Title
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Abstract: We first report recent examples of *supply chain transparency* with companies disclosing information on their products and supply chains. Next, by noting that gaining supply chain visibility is a prerequisite step towards a company offering supply chain transparency, we present potential benefits of supply chain visibility and those of supply chain transparency separately for the company. Finally, we propose some research topics for OM researchers pertaining to supply chain transparency based on the needs of different stakeholders.

Keywords: Supply chain transparency, supply chain visibility, traceability, benefits, research topics

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1. Introduction

Companies are increasingly disclosing information about their products and their supply chains to consumers (Marshall et al. 2016).[1] This information, disclosed in in annual reports, sustainability reports, press releases, and third-party platforms, may include provenance of their products, results of product testing, and supply chain operations at different tiers. However, the value of disclosing supply chain information or even what to disclose publicly is not well understood by practitioners or researchers. As such, this paper seeks to offer a research agenda for operations management (OM) scholars on *supply chain transparency* to motivate further research on this topic.

As a necessary step for supply chain transparency, companies need to first invest in gaining *supply chain visibility* by mapping out the supply chain, by conducting audits and interviews, and by developing and disseminating reports. This investment in supply chain visibility results in economic value to improve various "operational decisions" (Handfield 2017). Next, using this information, firms seek to create further value by disclosing product and supply chain information to the public (New 2010). The firm decides on the type and the detail of this information to be disclosed to the public to provide *supply chain transparency*. Visibility caters to the needs of stakeholders *internal* to the company like managers or to immediate suppliers or customers, while transparency targets a broader set of *external* stakeholders, including consumers and consumer rights' and other advocacy groups as well as investors and regulators.

In this paper, we first report the transparency phenomenon with examples of companies providing information to consumers, investors, and regulators. Next, we delineate the potential benefits from *supply chain visibility* and from *supply chain transparency*. Doing so not only helps us structure future investigation on the value of transparency but also remove some of the confusion around these terms as they are often used together without distinction or even interchangeably. Finally, we propose some

research topics to motivate research to improve our understanding of the value of supply chain transparency and refer to some extant research.

The rest of the paper is structured as follows: Section 2 reports on the phenomenon of companies publicly disclosing supply-chain information to the public through examples. Then we discuss the potential benefits of supply chain visibility in Section 3 and the potential benefits of supply chain transparency in Section 4. In Section 5, we propose some research topics before concluding in Section 6.

2. Examples of Supply Chain Transparency

Many companies have broadened their focus from corporate social responsibility to environmental and social sustainability (Tang, 2018). For some of these companies, this has entailed making their supply chains more transparent to the public, possibly to signal to consumers and investors their commitment to environmental and social sustainability. Below are some examples of companies disclosing supply chain information to the public in varying detail. Nearly all these examples are from the apparel industry, which in itself is a noteworthy fact, along with only a couple of exceptions from computers and electronics. The food sector should have been another sector especially when it comes to provenance (Wognum et al. 2011) but there is a dearth of examples. That is not to say companies in sectors other than apparel are not practicing environmental or social sustainability or ensuring compliance upstream in their supply chains. It's just that they are not disclosing enough information about their supply chains to qualify as supply chain transparency.

***Disclosing supply chain information at all tiers*.** Some companies collect and disclose process information for the entire supply chain. Heidi.com S.A. is a Swiss company that produces and sells apparel for men and women, offering "openness" as its core value to differentiate itself from other apparel companies. Specifically, each piece of Heidi garment has a tag that comes with a code that can enable

consumers to review the entire supply chain process from the source of the cotton to the distribution center by entering this code on the Respect Code website.[2]

***DisclosingTier-1 supplier information*.** Many apparel companies disclose Tier-1 suppliers including the supplier's name, location, and activity as of this writing. After facing years of criticism over labor practices using children at supplier facilities abroad, Nike became the first major company in the global footwear and apparel industries to disclose publicly its contract supplier base in 2005. Specifically, Nike provides the names and locations of its Tier-1 active contract factories (Doorey 2011)[3] -- all 567 of them in November 2017 -- on its 'manufacturing map' website.[4] Apple too discloses its top 200 Tier-1 suppliers, which in 2014 represented 97% of its costs of procurement of components, manufacturing, and assembly. Marks and Spencer, a leading UK-based retailer, launched an initiative disclosing the name, the location, and the percentage of female workers of each of its 1539 factories in 57 countries on an interactive map online.[5] California-based apparel company, Patagonia, has also launched its 'footprint chronicles'[6] by disclosing information about its suppliers (raw materials such as wool, cotton, and down) and its contract manufacturers.

