

An Integrated Collaboration Framework for Sustainable Sugar Supply Chains

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Abstract — Stakeholders in sugar supply chains face challenges to identify strengths and weaknesses, as well as opportunities and capabilities of all collaborating stakeholders. This paper proposes a conceptual model as a framework for sustainable sugar supply chains to achieve an effective collaboration system. This model identifies essential elements and how they are linked in the boundary of sustainability. An existing general collaboration model is selected as the basis to develop a new supply chain collaboration model based on the characteristics, the synergies, and the elements. The framework consisting of six elements: boundary and context; drivers (value proposition, assets, and supply chain capabilities); stakeholder requirements; collaboration system requirements; quality indicators; and a common goal. This study provides the novelty to the theories by developing the integrated collaboration model for sustainable supply chains. This conceptual model gives insight to the sugar stakeholders who join in collaboration regarding what are the specific drivers and elements that possible and essential to propose a sustainable collaboration, what their roles are, and how they are linked. The finding can be used as the basis for a collaboration quality assessment model.

Keywords — supply chain integration, sustainability, buyer-supplier relationships

1. Introduction

The sugar supply chains are a typical agri-food supply chains that have a long distribution network, and each stakeholder in the system has different significant roles. Some of these stakeholders work independently and possibly have different views and expectations from one another. Nevertheless, the level of interdependency among them in the sugar supply chains is high [1]. They need material and non-material, as well as financial and non-financial support from others in the form of collaboration.

However, the understanding of stakeholders about the elements of collaboration is low with not many research studies paying attention to analyzing the element [2].

Therefore, the purpose of this paper is to develop a framework that covers essential elements in proposing and maintaining a good collaboration system in sustainable agri-food supply chains.

2. The sugar supply chains and collaboration

The supply chain processes in the sugar industry start from harvest time in farm sites, and then involves transportation of sugarcane to the miller, processing time, and finally the distribution to end consumers. Stakeholders in the sugar supply chains are divided into two types (primary and secondary stakeholders). A primary stakeholder is an organization which has interests in the business and directly collects the benefits. The main players in the sugar supply chains are farmers, millers, distributors, retailers, and consumers. A secondary stakeholder is an organization which has a function as an indirect partner and does not necessarily engage in the supply chain process but has a concern in managing and influencing to the business system. They consist of the government, Non-government organizations (NGOs), sugar/sugarcane associations, and financial institutions. A general sugar supply chains model is illustrated in Figure 1.

The sugar supply chains have three types of flow: material, information, and financial flows. Material flows are among primary stakeholders, who are farmers, a miller, distributors, retailers, and consumers. Information flows which involve primary and secondary stakeholders include information about demand, material, process, product, cost, quality, resource, and order information [3]. Information sharing has impacts on operational, tactical, and strategic decisions within the supply chains [4]. Financial activities, besides flow among the primary stakeholders, also involve NGOs and financial institutions as other financial resources. The government itself has functions to supervise all institutions and control the activities of the supply chain processes. Moreover, to have the holistic supply chain system, the interaction between primary and secondary stakeholders has to be established. Secondary stakeholders as the supporter of the supply chain will act as the sub-

