Towards traceability in cocoa - chocolate supply chain

Syahruddin, Normansyah

Universita degli Studi di Bergamo

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Syahruddin, Normansyah
Universitá degli Studi di Bergamo
Italy

Abstract

The multi – events of food alerts and food risks which occurred in a lengthy period and various locations, grows concern of consumers to question the safety of the food that they consumed. For food producers, occurrences of food alert forced them to review their supply chain to identify what went wrong in their supply chain. To do this, they need a good traceability system that capable in revealing the problems occurred along the chains. In general, a typical food supply chain is consists of farmers, middlemen, manufactures, retailers and consumers, which can be represent by cocoa – chocolate supply chain. This paper is the initial stage in identifying cocoa – chocolate supply chain and proposes a conceptual framework on its traceability system. Moreover, this paper aims at linking the traceability to performances of the chains as a driver to reach sustainability

Keywords : *Cocoa, Chocolate, Supply Chain, Traceability, Conceptual Paper*

I. Introduction

Globalization and internationalization of companies led to investments in different parts in the world due to various reasons such as low cost labors, low cost materials, relaxed regulations, strategic locations, partnership and alliance and access to raw materials. For the food industry, current trend showed that the movement of the goods mostly starts from the southern part of hemisphere, where the raw materials are located, to the northern part of hemisphere, where most of the processing industries are located. Responding to this trans-boundaries and trans-national supply chain, companies needs to carefully arrange their supply chain in order to meet the consumers' demand and managing uncertainties. In other words, companies needed to outlook carefully their supply chain from the first echelon to the end tier/s, expecting that there will be no flaw between echelon that could damage their reputation or even their existence in the competition. This situation may incur to opportunistic behavior that may lead to falsified of the documentation that must accompany foodstuffs, usually in order to increase profit (Martinez and Friis, 2004).

Corresponding author:
Faculty of Engineering, Department of Economics and Technology Management
Universitá degli Studi di Bergamo, Via Marconi 5, Dalmine (BG), Italy – 24044
Email : norman.syahruddin@unibg.it ; tel. +393277474543

Taking this consideration, traceability systems become important to identify what supplier's produce, how they produce and when the products will be delivered between echelons (Deasy, 2002). Identification of inputs or raw materials into the food processing system has been highlighted in the recent years. Previous researches have demonstrated that traceability has become key issue in most of industries, especially in food industries. This particular sector is volatile to the hazardous contaminants that can infect the materials or processed products which will eventually, affected consumer at the end. Thus, several questions arise. Does traceability answer the problems in the cocoa – chocolate chain? Until which n^{th} does traceability work?

This paper is the initial stage in identifying cocoa – chocolate supply chain and proposes a conceptual framework on its traceability system. Moreover, this paper aims at linking the traceability to performances of the chains as a driver to reach sustainability.

The article consists of six sections, where in introduction we discussed some background that reinforced our proposed research. In the next section, the framework for traceability is detailed. The third and fourth sections provide brief illustration on how cocoa – chocolate supply chain works and its industries, while sections five and six are dedicated to the proposed concept on holistic traceability, discussion and further development of the paper.

II. Framework for Traceability

The framework on traceability has been constructed since 1994 with the definition of traceability as *the ability for the retrieval of the history and use or location of an article or an activity through a registered identification* (ISO 8402, 1994) followed by the definition on quality assurance which stated traceability as *the ability to trace history, application or location that which under consideration* (ISO 9001, 2000). A more concrete description provide by the European Union through Regulation (EC) No. 178 / 2002 defining traceability as *the ability trace and follow a food, feed, food – producing animal or substance intended to be, or expected to be incorporated into food or feed, through all stages of production and distribution*[1]. The methodology for this framework is one-up-one-down principle. Of all sustainability elements, traceability has been highlighted in recent years following recalls of many food products in several countries, leading to higher consumer concerns on food safety and hazardous materials that may contained on food products.

The multi – events of food alerts and food risks[2] which occurred in a lengthy period and various locations, grows concern of consumers to question the safety of the food that they consumed. For food producers, occurrences of food alert forced them to review their supply chain to identify what went wrong in their supply chain. To do this, they need

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[1] European Community. http://ec.europa.eu/food/food/foodlaw/traceability. Accessed on 15th April 2011.