***Disclosing environmental footprint in the supply chain (all tiers)*.** Environmental disclosure information includes the extent to which the factories of a company's suppliers comply with the environmental regulations or accepted norms in energy usage, water consumption, water recycling, waste treatment, and air pollution. Many companies, including Walmart, Target, and Cosco, now share their environment reports with the public, but very few companies provide information about suppliers beyond the first tier. As a notable exception, the Kering group, parent to luxury brands such as Alexander McQueen, Bottega Veneta and Puma, issues its "Environmental Profit and Loss Statement" online by disclosing information about greenhouse gas emissions, air and water pollution, land use and water consumption incurred by its suppliers all the way from Tier-1 contract suppliers performing assembly operations to Tier-4 suppliers producing raw materials.[7]

Disclosing supply chain cost. Supply chain costs include materials cost, labor cost, transportation cost, and customs duties. Normally, in the retail industry, such costs are highly confidential because companies do not want consumers, competitors or suppliers to gain such information (Sinha 2000). However, San Francisco-based apparel retailer Everlane is pushing for "radical transparency" on this front by not only disclosing information about its contract manufacturers (like Nike and others) but also its supply chain costs as well as the average price markup by others in selling similar items.[8] Everlane's online customers can determine the retailer's markup relative to what it pays its suppliers to inform their purchasing decision.

Disclosing supplier workplace safety compliance. Workplace safety compliance information is about the extent to which a supplier's factory meets the Environment, Health, and Safety (EHS) standards. After the collapse of Bangladesh's Rana Plaza in 2013 with a death toll of 1134, over 166 apparel corporations from 20 countries along with NGOs and Bangladeshi worker unions formed the Accord on Fire and Building Safety in Bangladesh for a five-year (2013-18) agreement to ensure a safe working environment. Some US retailers including Walmart formed a separate Alliance for Bangladesh Work Safety without involving worker unions.[9] The goal of these two consortia, Accord and Alliance, is to improve workplace safety for over 2 million workers at 1,800 factories over a limited period of time (Kapner and Banjo, 2013). The organizations created by these consortia respectively conduct joint audits of suppliers, with audit reports posted online (Caro et al. 2017).[10] PVH Corporation, owning such brands as Calvin Klein and Tommy Hilfiger, has audited 84% of its Tier-1 suppliers at least once per year since 2012 to assure western consumers about their compliance of EHS regulations.

Assuring provenance. Provenance information includes names or suppliers, and the materials used and produced by suppliers, including the source location and how the materials were extracted or produced. This is *supply chain traceability* – being able to trace the path of materials upstream 'all the way'. Some companies disclose their process of ensuring compliant provenance to assure their customers that suppliers meet certain standards but without disclosing the names of suppliers or any other details. After

the German animal-rights organization Four Paws accused Patagonia, a California-based apparel company, of using live-plucked down from force-fed geese harvested for foie gras and meat, the company developed a "Traceable Down" initiative to trace the sourced down upstream all the way to the farm to be able to assure consumers that its products are free from down collected using such reprehensible practices.[11] Similarly, Intel seeks information about its systems and processes to be able to assure its customers that the minerals used in, or for, its products are conflict-free.[12]

Of course, if a company does not provide transparency voluntarily, there is a risk that third parties may obtain such information and make it publicly available. Consider the following examples.

Involuntary third party-disclosure of a company's information: When companies source from Chinese contract manufacturers who source their materials from yet other Chinese suppliers, the supply chain is often opaque and lower tier suppliers' environmental regulations compliance records are not easily accessible. The Institute of Environmental & Public Affairs (IPE) (www.ipe.org.cn), an NGO based in Beijing, compiles information about water and air polluting factories in China and discloses the identity of their overseas customers of polluting factories on its website. In 2011, IPE published a report detailing the alleged malpractice in Apple's supply chain in China, which resulted in some factory workers being poisoned and disabled, and led to some communities being polluted (Schroeder 2011). In response, Apple developed its "supplier responsibility" program by conducting more audits and providing more education and training to improve its supplier's environment, health & safety performance.[13] Apple does not disclose supply chain cost information in contrast to Everlane; however, the Economist provided cost transparency for Apple's iPhone in 2011 – $178 worth of parts against US list price of $560, which grows substantially in other countries, raising questions about the company's markup.

As observed from these examples (**Table 1**), companies disclose information to varying degrees: in detail at all supplier levels, only for one tier of suppliers, only to assure customers that they check the suppliers to ensure western norms are being met, or simply not provide any information at all by way of

transparency. This variation across companies may be because there is no shared understanding of the value of transparency to the company. We need further research for better understanding of transparency, but, before we outline research topics, we outline potential benefits of *supply chain transparency*, over and above those of *supply chain visibility* alone. We separate these potential benefits of visibility from those of transparency for three reasons: (1) gaining visibility and thus getting information is a necessary step towards transparency and disclosing part of this information, (2) visibility effort targets stakeholders internal to the company along with immediate customers or suppliers while transparency targets external stakeholders by way of consumers, investors and regulators amongst others, and (3) as stated before, to provide structure.