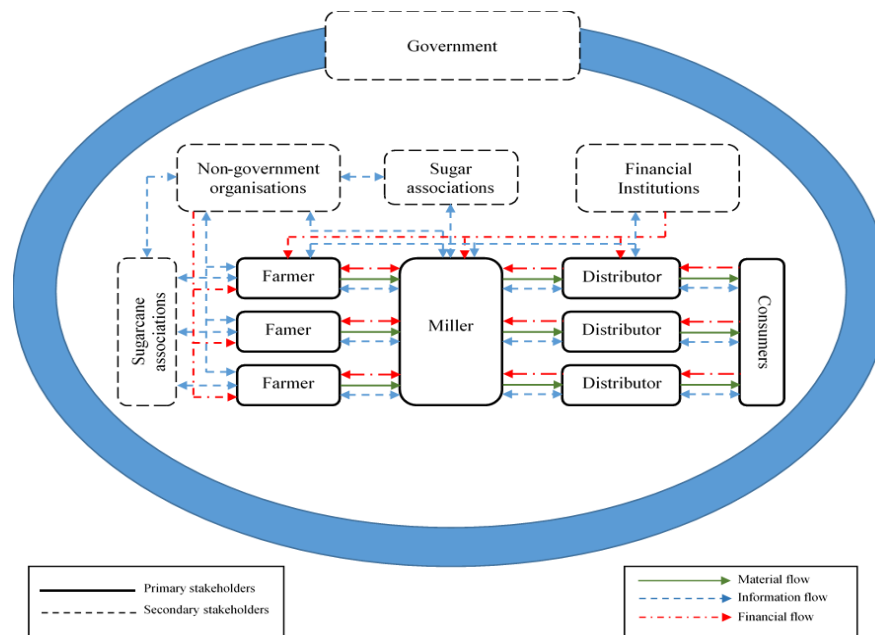


Figure 1. General Sugar Supply Chains Model

layers that monitor the collaboration process in achieving a competitive advantage that gives fair benefits for all parties involved.

The sugar supply chains have several characteristics that need to be considered in designing the collaboration process namely characteristics of raw material, process classification, and the nature of interaction process. Sugar, as perishable food, has a short time post-harvest deterioration because the bio-degradation process from sweet juice of sugarcane into acid juice happens in less than 24 hours [5]. The high lactic acid concentration indicates microbe contaminants in sugarcane [6]. Besides delayed processing, other factors with an impact on the quality of sucrose in sugarcane are humidity, ambient temperature, a period of storage, cane variety, and maturity status [7]. Therefore, sugarcane needs an effective post-harvest material handling to minimize losses.

The nature of the interaction among the stakeholders in the supply chains becomes the basis for creating a collaboration system. Each stakeholder has an interaction with many organizations [8] and understanding among them is essential. They need to enhance competitive advantage without other parties suffering. Therefore, the awareness of the elements that support the collaboration process is vital as the basics to creating the strategy of partnership.

Collaboration among the stakeholder in sugar supply chains brings optimal benefits while reducing the risks through all the stages. The benefits spread in all supply chain activities, from the operational to strategic levels. Through collaboration, the sugar supply chains provide traceability and transparency to the entire system. Therefore, stakeholders have an opportunity to enhance fair market share, market growth, and high margins.

Collaboration in the many sugar industries in the world already exists [11]-[14]. However, sugar stakeholders realize that maintaining good supply chain collaboration is challenging. Some studies cover both vertical and horizontal collaborations in the agri-food supply chains [9-15]. However, an integrated vertical and horizontal collaboration model related to sustainability in the sugar supply chains is beyond their concern. Particular aspects still need to be explored and represented in a robust model, such as what parties are involved in both types of collaboration, what elements that collaborate, what aspects that need to be considered, and how they collaborate to achieve good collaboration quality. Without exploring all those elements, collaboration quality is difficult to measure. Therefore, an integrated collaboration model will give a broad overview of collaboration that influences collaboration quality and to capture the dynamic and behavior of the interaction.

This paper presents an integrated collaboration model for sustainable supply chains that are more beneficial for the parties involved directly in the sugar supply chains. It proposes the collaboration model for sugar supply chains based on an existing collaboration model for the basis to generate the new model. Therefore, in the next section, the analysis of the current collaboration model that is applicable to the sugar supply chains is presented. Then, the most comprehensive and relevant model is selected and discussed. Then, based on the construction of the original model, collaboration model for sugar supply chains is created by integrating economic, environmental, and social aspects.

3. Methods

The method used in this research is to select a collaboration model from many existing ones to develop a collaboration model for sustainable sugar supply chain. The inputs and ideas from the selected collaboration models general will give a better understanding of the construction, elements, and systematic process in collaboration.

Many studies developed collaboration model in diverse contexts such as supply chains, logistics, global enterprises, and rural community development. Each model has its own purpose, uniqueness, and limitations. The existing collaboration models were compared to select one as the starting point-[31]. Most of these collaboration models are not limited to a supply chain collaboration model to obtain a broader idea of the construction of the proposed collaboration model. These models are applied in various contexts, but most of the models could not be adopted and adjusted for collaboration in sustainable sugar supply chain. These models had limitations, for example, they do not reflect all the sustainability aspects, do not include stakeholders involved in the collaboration, nor cover the elements that will collaborate.

The collaboration model selected is Zhu et al.'s integrated model [30] for the development of the stronger communities. This model is the most relevant to be adapted in the current research since it has the same nature with this research, which focuses on sustainability and involves multi-stakeholders. In addition, it has integrated and interconnected important elements that support their main goal, which is the development of community support. This model captures the synergies of the stakeholders for co-creation values. A detailed explanation of this model will be discussed in the next section.