[2] Food Standard Agency. http://www.food.gov.uk/enforcement/alerts/. Accessed on 16th April 2011

a good traceability system that capable in revealing the problems occurred along the chains. Understanding traceability's impacts requires shifting perspective in order to encompass the vast array of interests, particularly because how each interest is incorporated into the system will determine how, who and what the human locational database embraces (Popper, 2007). Furthermore, traceability itself offers the promise that the individual can know the full story – the places, people, processes, and practices – of items raised and routed all over the world to end up in one's own mouth.

Traceability in agricultural / food chain is nowadays a fundamental requirement, which is becoming mandatory in almost all developed countries. The aim of a traceability system is to collect in a rigorous way all the information related to the displacement of the different products along the supply chain. This information proves essential when facing food safety crisis, and allows efficiently managing the consequent product recall action (Dabenne and Gay, 2011). To ensure the safety and quality of food products, consumers can indentify extrinsic indicators and cues convey information about the products through certification and labeling, which available on the point of purchase (Caswell, 2006) and obtained standard information of the food products (Gellynck *et al*, 2006). One of the biggest challenges with supply chain traceability is the exchange of information in a standardized format between various links in the chain (Thakur and Donnelly, 2010).

III. Industries at a glance

Previously, there was stigma that chocolate is the source of fat, unhealthy product that can cause obesity and heart attack. Yet, it was revealed that chocolate is not causing heart attack, while instead, one type of chocolate (dark chocolate) can strengthen the heart of human and can lowered the human blood pressure[3]. This finding indirectly promotes the production of dark chocolate due to shifted preference on healthier products (Knickel *et al* 2002). Similar finding also provided by International Coffee and Cocoa Organization or ICCO (2008) showing that chocolate candies are more dark and high content of cocoa in the recent years. The study was done in US and UK market which can be considered as premium market in chocolate industry. Relevant to that context, market trend shows the consumption of the chocolate in the world is increasing by 14% on average within the period of 1997 – 2006 with USA as the leading country with about 1.600.000 tons in 2006 of chocolate consumption followed by Germany, United Kingdom and France.

The rising demand for chocolate affected the performance in the export of cocoa beans. In the period 2005 / 2006, European region has been accounted for the largest cocoa consumption by 49% followed by American region with 35% and Asian region with 14% of total world consumption. There is significant increase by 728.000 tons in the 2005 / 2006 period compare to the 1995 / 1996 period or equal to 27% increase. Trend showed significant improvement in the organic or sustainable chocolate that comes from sustainable supply chain management due to for example environmental issues and food safety reasons.

[3] WebMD. http://www.webmd.com/diet/news/20030827/dark-chocolate-is-healthy-chocolate. Accessed on 16th April 2011.

In the production side, Ghana, Cote d'Ivoire and Indonesia dominated the cocoa production in the world, accounted for more than 70% of total world production.

Market for Indonesian' cocoa beans in European countries still counted as a niche market since only less than 15% of market share is available (Ministry of Agriculture, 2005). Moreover, the challenges for Indonesian' beans are the standard for quality set by European countries and General System of Preferences (GSP) rules in trading, where EU gave zero percent tariff to several beneficiaries (Coté d'Ivoire, Ghana, Brazil, Cameroon and Ecuador), compare to Most Favored Nation (MFN) rules that set 3.5% tariff for Indonesia. In general picture, most of the beans produced in Indonesia are unflavored cocoa beans, which counted for discounted price in the destination countries and subject to importing tariffs (Dradjat *et al*, 2003) and government intervention (Neilson, 2007), while additional fermentation will increase the value added to the beans (Latuhihin *et al,* 2007; Ardhana and Fleet, 2003) Like any other food chain, cocoa – chocolate chain also faced sustainability problems such as forest degradation, biodiversity destruction or child labor issue (Neilson, 2007; Schrage and Ewing, 2005) that often occurred in food supply chains.

