierarchy of AI focusing on Learning and Recognition Methods by Core Functions and on their Application Devices.

algorithms, and engineers who knew how to move data around like fireballs. Amazon used those parts to create a platform that was itself a valuable asset, beyond its use in fulfilling the Echo’s mission.

Levy [28] noted that integrating Echo with Alexa was a game-changer that stimulated AI-based innovations. Alexa became the catalyst for further AI advancements. Amazon successfully integrated voice technology into other products such as Fire TV, Dash Wand, Amazon Fresh and, finally, AWS. Over the years, Alexa has reached numerous customers with several skills. The advancement in voice technology fueled Amazon’s growth more rapidly because Alexa interacts with humans and collects their data to be used in developing machine-learning algorithms.

With AI and machine learning, Amazon has become a market leader of customer–centric digital innovations. The Flywheel is a fundamental strategic virtuous cycle that represents the positioning of AI throughout Amazon’s innovation process [27]. Amazon Echo, Amazon Go, Amazon Flex, recommendation systems, and advanced fashion technologies are heavily dependent on AI and machine learning algorithms. In the Flywheel approach, technological innovations in one sector stimulate/empower the innovation process in other sectors of the firm [28]. For example, although Alexa was introduced for other tasks, such as music playing, home automation, or voice-based shopping, etc., it now has transformed to a personal fashion assistant representing Echo Look. It not only recommends fashion trends but also at the same time collects valuable insights from customers. These insights can be used to fuel machine-learning algorithms for further innovations, thus aiding in continuous spinning of the Flywheel. Therefore, the success of Amazon’s diverse business lies in continuous spinning of the Flywheel, because every customer-centric innovation is a spoke of the Flywheel, which has implications on other existing and future products and services.

Even though fashion is not Amazon’s core business, nevertheless Amazon has still been able to run a fashion business successfully. The preceding innovations, such as AWS, which offer numerous services including advanced computing, data storage, machine learning, deep

learning, AR, VR, etc., and Prime, are building blocks in the development of Amazon’s advanced digital fashion endeavor, ultimately empowering the wheel with fashion customers.

Amazon’s business culture as an R&D-based customer–centric company, and its subsequent R&D strategy as transforming routine or periodic alteration into significant improvement, inevitably utilized AI in unique ways, such as inducing multiple hierarchy-level functions for approaching human behavior and thoughts by means of learning from preceding innovations. This institutional system has enabled Amazon to enjoy the effects of learning orchestration externalities through the course of its successive development of seven ADFs.

3.3. Advanced digital fashion in a non-contact society

Confronting an unexpected COVID-19, the apparel industry has been suffering stagnation. The fashion industry cannot be an exception. Fashion designer Junko Koshino provided a warning that, “The significance of fashion is being re-questioned by COVID-19. Apparel companies must abandon their past success experiences” [81].

The highly integrated global supply chains represent the fashion industry. Several challenges affected this industry during pandemic, such as disruptions in global supply chains, reduced fashion manufacturing orders, increasing employment crises, retail stores rethinking their business models, and customers remaining socially distant. COVID-19 revealed the fashion industry’s fragility and structural impediments that necessitate a shift from traditional business models to digitally-driven ones.

COVID-19 has accelerated transformation of the fashion industry from brick-and-mortar stores to digital channels. Digital solutions, from product development to delivery with minimal physical contact, are being accelerated. For example, fashion shows and weeks throughout the world are held virtually [82]. In Helsinki, Finland’s fashion week (digital village) used advanced 3D technology, which created and sold digital versions of fashion items [83]. Visitors joined the virtual shows as

avatars [84].

There are also new discoveries with COVID-19 which suggest that combining digital to create new value is essential [81]. Amazon has demonstrated its indigenous strength to transform the crises into a springboard for the new innovation.

As reviewed earlier, The Drop has enabled Amazon to capture worldwide fashion trends, influencers' markets and their followers by providing street style limited edition fashion in collaboration with social media fashion influencers. Customers can examine these fashion collections for a limited time on Amazon's Marketplace for their decision making. This service explores the possibility of *on-demand manufacturing service* enabling customers outfits by their own initiatives [85].

In 2017, Amazon was given a patent for on-demand apparel manufacturing. The smart system starts production as soon as Amazon confirms the customer's order. The manufacturing system is controlled by a computing environment. The manufacturing process is completed in small batches that are based on sizes, shapes, fabric types and delivery locations [86]. This venture could facilitate Amazon in providing fashion manufacturing as a service in the same way as it provides its logistics services to third-party sellers [87].