4. The basis of proposed collaboration model

The selected collaboration model used as the basis for the collaboration model for sustainable sugar supply chain was proposed by Zhu, Lan [16]. This model has a purpose to explain how a community enterprise and social entrepreneurship support community development in rural areas by improving socio-economic competencies and capacities, creating and sustaining local employment, and becoming independent. Community development has a close correlation with the control of knowledge, abilities, assets, organizations and how they use it to create their destiny [17]. The model captures the key elements that foster community development, covering the ability to stay extensive, strong and innovative, to access resources, and to obtain knowledge and skills [18].

This collaboration model is selected to be modified because it has an emphasis on socio-economic and environmental contexts and the interaction between these

elements. It shows how different elements involving multi-stakeholders can support the development of social enterprises to enhance the stronger and self-dependent communities. Therefore, the model helps to organize critical factors to achieve the common goal by capturing the interests and needs of all actors in the network. The focus on the involvement of multi-stakeholders can be adopted into the proposed model to capture the essential elements for supporting collaboration in sustainable sugar supply chains.

However, the existing model needs some adaptations and adjustment to bring the sugar supply chain context in the model for several reasons. **First**, the current model focuses on social entrepreneurship and community enterprises that are more focus on social and cultural issues. While, the proposed study will balance among economic, environmental, and social aspects since the stakeholders that are involved in the system are profit-oriented organizations. **Second**, the main goal of the current model is to enhance stronger rural communities which involve a group of people in the certain region. Whereas, in sugar supply chains, the main goal is to achieve high quality collaboration in sustainable sugar supply chains that involve certain stakeholders in one specific industry. **Third**, the current model does not cover the requirements for each interested parties and what strategies to achieve them. While, in this research, those factors become one of the essential elements in creating well collaboration system. **Fourth**, this model does not consider collaboration quality that is important to measure how well the collaboration system runs by considering sustainability perspectives. Hence, to be more relevant to key factors that are important to support a high quality of collaboration, supply chain perspectives and collaboration quality assessment elements will be used to customize the existing model. The development will be informed by and based on the characteristics, requirements, and constraints of sustainable sugar supply chains. Based on this model, an integrated collaboration model for sustainable sugar supply chains management will be developed.

5. Result and discussion

5.1 The proposed collaboration model for sustainable sugar supply chains

Encompassing many stakeholders in the sugar supply chains, apt collaboration model is essential. The proposed collaboration model will arrange, organize, and control the collaboration that exists in these chains. Whoever that become the user of this model can identify the important elements that are required as a guideline in joining collaboration system. Within the collaboration model, each stakeholder can identify their strengths and weaknesses. Therefore, it will help to select the potential partners.

Essentially, the development of collaboration in the sustainable sugar supply chains needs to consider six elements in the integrated collaboration model. The collaboration model should control the interaction among the stakeholders and be the checkpoint to ensure that the collaboration process brings positive impacts for all

organizations involved. The proposed model reconceptualizes Zhu, Lan [16].’s model resulting many layers, from the fundamental concept to the more specific and technical factors. which are illustrated in Figure 2.