Types of information	**Entity who discloses information**	**Extent of disclosure**	**Examples**
Supply chain (suppliers at all tiers)	Company	Transparency	• Heidi's respect code initiative.
Supplier base (Tier 1 suppliers only)	Company	Transparency	• Nike's manufacturing map initiative • Marks & Spencer's supplier map the initiative • Patagonia's Footprint Chronicle initiative • Apple disclosing top 200 suppliers
Supply chain environmental footprint	Company	Transparency	• Kering Group's Environmental Profit and Loss Report
Supply chain cost information	Company	Transparency	• Everlane's disclosure of its supply chain cost as well as markups on competing products in the market
Supplier workplace safety compliance	Consortia	Transparency	• Accord on Fire and Building Safety in Bangladesh • Alliance for Bangladesh Work Safety
Supplier workplace safety compliance	Company	Assurance	• Patagonia's traceable goose down initiative • Intel's Conflict-Free Supply Chain initiative • PVH Corporate Responsibility Initiatives
Supplier Environmental regulations	Company / NGOs	Involuntary	• Institute of Public & Environmental Affairs (IPE) disclosing information on treatment of workers at Apple's

compliance			suppliers
Supply cost	Company	Involuntary	• The Economist disclosing supply chain cost for iPhone compared to Apple's list price.

Table 1. Disclosing product and supply chain information to consumers.

In the next two sections, we discuss the potential benefits to a company from gaining supply chain visibility in Section 3 and the potential benefits to this company for providing transparency to its external stakeholders in Section 4.

3. Potential Benefits of Gaining Visibility for Internal Stakeholders

Gaining visibility creates value for a company, not only to enable it to provide transparency, but, more than that, to potentially transform its supply chain and the way it manages its supply chain to reduce its exposure to risk and, at the same time, improve efficiency.

3.1 Managing Supply Chain Risk

Companies need to coordinate their global supply chains across many layers of suppliers located in many geographical locations. These supply chains are vulnerable to different types disruptions *external* to the supply chain (earthquakes, floods, terrorist attacks, etc.) or, more typically, by disruptions *internal* to the supply chain (product recalls, supply shortages, supplier bankruptcies, etc.) (cf. Sodhi and Tang, 2012). Moreover, as western firms source from suppliers in the so-called 'low-cost countries', they put the suppliers under tremendous pressure to do things faster, better and cheaper. Under such pressure, suppliers may be tempted to engage in risky behavior (Lee et al. 2012), potentially resulting in legal liabilities and/or brand damage (Tang 2006). **Table 2** provides examples of categories of supplier-related risks to the buying firm.

Risks for the buying firm	**Suppliers' risky behavior**
Materials risks	Suppliers use materials (e.g., conflict minerals) that violate certain agreements/regulations. Other materials may include ingredients that should not be used as regards consumers and regulations in the buying

	firms' markets
Product risks	Suppliers produce unsafe products using unsafe materials (e.g., lead and cadmium in toys, melamine in food products, etc.) or shoddy manufacturing practices or materials
Reputation risk	Suppliers create unsafe workplace due to unsafe buildings and/or forced child labor
Environmental risks	Suppliers violated environmental regulations
Product development risks	Suppliers unable to develop certain modules/components or the manufacturing process for a new product for the buying firm in time for market launch (as in Sony's release of PlayStation IV)
Product delivery risks	Suppliers fail to deliver on time

Table 2. Supply chain risks.

Many examples of supply chain risk incidents and their impact on companies are cited in the literature: Ericsson losing 400 million euros in one quarter alone after their supplier's semiconductor plant in New Mexico caught fire in 2000; Land Rover laying off 1,400 workers after one of their key suppliers became insolvent in 2001; Baxter recalling Heparin in 2008 after its supplier used unsafe materials; Mattel recalling toys in 2007 after its supplier produced lead-tinted toys; Boeing's experiencing a major delay in its 787 development in 2009 after its suppliers failed to deliver different modules; major international brands facing media attention after the collapse of several Bangladeshi contract factories in the Rana Plaza tragedy; and western multinationals facing bad press after their Chinese contract factories were caught violating air and water environmental regulations.

With supply chain visibility, companies can avoid severe consequences when risk incidents do occur. For example, Boeing would have managed their supply chain differently to reduce the delay of its 787 development had the company known about the true capabilities of its tier-1 suppliers (Tang and Zimmerman, 2009). It was only after the recalls that Mattel introduced the "three-point check system" to gain visibility about its suppliers' compliance by inspecting each batch of paint, inspecting the manufacturing process at the factory, and inspecting each batch of toys shipped from the factory to assure consumers that Mattel's toys comply with safety standards (Tang 2008).