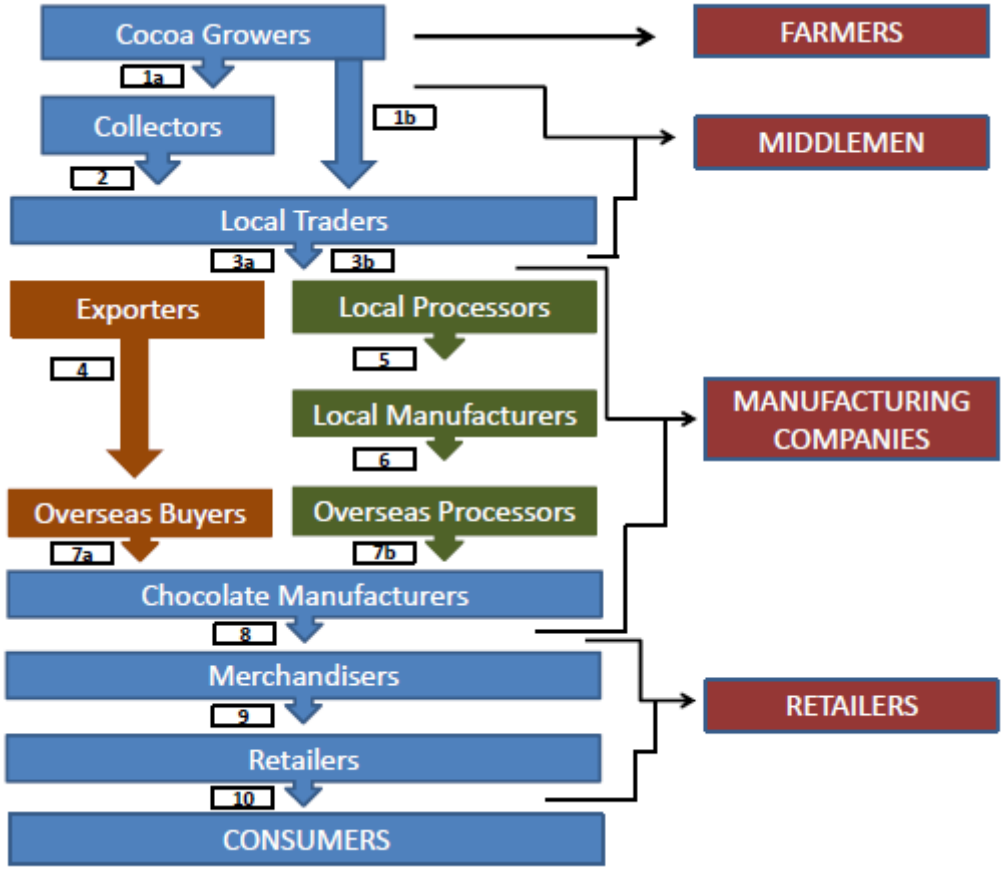
Approximately there are 400,000 – 500,000 smallholder households engaged in the cocoa production in Indonesia (Panliburton and Lusby, 2006) where most of the plantations are located in Sulawesi Island. Being the 3rd largest cocoa producers in the world, the area of plantations in Indonesia reached 920,000 hectares with the yield reached 630 kg/hectare. The production rate was counted for 600,000 tons/year (Djajusman, 2007). However, only 10% of cocoa beans are locally processed, while the rests were exported as raw beans. One of the largest processor in Sulawesi is PT. Effem, a subsidiary of Mars / Masterfood. Approximately 80% of the cocoa beans in Indonesia are sold by the five main multinational affiliate exporters namely: EDF and Man, Olam, Cargill, ADM and Continaf (Panliburton and Lusby, 2006).

IV. Cocoa – Chocolate Supply Chain

The selection of cocoa – chocolate supply chain (herewith CCSC) in this paper is due to similar characteristic compare to other agro – food supply chains. It has farmers / cocoa growers as the first echelon in the chain, collectors / processors in the middle and consumers at the end of the chain. It also has different complexity in addressing sustainability issues, whereas most of the issues are situated in farmer's and companies level. Moreover, CCSC also represent the trans-boundaries supply chain and multiple transportation modes with probability of food contamination problems. In that context, traceability becomes mandatory in Europe when the regulation (EC) 178 / 2002 come into force. Retailers and marketers within that region obliged to comply with the prerequisite set by the standard. Thus, traceability becomes an important tool to food, perishable food and feedstock industries. Indeed, the regulation stressed on the substantial responsibilities of farmers and processing companies for the food quality assurance and therefore, need to prove the diligence and traceability practices in their operations and supply chain (Savov and Kouzmanov, 2009). Stressing from that point, traceability for cocoa and chocolate become prerequisite as prevention against food alert.