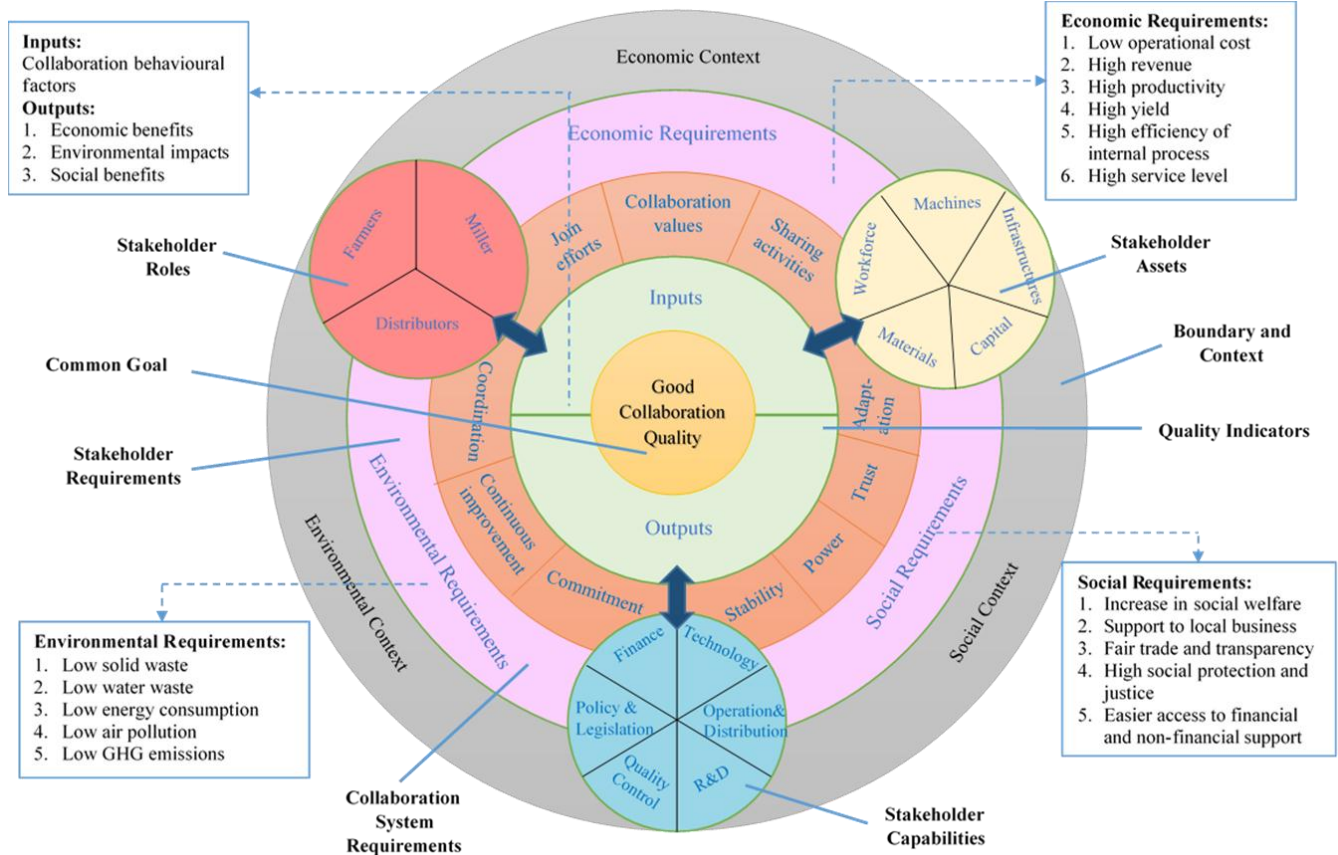


Figure 2. Collaboration Model for Sustainable Sugar Supply Chains

In Figure 2, all the elements in the collaboration model are linked. The model captures the interaction and contribution of stakeholders in the development of sustainable sugar supply chains in an integrated and holistic view. The first layer represents the boundary and context which acts as a reminder for the stakeholder that any activities should be within the scope of sustainability. The second layer represents the stakeholder requirements. It shows the expectation of stakeholders regarding economic, environmental, and social aspects when they are joining the collaboration. These requirements are answered by the next layer, which is collaboration system requirements. Collaboration system requirements, which represent organizational behavior, will fulfill the stakeholders' demand. However, the collaboration cannot be proven that it is going well and robust unless there is an assessment process. Therefore, the next layer is quality indicators as the evaluation variable to check the achievement of fulfilling the common goal by using collaboration system requirements. The indicators have a direct link with value propositions, assets, and supply chain capabilities. It

means that the evaluation process will involve all assets and capabilities of stakeholders as the drivers to reach the success of collaboration processes. These drivers have a function as a magnet for stakeholders to join in collaboration. The model can be utilized as a guideline to identify the strengths and weaknesses of others. Then, the center of the collaboration model is the common goals. It represents the main target in proposing collaboration among stakeholders to achieve a high profit and low risk while sustaining social and environmental aspects. The detail of the elements is explained in the next sub-section.

5.1.1 Boundary and context

The fundamental concept of collaboration underlying the processes, characteristics, needs, and interaction among stakeholders is critical and must be clear. This boundary helps stakeholders to focus on specific contexts in identifying the needs and determining the strategies to deal with stakeholder requirements. A clear understanding of the context helps the stakeholders to set up quality

assessment system to achieve the common goal. Therefore, all issues, constraints, opportunities, and approaches must be included and correlated within the boundary.