3.2 Reducing Reputation Risk from Environmental or Social

With improved supply chain visibility, firms can develop different auditing/inspection mechanisms for improving social responsibility. This way, they can prevent reputation risk caused by the disclosure of unseemly supplier behavior or undesirable supply provenance. To ensure the factory buildings of suppliers in low-cost countries comply with safety standards, over 200 apparel brands, retailers and importers worked with various trade unions and NGOs to establish the ACCORD (on fire and building safety in Bangladesh) in 2013. Intel has conducted surveys, visited different smelters, conducted on the ground interviews, and supported independent audits since 2013 to ensure the company is using "conflict-free" minerals for its microprocessor manufacturing. The ACCORD calls for independent audits of different factory buildings and the requirements for factories to take corrective measures to ensure building safety (Caro et al. 2017). Finally, to ensure its suppliers comply with environmental norms and regulations, since 2011, Apple has increased independent audits of its Chinese suppliers for labor-rights and environmental violations.[14]

3.3 Improving Supply Chain Efficiency

As firms gain more visibility about their supply chain operations, they can evaluate different possible supply chain configurations. For example, after realizing the benefits of developing and producing certain products closed to their customers, GE re-shored its water heater production was re-shored back to the US, Ford and Boeing re-shored some of their operations back to the U.S.[15] In a similar vein, after Amazon experienced UPS late deliveries of its products to customers in 2013, Amazon developed its in-house logistics services to improve its delivery performance in 2017.[16]

As firms improve their visibility into their supply chains, they will eventually get real-time information and use this to make real-time decisions to prevent and/or respond to supply-demand mismatches quickly. However, there is need for new tools to take advantage of real-time information (Handfield 2017).

Besides these potential benefits (Sections 3.1-3.3 above), having supply chain visibility enables firms to disclose some of this information to the public and thus be more transparent to external stakeholders. Firms can thus obtain "extra" benefits by offering supply chain transparency, which we discuss next.

4. Potential Benefits of Offering Transparency to External Stakeholders

Traditionally, companies safeguarded supply chain information because supply chain operations affect the company's competitive advantage in product development, production cost, product quality, and delivery speed. By making its supply chain operations more transparent, the company may fear losing its competitive edge, possibly through intellectual property leaks. However, with the free flow of information on the internet, it is getting more difficult to safeguard this information, and involuntary or third-party disclosure can be damaging to a company's reputation. Moreover, there are many potential benefits for a company to make more information available to consumers, as well as to investors, NGOs, regulators and others efficiently by simply making such information about its products and supply chain public. Let us consider some of these potential benefits.

4.1 Gaining Consumers' and Investors' Trust

Consumers' need for supply chain transparency, whether real or perceived, can be linked to the advent of information and communication technologies that enabled consumers to seek, share, and discuss information about products and services. Few online consumers rely on advertisements alone to make purchasing decisions and instead turn either to comparison platforms that include KBB.com for comparing price and quality of cars and Shopzilla.com for price comparisons of consumer goods, or to review platforms such as Yelp for local businesses, Goodguide.com for consumer goods, and Tripadvisor for hotel and airline reviews. According to eMarketer (2016), 80.7% of 1132 surveyed internet users say that online reviews influence their online purchasing decisions. Phelon (2017) reported that 74% of young consumers turn to social networks such as Facebook for guidance on purchase decisions.

More to the point here, consumers may also look for, or simply come across, information on social media on a company's products and supply chain operations specifically regarding whether or not they meet western norms even if the company operations are in low-cost countries. If they use this information to inform their purchasing, this puts companies under pressure to make more information about their products and supply chains available online than they would have otherwise. Thus, transparency becomes necessary with consumers and investors seeking more information about companies' products and their supply chain operations (Nunes 2014).

Companies need to provide information to the public to gain consumer trust, to create consumer awareness, to solicit feedback from consumers, to communicate its improvement processes and the corresponding results. Indeed, younger consumers, the so-called Millennials, have less trust in big corporations than the preceding generation (Hertz, 2016). Also, companies come under pressure to change their ways to interact with consumers especially when there have been product recalls (e.g., Europe's horsemeat scandal in 2013). The same applies to investors when there are development and production setbacks leading to delays in product delivery or launch, e.g., Boeing's 787 development problems in 2009, and Tesla's production problems for its Model 3 in 2017. Such events can cause consumers and investors to lose trust in the company.

Some companies have responded quickly. As mentioned earlier, after Patagonia discovered that its suppliers were using live-plucked goose down, the firm apologized publicly, developed its Traceable Down initiative, and publicly communicated its process to assure consumers that the geese are protected against force-feeding and live plucking.

Companies can also use supply chain transparency as a marketing tool to differentiate themselves (Werbach, 2009). Getting consumers' trust would, therefore, be reflected in increased revenues. According to the 2016 Label Insight Transparency Study, Klein (2017) reported that 73 percent of the respondents reported themselves as being willing to pay more for a product with supply chain transparency.

Therefore, supply chain transparency can be used as a competitive strategy to sell more and (potentially) charge more. Everlane was the first online apparel retailer to disclose its costs in its supply chain. Indirect evidence is also provided by Unilever's heavy advertising and rebranding of its Lipton tea in western Europe by getting Rainforest Alliance to certify its social responsibility initiatives in the countries where tea is grown. Lipton tea revenues increased dramatically in western Europe after this effort (Seifert and Ionescu-Somers, 2011).