The structure of CCSC, typically In Indonesia, can be seen as follows:

Fig. 1 . Value Chain of Cocoa in Indonesia for Smallholders Plantation



Source : Adapted from Bedford et. al. 2002

This CCSC is based on smallholder plantations, which count for more than 75% of the total cocoa plantation in Indonesia. To simplify, the chain was break down and group based on their operation as the following:

Cocoa growers

Like most of the food supply chain, cocoa growers become the initial echelon for the CCSC. Farmers cultivate beans nurture them and finally harvest the beans. During the nurturing session, farmers often used pesticide and herbicide to exterminated cocoa's diseases such as cocoa pod borer (CPD) and vascular streak dieback (VSD). The typical

characteristics of cocoa growers can be divided into 3 that are owner farmer, sharecroppers and farm managers (Bedford et al, 2002).

Middlemen

Middlemen consist of collector and local processors. The role of collectors is to collect all beans from the farmers and supply it to the local processors or straightly to the manufacturing companies. In the case of local processors, the price often gets higher when the processed bean arrived in the company's warehouses since the beans are already fermented leading to better remuneration for the earlier echelons (e.g. farmers, collectors, local processors). Though it seems that better in supplying beans to the local processors before selling it to the manufacturing companies, most of the collectors prefer to sell it directly to the manufacturing companies due to time constraint and immediate payment with lower economical margin.

Manufacturing companies

In this stage, the improvements of the materials for chocolate were done. Separation of cocoa beans into cocoa liquor, cocoa butter, cocoa cake etc provides the necessary substances for the making of chocolate. Additional material such as sugar, vanilla, blueberry depends on consumer preferences and market demand. Several steps also concluded in this stage such as blending, mixing, and cooking to packaging before it can be transported to retail companies.

Retail companies

The final stage of the CCSC before the final products can reach the shelves in the supermarket. Retail companies, including merchandisers, received ordered products and identify them by scanning the barcode attached in the package of chocolate, showing the supplier, type and batch of the products.

Table 1. Denotation of operation in CCSC in Indonesia

No	Action	Transportation mode	Notes
1a	Cocoa growers delivers beans to the collector	Local transportation, trucks	
1b	Cocoa growers delivers directly to local traders	Local transportation, trucks	Location of local trader is reachable
2	Collectors delivers the beans to the local trader	Local transportation, cars, trucks	
3a	Local traders delivers the beans to the exporters	Local transportation, cars, trucks	

3b	Local traders delivers the beans to the local processors	Local transportation, cars, trucks	
4	Exporters sells the beans to the overseas buyers	Shipping vessel	
5	Local processors performed fermentation process to the beans then deliver the fermented beans to the local manufacturers	Local transportation, cars, trucks	
6	Local manufacturers performed manufacturing process (i.e. winnowing, blending, roasting, grinding) then deliver the nibs to the overseas processors	Shipping vessel	
7a	Overseas buyers delivers the beans to the chocolate manufacturers for complete process of the chocolate (i.e. mixing, refining, conching, tempering)	Trucks, trains, cars	Extra processing costs that lowered the bean prices
7b	Overseas processors performs processing activities to produce ingredients for chocolate (i.e. cocoa powder, cocoa liquor, cocoa cake) then deliver them to the chocolate manufacturers for complete process of the chocolate	Trucks, trains, cars	Higher profit received for value added products
8	Chocolate manufacturers delivers the finished products (i.e. chocolate chips, bars, liquid bulk chocolate, chocolate blocks) to the merchandisers	Trucks, cars	
9	Merchandisers performs merchandising (i.e. branding, licensing) activities on the finished chocolate products then deliver them to retailers	Trucks, cars	
10	Retailers performs sales activities on the chocolate products	Trucks, cars	

In general, the traceability system in CCSC consists of two methodology that are manual tagging and Radio Frequency Identification Data (RFID). Traditionally, in the farmers to overseas manufacturers (*see* Fig. 1. 7a and b), the sacks were marked in identification number and recorded manually in the book or in computer database. Then, this data were transferred into RFID form when the products entered the chocolate manufacturer and end up in the shelves of the supermarket. This entails to the possibility of data mismatch during the supply chain process due to transformation of manual data into automatic data (i.e. Thakur and Donnelly, 2010).