While customers have been craving this system and expecting it to move beyond limited street style fashion, the current marketplace-initiated system impedes their satisfaction. Therefore, the timely application of on-demand apparel manufacturing to broad digital fashions by overcoming the structural impediments indigenous to the current marketplace-initiated business model is strongly expected.

In line with its successive *ADFs* development, Amazon introduced a new digital platform for luxury fashion, **Luxury Stores**, in 2020 by collaborating with renowned luxury fashion designers and brands.

Luxury Stores provides a new shopping experience that features established and emerging luxury fashion and beauty brands. This enables access to the latest collections and exclusive items from each luxury brand through mobile, fast and free delivery [88]. Unlike Amazon's traditional business model, it created a store within a store experience, because luxury fashion items will be sold directly from brands while using Amazon's interactive platform. It allows luxury fashion brands to control prices, inventories, and customer service queries in order to keep their brand's identity, whereas on the backend Amazon provides services for personalization, content creation and a vast range of Prime members [89].

This business model incorporates the following advantages to Amazon as well as to its stakeholders:

- (i) Amazon is always listening to and learning from its customers, and is inspired by feedback from Prime members.
- (ii) Contrary to Amazon's sole control in its traditional business, luxury fashion brands are able to control prices, customer services, and inventories, while Amazon provides merchandizing tools and customers data for creating and personalizing content for each brand's identity.
- (iii) Amazon can gain trust from luxury fashion brands by allowing them freedom.
- (iv) For fashion and beauty shoppers, mobile technologies are more convenient.
- (v) This business model could be a logical extension of Amazon's fashion innovations in creating new luxury fashion experiences for customers.
- (vi) Amazon can increase its sales volume which enables it to leverage its position as the leading fashion retailer and to extend its reach in the luxury fashion industry, while providing luxury fashion brands as solution for increasing their sales without depending on brick-and-mortar retailing, in a non-contact society.

Attracting luxury fashion brands to its platform was Amazon's long-awaited ambition, but it failed due to its solo-channel approach, selling basic apparel by its own control over branding, pricing and discounts.

Due to these impediments, luxury fashion brands have been reluctant to collaborate with Amazon.

Luxury Stores is expected to remove these impediments. Through this business model, Amazon enters into luxury fashion and sheds its image of an uncool fashion brand by opening a multichannel approach that allows luxury fashion brands control over branding, pricing and discounts. Simultaneously, it provides a timely solution to luxury fashion brands in a non-contact society by enabling customers to access their fashion by mobile phones and by staying at home, while most of luxury fashion business relies on physical stores due to the sensory experience [90].

A non-contact society encouraged the digitization that enabled the fashion industry to resurge its growth with new business models. Stay-at-home policies enabled Amazon to rethink its business strategy encompassing new services, actors and customers, i.e., by introducing **The Drop** with on-demand manufacturing, and **Luxury Stores** with a multichannel approach.

With this breakthrough by **Luxury Stores**, it is expected that *ADFs* may remove the structural impediments impeding on-demand manufacturing in the fashion industry.

On-demand manufacturing in the fashion industry is not widely adopted, although there has been growing interest in recent years.

In the fashion industry, since a traditional manufacturing system is based on matching demand and supply, attempts at on-demand manufacturing have failed. Covid-19 acted as a catalyst in finding new solutions. It encourages local production that solves emerging issues such as lockdowns, store closures, and halted international shipments during crises such as a pandemic. Due to the sharp decline in demand, fashion brands are struggling with excessive unsold items. Manufacturing fashion products on demand might be appealing because it will allow brands to rapidly respond to changing customers preferences that encourage personalization and customization, leading to luxury fashion development.

This necessitates reconsideration of the business model. While traditional fashion businesses rely on the single channel business model, they need digital solutions encompassing direct-to-customer models. Widespread use of mobile devices supported by AWS-initiated AI advancement enables this solution, while supporting staying-at-home policies during pandemic.

The multichannel approach with which **Luxury Stores** is equipped increases flexibility in demand and supply matching, and corresponds to the above critical demand in a non-contact society, leading to removing structural impediments that impede on-demand manufacturing in the fashion industry. This approach can bring more data from luxury fashion brands and existing customers. The insights gained from this data could be a catalyst for on-demand fashion manufacturing.

These noteworthy trends suggest the emergence of hybrid externality, combining learning orchestration and on-demand *ADFs* manufacturing.

Over the last quarter-century, Amazon has explored its notable business model according to change in institutional systems encompassing economic, cultural and social life, by shifting from network externality to big data externality.