4.2 Meeting Regulatory Compliance or Preventing Bad Publicity

Yet another source of pressure on companies to disclose information is regulation. Various governments have passed new laws requiring companies to provide more transparency for their supply chain operations. These laws include the California Transparency in Supply Chains Act, the United Kingdom's Consumer Protection Act, and Europe's General Product Safety Directive (Marshall et al. 2016).

Companies also need to manage the reviews of different NGOs advocating human rights (Fair Labor Association), animal rights (Four Paws and PETA), or environmental sustainability (IPE and Green Peace). This is not regulatory compliance per se but bad publicity can potentially result in a loss of revenues. Apple initially ignored IPE's information on the company's suppliers in China violating air and water pollution. IPE then issued a report, "The other side of Apple" in 2011, publicly sharing its findings on Apple's suppliers in China. The consequent publicity forced Apple to change from being fully opaque to becoming somewhat transparent, and in 2012, Apple released its first "supplier responsibility progress report" including a list of its top 200 suppliers (Gies, 2012).

4.3 Monitoring Suppliers through "Crowdsourcing"

It is costly for companies to monitor and audit their suppliers in their entire global supply chain at all tiers and at all times. By disclosing information about their suppliers (name, location, operations, and employee demographics) to the public, these companies can enlist consumers, NGOs, and even the

suppliers' own employees to monitor these suppliers' activities through "crowdsourcing". Any of these entities could expose suppliers' violations of standards such as those pertaining to child labor, EHS, or water-and-air pollution. Supply chain transparency can, therefore, help the focal company reduce the cost of audits and enforcement. For example, after facing with many unsafe food and consumer products in China, GlobeScan (globescan.com) reported that over 200 million Chinese consumers are using social media networks (Weibo, WeChat, etc.) to investigate how responsibly companies are behaving on social and environmental issues. With increased scrutiny and rapid news dissemination via social media networks, suppliers may be deterred from undesirable practices to avoid being in the spotlight (Tang and Babich, 2014) thus reducing the monitoring costs for the buying firms.

With these potential benefits (Sections 4.1-4.4 above), many companies are warming up to the idea of disclosing product and supply chain information to the public, at least in the apparel industry. Still, there are many issues arising from supply chain transparency that remain unclear and this motivates many research opportunities.

5. Research Opportunities in Supply Chain Transparency

In this section, we outline OM research topics arising from supply chain transparency -- **Table 3** provides a summary. These topics can be examined with field experiments, behavioral experiments, empirical analysis, and mathematical analysis, or through the use of multiple methods to create *research streams* (Sodhi and Tang, 2014). We arrange these by (external) stakeholder – the investors (and the managers working for them), the consumer, competitors, and suppliers – in keeping with the *stakeholder resource-based view* of the firm (Sodhi, 2015).

Stakeholder	Research Questions
5.1. Investors	*1. Why do companies not seek more supply chain visibility?* *2. What type of supply chain information should a company disclose to the public?* *3. What are the potential risks associated with disclosing different supply*

	chain information to the public? *4. How should a company mitigate risk arising from disclosure?* *5. As companies share their suppliers' performance on environmental and social sustainability metrics, how do investors react to good news and bad news?* *6. How should a company evaluate costs and benefits from transparency and map out an implementation approach for disclosure to maximize shareholder value?*
5.2. Consumers	*1. How does transparency offered by a company impact consumers' willingness to pay for the company's products and services?* *2. How does transparency offered by a company impact consumers' actually purchasing the company's products and services?* *3. Do consumers react differently to supply chain information disclosed by a company versus a third party like an NGO or a representative of a consortium?* *4. Do consumers react differently to supply chain information disclosed by a company voluntarily versus under regulatory or other mandatory requirements?*
5.3. Competitors	*1. When a company implements supply chain transparency, should its competitors follow?*
5.4. Suppliers	*1. How can a firm collaborate with its suppliers to improve traceability?* *2. How can Blockchain be used in collaboration with suppliers to offer improved supply chain visibility as well as transparency?*

Table 3. Research topics in supply chain transparency, arranged by stakeholders

5.1 Investors

A potential benefit of visibility is that it helps a company avoid, mitigate, and respond to supply chain disruptions (cf. Tang, 2006; Werbach, 2009) that threaten shareholder value (Hendricks and Singhal, 2005). Moreover, as we have argued, transparency is not possible without visibility. However, many firms still do not have sufficient visibility to manage supply chain risk. According to a survey of 335 global manufacturing executive respondents of the KPMG's 2013 Global Manufacturing Outlook (a report from the Economist Intelligence Unit), 49 percent of the respondents admitted that their companies currently do not have visibility of their supply chain beyond Tier-1 suppliers. Only 7 percent of the US respondents claimed that they have complete visibility of their supply chains. This result is consistent

with a 2013 survey of Australian fashion companies in which 93% of the respondents admitted they did not know the identity of their raw material suppliers (Nimbalker et al. 2013).