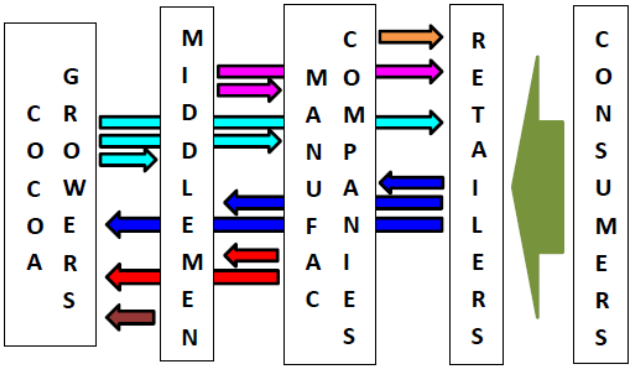
V. A Holistic Traceability

Consumers gain from increased traceability to the marketers by having better chances of receiving compensation in case of a food safety event and by consuming safer food. Additional traceability from the marketers to the farms does not increase consumer's compensation because it does not chance the marketers' liability. However, additional traceability to the farms allows marketers to impose liability costs on farms and thus creates incentives for farms to supply safer food. In return, with more traceability, marketers and farms receive a premium for supplying safer food. […] suggested that downstream firms may use traceability back to the farms to shift liability upstream and reduce the chance of food safety problems (Pouliot and Sumner, 2008). Reflecting to that, all chains need to identified, not only final supplier(s), but down to the initial echelon.

Proposition 1: Traceability must be treated as holistic context compare to partial sight limited to one chain before and after the viewed chain.

Proposition 1 stresses on the importance of holistic responsibility compare on one or two echelon. In this way, the problem within the supply chain can be minimize and particularly overviewed whether farmers always be the responsible party in the case of food alert.

Fig. 2. Concept of Holistic Traceability in CCSC



The holistic traceability enables each echelon in the supply chain recognize what agricultural and processing practices had been conducted by the previous echelon even from the initial stage. By this approach, retailers can identify not only their immediate

suppliers, but also went back to cocoa growers. The identification of traceability also leads to improving transparency, increasing trust and reducing liability cost in business – as – usual CCSC. Labeling also considered as an important feature relating to identification of ingredients and source of fat and protein that we expect to find inside a chocolate bar. Moreover the recycling indicator immediately alert us of the recyclable paper used for wrapping up the chocolate. Responding to Pouliot and Sumner (2008), it seems that farmers are the subject in the traceability systems, which easily being attribute to the . Thus, it worth taking into consideration the framework of forward traceability, where farmers can identify even their retailers to create more transparent information within the supply chain (fig. 2).

5.1. Traceability in other sectors

Recent development in ICT led to computerized system in traceability. Among them, radio frequency identification data or RFID (Gandino *et al* 2009; Regattieri *et al* 2007; Sahin *et al* 2002) is the most used techniques in agri – food chain to indentify supplier' products including process system, raw materials, number of batch, etc (e.g. barcode, tagging). In fast moving consumer goods (FMCG) labeling becomes important feature to identify, not only the brand of the product, but also the ingredients contained in the food products, enabling consumer to observe chemical materials inside the food products. In most of the seafood food chain, DNA based identification is the most applicable techniques to categorize species identification, production methods and geographical origin of species (e.g. Schröder, 2008; Ardura *et al*, 2010; Maldini *et al*, 2006; Fernández – Tajes *et al*, 2008) and in wheat industry (Scarafoni *et al* 2009). In this context, traceability is important for offering fresh and high qualified seafood products.

Another interesting case study comes from soybean supply chain showing that only information that will be delivered to the next link is considered important (Thakur and Donnelly, 2010). The study also suggested the utilization of Electronic Data Interchange (EDI) and Extensible Markup Language (XML) for standardize data exchange. Other technologies for modeling traceability are EPCIS framework and UML statecharts, which modeled transitions in food production. However, EPCIS specification does not cover all of the events (transitions) described in the previous sections (Thakur et. al, 2011), thus not revealing all relevant information within the supply chain. Different methodologies also performed to serve different purposes. High – performance Liquid Chromatography (HPLC) is performed to identified nitrate concentrate in several vegetables to see whether the level of concentrate can be acceptable for daily intake (Castanheira et al. 2004), Failure Mode Effect and Critically Analysis (FMECA) on durum wheat pasta (Bertolini, *et al* 2006), carbon and sulphur isotope composition on beef industries (Schmidt *et al* 2005).