The above reviews on successive emergence of *ADFs* suggest that learning orchestration externality takes a lead in the current digital economy, where people's preferences have been shifting from economic functionality to supra-functionality, beyond economic value. This inevitably leads to broad stakeholder's involvement, betting on its challenge and expecting the future prospects of Amazon and *ADFs* that can be expected. A non-contact society after COVID-19 accelerates this trend toward hybrid externality, combining learning orchestration and on-demand *ADFs* manufacturing.

Given that fashion reflects the change in aesthetic, economic, political, cultural, and social life [10], this trend suggests a prospect of stakeholder capitalization.

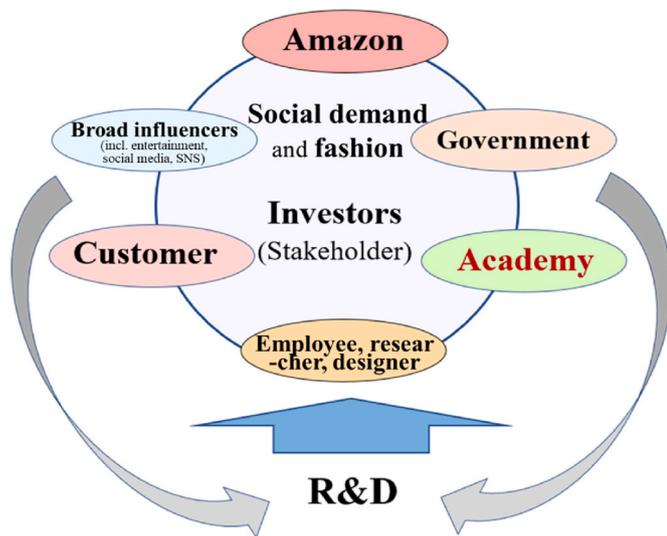


Fig. 10. Broad Stakeholders' Involvement Betting on Amazon's Solid Growth by means of R&D-driven Successive ADFs Development.

efficiently as demonstrated in Fig. 12 D.²

Thus, Amazon has constructed a virtuous cycle among an investor surplus, R&D and stock prices as illustrated in Fig. 13.

Because Amazon has not paid a dividend since its initial public offering (IPO) in 1997, nor has it made any buybacks of its shares since 2012, investors incorporate not only shareholders but also broad stakeholders centered on users.

Therefore, broad involvement of stakeholders, as was demonstrated in Amazon's successive ADFs development, stimulates this virtuous cycle and accelerates stakeholder capitalism, which accelerates the accomplishment of neo-open innovation by effective utilization of SIRs, as illustrated in Fig. 13.

Thus, with the indigenous nature of the fashion industry embracing broad stakeholders, and also with the art of fashion hitting them, broad stakeholder's involvement betting on a higher R&D with the expectation of future prospects of company involvement in a new fashion industry in the digital economy can be expected.

This corresponds to a new business doctrine toward stakeholder capitalization (Business Roundtable, 2019). A non-contact society after COVID-19 accelerates this direction, as analyzed in the case of Luxury Stores that emerged amidst the COVID-19 backdrop.

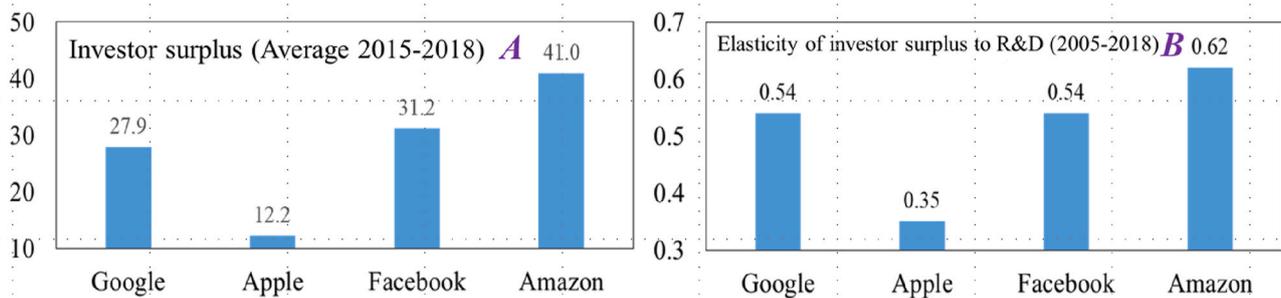


Fig. 11. Investor surplus and elasticity of investor surplus to R&D in GAFA.



Fig. 12. Elasticity of R&D to stock prices and stock prices to investor surplus in GAFA (2005–2018).