It is possible that many firms view the cost of obtaining supply chain visibility as being too high. However, consulting firms (e.g., Kinaxis) and software development firms (e.g., GT Nexus) lower the cost for companies to gain visibility into supply to end-customer delivery, including information about production, in-transit operations, on-hand inventory, and cost visibility along the supply chain. Also, IT service providers such as Zetes.com and Freqentz.com have developed mobile solutions for pharmaceutical and for food products to enable manufacturers to obtain visibility into their own supply chains. As such, a pertinent research topic is

1. *Why do companies not seek more supply chain visibility?*

Many more firms are accumulating different types of supply chain information than ever before, but may not understand the impact of different types of supply chain information (location of suppliers, demographic information of supplier workers, supplier factory's labor practice, supplier factory operations, etc.) on consumers' valuation of a product (or a company). Specifically, companies need to consider what to disclose as there are many types of supply chain information (**Table 1**) that a company can share with consumers, investors and other external stakeholders. To avoid information overload and to create economic value for the firm, it is important to examine the impact of different types of supply chain information on consumer valuation of the product as well as their purchasing decisions (New and Brown 2011). Therefore, there is a great research opportunity to explore what to disclose, given the needs of investors and other external stakeholders for the maximum economic benefit for the company:

2. *What type of supply chain information should a company disclose to investors and other external stakeholders?*

When deciding whether to disclose different types of supply chain information to the public, the company needs to identify and assess different types of risks associated with information disclosure that could

threaten shareholder value. For instance, companies such as Coca-Cola and KFC may disclose certain ingredients of the products but not all ingredients so that the "product formula" remains a secret to retain its unique offering. However, there are potentially various types of risks that arise from supply chain transparency for the focal company:

- *Information overload*. Too much information can be counter-productive if it creates information overload, discouraging consumers from buying from the company
- *Product and service differentiation*. When a company discloses its supply base and other cost information to the public, other companies can use the same set of suppliers to produce similar products at similar costs and the company's products may no longer be distinctive
- *Guilt by association*. When a company discloses its supply base to the public, suppliers with bad (e.g., environment, health & safety) performance will be linked to the firm and it can jeopardize the firm's reputation.

This leads to the research topic:

3. *What are the potential risks associated with disclosing different supply chain information to the public?*

When a company decides to disclose suppliers' identity as well as their environmental, health, and safety performance to the public, should it invest further in the suppliers' capabilities to improve compliance with norms or simply let "crowdsourcing" ensure such compliance? Accord and Alliance take different approaches to this, with Accord companies taking more of a development approach towards the suppliers. This means that it is useful to investigate:

4. How should a company mitigate risk arising from disclosure?

Also, companies may take the "no news is good news" or "disclose good news only" as approaches. Many companies tend to disclose only good news. However, hiding negative news about the supply chain from the public, hence investors, can cause major backlash. Consider two examples. First, by not

disclosing the internal production problem that the actual production quantity of Tesla's Model 3 is 80% below target, the stock market responded more negatively after the bad news was disclosed by Wall Street Journal on October 9, 2017. Second, by using the environmental incident data disclosed by IPE (the NGO mentioned in Section 3) from 2006 to 2013, Lo et al. (2017) find empirical evidence that an environmental violation can cause the stock price of the polluting Chinese manufacturer as well as that of its overseas customers to drop. It would be interesting to examine the conditions under which firms should disclose good news and bad news about its supply chain operations to investors. This observation leads to another question.

> *5. As companies share their suppliers' performance on environmental and social sustainability metrics, how do investors react to good news and bad news?*

Before committing to disclose all sorts of supply chain information, a firm needs to examine the costs (including expected costs from realized risks) and benefits of disclosing supply chain information to the public. For example, since 2011, Switcher SA, a Swiss clothing company, used the Respect-Code platform (like Heidi.com). While this information is novel, it appears this particular form of supply chain transparency did not increase consumers' valuation of the product and hence, consumers were unwilling to pay a higher retail price. By 2016, Switcher was bankrupt, unable to pay its employees and suppliers. Therefore, there is also a need to map out a strategy to implement transparency initiatives (Werbach 2009):

> *6. How should a company evaluate costs and benefits from transparency and map out an implementation approach for disclosure to maximize shareholder value?*

5.2 Consumers

Recently, some researchers have explored this question in different settings. Buell and Norton (2011) conduct different laboratory experiments and show that consumers value the service more when the firm discloses information about labor effort on its website. They concluded that operational transparency can increase valuation by consumers. In a separate study, Buell et al. (2016) conducted laboratory

experiments in food service settings and showed that customers valued the service more when they can observe the employee's effort in the production process. This finding is consistent with the international success of Ding Tai Fung, an acclaimed Chinese restaurant that was named as one of the top gourmet restaurants in the world by the New York Times in 1993, where customers can observe the dumpling making process through a glass-enclosed kitchen (Hwarng and Yuan 2016). By conducting different laboratory experiments, Kraft et al. (2017) show that consumers' willingness to pay increases with a higher level of transparency into the firm's payment to the worker when workers are disadvantaged.