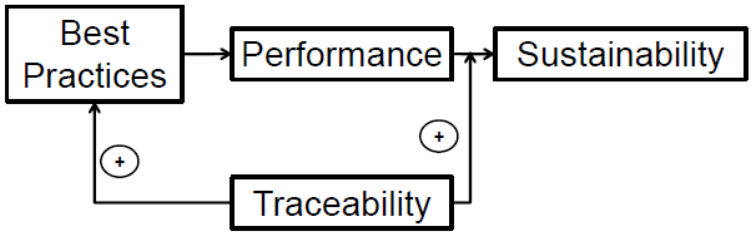
5.2. Traceability for sustainability

As part of operations, supply chain holds an important position in maintaining the flow of the materials to the processing units up to supplying finished goods to the end consumer (Chopra *et al*, 2001; Chopra and Meindl, 2007). As a consequence of globalization, global supply chains are typically characterized by greater use of transportation with obvious implications on the environment and induce local behaviors that sometimes may not be socially sustainable (e.g., exploitation of low cost labors). These factors are urging

stakeholders to take sustainability into account due to both rising concern of national and international regulations and an ever growing attention of end consumers of the implications on sustainability. In the last decade, there have been raising concerns on environmental damage, depleted resources, exploitation of child labor, endangered species, and global warming. Reuter *et al* (2010) state that sustainable supply chain in terms of global supplier management must be managed carefully to reduce risks, which also implies to the globalized food supply chain.

These concerns have shifted the traditional way of manufacturing and operation of most firms in the world so to become more concerned with the triple bottom line (Elkington 1998, 2004), thus guaranteeing both economic, social and environment sustainability of operations. In response to this growing concern, the number of papers that discuss sustainability has increase in the last decade by quintuple-fold (Linton et.al 2007). In the context of performance, traceability provides companies with supporting framework in understanding what practices that been applied by their suppliers. Within this perspective, traceability also can be extended as ethical approaches and ensures certain consumers to acknowledge information related to the food products that may lead to sustainability[4] (Beekman, 2008). Similarly, Epstein (2008) pointed out the importance of traceability in identifying sustainability while Kaynak and Montiel (2008), Beamon (2008) and Smith (2008) summarize the relationship between sustainability and performance, where traceability is identify as one of the key element in the performance for reaching sustainability, which lead us to the proposition 2 and 3.

Fig. 3. Traceability towards sustainability



Proposition 2: Traceability has indirect positive effect towards sustainability through best practices

Proposition 3: Traceability has moderating positive effect on performance and sustainability

[4] Ethical traceability can be functioned as public management tools used to ensure consumer that consumers are provided are provided with food that respect some threshold level of animal welfare, sustainability or fair trade and as public – private tool, used to allow certain consumers to be provided with food products and sufficient information about these products (pp 70 – 71).

VI. Discussion and Further Development

Traceability becomes important figure in the supply chain to identify products, materials, service and processes that had been conducted by the suppliers within the supply chain. Moreover, it can provide a significant impact on the pursuant of sustainability. In this context, traceability can provide more detailed information, not limited to the products, but also to the sustainability performance of the supply chain (i.e. social and environmental performances). In the end, traceability must be conducted by all elements in the supply chain and not limited to certain chain. However, regarding the information' availability, certain chains should possessed complete information regarding the traceability. Nor the consumer nor the farmers, but chains that have better financial performances (i.e. retailers, manufacturers) whereas consumers have strong preferences that other stakeholders, retailers and governments, in the chain possessed information on traceability and available upon request (Gellynck *et al*, 2006).

In general, this paper provides an insight on how traceability should be conducted, with specification of cocoa – chocolate industries. Next, it would be interesting to test the proposed model with actual data based on the direct surveys to each chain within the supply chain. It also will be interesting to see the development of technology that can identify the practices of the supply chain by only scanning the barcode of the chocolate products. With this advancement, cocoa – chocolate industries is one step closer in reaching sustainability.

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