4. Stakeholder capitalization

The above analysis on Amazon's R&D-driven ADF challenge demonstrates broad stakeholders' involvement betting on the continuation of its solid growth by means of successive ADF development, based on its aggressive AI-oriented R&D investment, as illustrated in Fig. 10.

Amazon maintains a high level of an investor surplus which demonstrates that investors are betting on the continuation of its solid growth by means of its aggressive investment in R&D, as demonstrated in Fig. 11 A [9]. This surplus induces R&D efficiently, as demonstrated in the highest elasticity of investor surplus to R&D among GAFA (Fig. 11 B).

Furthermore, this R&D efficiently induces stock prices as demonstrated in Fig. 12 C. Induced stock prices induce an investor surplus

5. Conclusion

In light of the increasing significance of co-evolution between the transformation of R&D that overcomes the dilemma between its expansion and productivity decline, and digital solutions of the advancement of the fashion industry that satisfy people's preferences shift to supra-functionality beyond economic value, this paper analyzed a prospect of this co-evolution.

Prompted by the digital global leader, Amazon, and their recent challenge in developing advanced digital fashion successively with aggressive AI-oriented R&D, an empirical co-evolutional analysis of the

² These demonstrations are based on Watanabe et al. [9].

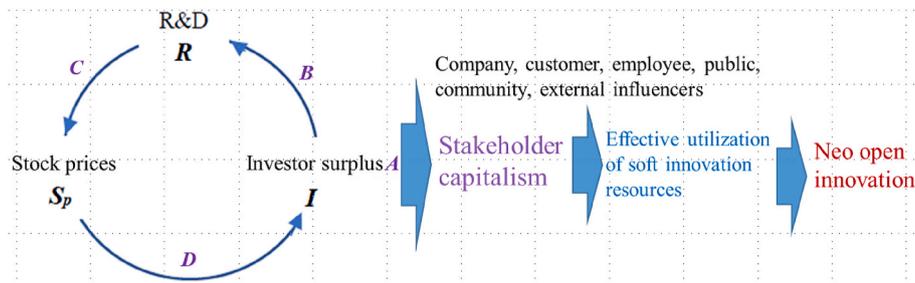


Fig. 13. Virtuous cycle among investor surplus, R&D and stock prices leading to neo-open innovation in Amazon.

development trajectories of Amazon's recent advanced digital fashions (*ADFs*) and the fashion industry, with special attention to the role of AI advancement, was conducted. The challenge of the fashion industry toward a non-contact society after COVID-19 was also examined.

Amazon has succeeded in securing timely digital solutions by developing seven *ADFs* successively. This success was enabled by the advancement of AI and Amazon's enthusiastic efforts to be an AI giant. Amazon's business culture as an R&D-based customer-centric company and its subsequent R&D strategy inevitably utilized AI in unique ways, such as inducing multiple hierarchy-level functions for approaching human behavior and thoughts by learning from preceding innovations.

Such institutional systems have enabled Amazon to enjoy the effects of learning orchestration externalities through the course of its successive development of seven *ADFs*. In addition, challenges to luxury fashion brands explored the multichannel approach that allows vendors freedom in managing their luxury brands on Amazon's Marketplace, while paving the way for on-demand manufacturing.

All these challenges led to broad stakeholder's involvement betting on these challenges, expecting the future prospects of Amazon and *ADFs*. A non-contact society after COVID-19 accelerates this trend toward on-demand *ADFs* manufacturing. This corresponds to a new business doctrine toward stakeholder capitalization.

These findings give rise to the following insightful suggestions for this capitalization:

- (i) The co-evolutional development between Amazon's *SIRs*-driven innovation and disruptive advancement of fashion should be applied to disruptive business models aiming at overcoming the dilemma between R&D expansion and productivity decline,
- (ii) The dynamism enabling this co-evolution should be elucidated and conceptualized,
- (iii) The function of fashion in tempting broad stakeholders to bet by investing in it should be elucidated, conceptualized, and then applied to stakeholder capitalization,
- (iv) The dynamism of fashion advancement through orchestrating shifts to the digital economy, the sharing economy, and the circular economy should be applied to digital fashion advancement, and
- (v) The potential for on-demand manufacturing in the fashion industry should be further developed for broader application.

Future work should focus on further elucidation, conceptualization and operationalization of the functions by which the above orchestration may lead to the transformation of the apparel and the fashion industry, and also to transforming R&D investment in the digital economy toward a non-contact society. Hybrid externality combining learning orchestration and on-demand manufacturing should be generalized.

Acknowledgements

The research leading to these results is the part of a project: Platform Value Now: Value capturing in the fast emerging platform ecosystems, supported by the Strategic Research Council at the Academy of Finland

[grant number 293446].

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