Similarly, Craig et al. (2017) conducted surveys in China, Europe, and the U.S. to examine customer's intention to purchase in two settings: (1) materials cost is higher than labor cost (i.e., high product quality but low social responsibility) and (2) materials cost is lower than labor cost (i.e., low product quality but high social responsibility). They find that, in general, female customers are willing to pay more for products produced by firms with higher perceived social responsibility. These issues motivate the following research topic:

> *1. How does transparency offered by a company impact consumers' willingness to pay for the company's products and services?*

There are survey reports that show consumers are willing to pay more if companies are more transparent. However, these surveys gauge consumers' *intent*, not their actual purchase decision. As such, before companies decide to disclose different types of supply chain information to consumers, they need to gain a better understanding of potential consumer response. Most recent studies of supply chain transparency are primarily based on laboratory experiments. These experiments can enable us to understand customers' intention to purchase as proxies of actual purchasing behavior. These proxies can be inaccurate predictions about a customer's actual purchasing behavior (Chandon et al. 2005). Therefore, there is a need to conduct field studies to understand actual consumer purchasing behavior rather than intent (Gupta and Zeithaml 2006). Mohan et al. (2016) conduct a field experiment and replicate it in a controlled laboratory setting where the firm discloses the cost information (materials, labor, duties, and

transportation) to potential customers. They find evidence that cost transparency can increase sales, at least in the field experiment, but only when cost information is disclosed voluntarily. These observations motivate the following question:

> *2. How does transparency offered by a company impact consumers' actually purchasing the company's products and services?*

When companies disclose its supply chain information in a selective manner, consumers may discount the good news and react more negatively to bad news that is exposed by NGOs or the press. Therefore, it is important for firms to understand how consumers respond to different types of supply chain information disclosed by different parties. For instance, it would be useful to examine settings in which the cost information is disclosed by an independent party. For example, Apple keeps its cost information secret. However, as we mentioned earlier, the Economist reported that the total materials cost of an iPhone 4 was $178 and yet the retail price was $560 (Economist 2011). This raised questions about Apple's price markup especially in light of the company's renowned tax avoidance in many countries. In this case, would the consumer's reaction have been different had Apple disclosed its cost information on its own like Everlane? Conversely, would information be more credible if a company got a third party to disclose information about its supply chain as Lipton did? As with Accord, the reporting third party could also be a consortium. Thus, it would be useful to investigate:

> *3. Do consumers react differently to supply chain information disclosed by a company versus a third party like an NGO or a representative of a consortium?*

In addition, it would be of interest to examine the different responses from consumers when certain supply chain information is disclosed voluntarily instead of under regulatory pressure. For example, Kalkanci et al. (2016) conduct experiments and show that a firm can gain trust from consumers and obtain additional market share if the information about the level of greenhouse gas (GHG) emissions or the amount of conflict minerals used in a product is disclosed voluntarily by the firm. More importantly, they

show that voluntary (mandatory) disclosure will encourage (discourage) firms from measuring the impact of GHG emissions and conflict minerals in their supply chains. These observations motivate the following question:

> *4. Do consumers react differently to supply chain information disclosed by a company voluntarily versus under regulatory or other mandatory requirements?*

5.3 Competitors

If transparency is a strategic choice for one company, it makes sense for its competitors to consider its response. However, we do not observe this to be widespread. For example, after Nike disclosed their supply base in 2005, its major competitor Adidas began disclosing all Tier-1 and Tier-2 suppliers and even its licensee factories.[17] On the other hand, after Everlane shares its supply cost structure with the public, no other apparel retailer reveals its supply chain costs. Therefore, it is of interest to examine the business environment (e.g., market competition, market segmentation, product quality) under which imitation is a good strategy or not. Lim et al. (2018) explore this issue and provide some preliminary results. Still, this question remains wide open:

> *1. When a company implements supply chain transparency, should its competitors follow?*

5.4 Suppliers

Many firms keep their suppliers at arm's length. Consequently, firms may have basic information about their suppliers, but the actual operations at the supplier factories remain opaque. As firms face pressure to improve social and environmental responsibility along their supply chains, collaborating with the suppliers would be an important first step to gain visibility about supply chain operations. For example, after the collapse of Rana Plaza in 2013, Li & Fung created the Vendor Support Services (VSS) unit in

2014 to work closely with its suppliers to improve their operations, and to become socially and environmentally compliant. By working closely with suppliers to measure greenhouse gas emissions and water usage, VSS develops ways to help these suppliers to use energy and natural resources more efficiently. Through this collaboration, these suppliers became more cost-efficient and environmentally compliant, and Li & Fung can improve its track-and-trace capability along the supplier chain (Lee and Tang 2017). And, once Li & Fung has supply chain visibility, it can then decide on whether to disclose certain supply chain information to the public. This example motivates the following topic:

1. How can a firm collaborate with its suppliers to improve traceability?

Blockchain technology[18] is a distributed ledger system that holds promise for improved supply chain coordination and information sharing. Through collaboration with suppliers, a company can improve supply chain visibility for itself and transparency for others. Such collaboration can reduce, for instance, counterfeit products thus helping not only the company but also the suppliers themselves and customers. World Health Organization (WHO) estimates that 10% or more of drugs sold in poor countries are fake and tens of thousands of children die due to counterfeit drugs each year.[19] In China, Wang and Armstrong (2017) report that, despite Alibaba suing its sellers for selling counterfeit goods in 2017, as many as 50% of goods sold on Taobao are fake or at least infringing on the intellectual property rights of others. Blockchain is a potential solution that, if adopted across the supply chain, the consumer can authenticate a product. The usage of this and related technology requires further research as more firms adopt this technology:

2. How can Blockchain be used in collaboration with suppliers to offer improved supply chain visibility as well as transparency?

6. Conclusion

In this paper, we discussed how some companies disclose supply chain information to the public as a mechanism. Noting that gaining supply chain visibility is a prerequisite for providing supply chain transparency, we discussed the key drivers and the potential benefits of supply chain visibility and of supply chain transparency separately. Through our understanding of supply chain transparency, we have proposed a set of potential research questions for OM researchers to explore.

As companies adopt different strategies for disclosing different types of supply chain information to the public, there will be even more research opportunities for OM researchers to explore. We hope that researchers find the questions proposed in this paper to be a useful initial step.

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Notes

1 Most companies keep their supplier identity secret to retain a competitive advantage. Not until 2005, Nike became the first company in the U.S. who discloses the identity of its suppliers (name and location) and the worker profile (number of employees, the percentage of female workers, the percentage of migrant workers, etc.) to the public. See: http://manufacturingmap.nikeinc.com/

2 See www.respect-code.org. For instance, typing "094CDFY", a code associated with a Heidi product, shows provenance and supply chain information on a map and gives a list of eight steps: (1) Cotton – India, (2) spinning – SCM Textile Spinners, India, (3) knitting-weaving – Radaan Textiles, India, (4) dyeing – Sathya Process, India, (5) confection – Sri Nanthika Knitting Mills, India, (6) printing – Sri Nanthika Knitting Mills, India, (7) transport – Kuehne-Nagel, Tirupur, India, and (8) distribution – Heidi SA, Switzerland. The code refers to a specific batch of 300 items, and the webpage shows the batch was produced in 2017 and gives the name and contact details of the person-in-charge at Sri Nanthika Knitting Mills. Also provided are the CO_2 emissions (2.5 kg) and the water used (485 liters) associated with this batch. A third-party certificate of Heidi's environmental and social sustainability performance is also provided.

3. This minimal level of transparency is demanded by NGOs so that they can conduct independent audits about forced labor, health and safety issues in contract factories.

4 Nike manufacturing map (http://manufacturingmap.nikeinc.com/)

5 Marks and Spencer's interactive map with suppliers (https://interactivemap.marksandspencer.com/)

6 http://www.patagonia.com/footprint.html

7 See Kering's sustainability website (www.kering.com/en/sustainability/epl).

8 Everlane (https://www.everlane.com/about).

9 See Accord website (www.bangladeshaccord.org) and Alliance website (www.bangladeshworkersafety.org). The Accord is committed to providing funds to improve building safety whereas the Alliance is not committed to financing needed safety improvements (Greenhouse and Clifford 2013) and (Jacobs and Singhal 2016). Both have been set up for a limited time only and it is not clear at the time of this writing how either initiative will progress beyond 2018.

10 Besides these two consortia that focus on the workplace safety in Bangladesh, Sedex (www.sedexglobal.com) is an international non-profit organization that develops an online platform for it members to share their supplier audits data on labor rights, health & safety, the environment and business ethics.

11 Patagonia's down traceability initiative (http://www.patagonia.com/traceable-down.html).

12 Intel's processes include: (1) Audits of smelters; (2) cooperate with both governmental agencies and NGOs to ascertain source location. For details, see: https://www.intel.com/content/www/us/en/corporate-responsibility/conflict-free-minerals.html

13 Apple's supplier responsibility program (www.apple.com/supplier-responsibility)

14 See Apple's Supplier Responsibility Report for details, https://images.apple.com/supplier-responsibility/pdf/Apple_SR_2012_Progress_Report.pdf

15 See: https://www.usatoday.com/story/money/business/2016/04/23/24-7-wallst-economy-manufacturers-jobs-outsourcing/83406518/. See http://www.reshorenow.org/companies-reshoring/ for a list of companies who re-shored their operations back to the U.S.

16 http://www.logisticsmgmt.com/article/report_says_amazon_is_focusing_on_in_house_delivery_service

17 Source: https://www.adidas-group.com/en/sustainability/compliance/supply-chain-structure/

18 Blockchain technology is a distributed ledger managed by a peer-to-peer network collectively adhering to a protocol for recording, verifying, and validating new entries (Economist, 2015).

19 Source: https://www.theguardian.com/global-development/2017/nov/28/10-of-drugs-in-poor-countries-are-fake-says-who. The Guardian. November 28, 2017.