Sustainability underlies the collaboration system. It should be at the heart of all organizations within the supply chain. It is the paradigm that inspires any process in the supply chains [19]. This concept is based on the triple bottom line of economic, environmental, and social aspects. Economic aspects have a function to create a better business environment by giving optimum benefits to all stakeholders in the system. Environmental aspects provide an overview about how to save the planet by reducing pollution, the carbon footprint, and waste. It covers factors that correlate with health and safety. Social aspects have an essential role in creating better communities.

5.1.2 Drivers

Drivers in the collaboration model reflect the elements that support the integration among the stakeholders. These key drivers represent specific values, competencies, and capabilities that are offered by organizations. They influence the performance of organizations in giving benefit to others. The three interconnected drivers are value propositions, assets, and supply chain capabilities. These drivers are directly linked to quality indicators meaning that the quality standard of the collaboration depends on the quality of the actors in the system, the assets they have, and the capabilities they can perform. All the drivers should be match one another. The mismatch among the drivers will lead to the inefficient collaboration quality.

(a) Stakeholder roles

As the organization engages in business process, they need to offer different functions to the customer in the sugar supply chains, which is called role. It represents the promise of the supplier to the customers to fulfill what they expect in the collaborative network. This research focuses on the collaboration among the primary stakeholders because the main supply chain activities and collecting the benefits occur in this type of stakeholder. Secondary stakeholders act as the supporting parties that do not include in the assessment system. There are three primary players in sugar supply chains, including farmer, miller, and distributor. Each stakeholder has a function as a supplier as well as a customer to others. They have similar interest and vision in engaging the collaboration process, but different abilities and focuses. Therefore, the interdependency among others increases the value co-creation in the network. The functions offered by stakeholders in sugar supply chains could include:

Farmers

As sugarcane growers, they promise to supply high quality sugarcane to the miller. They have a role to ensure the continuity of sugarcane as the raw material for the miller. They also have a role in protecting the environment by minimizing the using of pesticide and the water usage as their support to green farming.

Miller

Miller has a function in production side to process the sugarcane become the sugar to increase the value. They also provide technical and financial assistance to farmers. Therefore, the farmers produce the better and valuable output. Moreover, small farmers can survive and continue their business.

Distributors

The spearhead of the marketing process is to the distributors. They have a role in marketing the sugar and maintaining the availability and continuity of sugar in the community. They have two functions neither supply the sugar to the company that needs sugar as raw material and distribute the sugar to the supplier then sell it to the end customers.

(b) Assets

Assets are an attraction for other stakeholders to create the form of collaboration. These assets are the main inputs required to operate the businesses. They consist of different kinds of resources such as man (human resources), machines (tools and equipment), materials (natural resources and other raw materials), money (financial resources and capital), and infrastructure (transportation, information, utilities, and telecommunication). Through the collaboration in the sugar supply network, valuable assets can be linked in facilitating the improvement in each stage in the supply chain. Within the capabilities and the value proposition of each organization, the optimal usage of the assets brings better mutual benefits. However, overlapping among the organization possibly happens. The collaboration model has a function to arrange and optimize the usage of the assets effectively in supporting the common goals.

(c) Supply chain capabilities

Building a collaboration not only depends on the availability of assets and the promises that are offered by stakeholders but also the abilities to utilize the assets effectively and efficiently. Supply chain capabilities represent the main competitive advantage of the organization to perform the supply chain collaboration process by classifying, utilizing and adapting both internal and external resources for company success [20]. Assets and supply chain capabilities drive the network into a global competitive advantage to improve capabilities in-

line with the harmonization of relationships in achieving mutual benefits .

Several studies have analyzed supply chain capabilities from different perspectives [37]-[42]. All the capabilities influence all supply chain activities from pre-processing to the distribution process. Of these capabilities, collaboration among sugar players requires capabilities such as technology, R&D, finance, operation and distribution, policy and legislation, and quality control. Technology helps the network to operate a business effectively and efficiently. The introduction of new technology is complemented by tacit knowledge, and creative and innovative skills. Technology helps to propose a better partnership and improve the quality of the system. It includes information technology, communication systems, machines, and tools. The application R&D and quality control also play a major role in creating a better process, product, and system. R&D contributes to plant breeding, sugarcane variety and product improvement in helping to structure a competitive and profitable supply chain while reducing environmental impacts. Quality control ensures the quality of the sugarcane before processing, during the production process into raw sugar, and the distribution process. Sustainable sugar supply chains also need sufficient financial support from the government, NGOs, and manufacturers to open opportunities for smallholders to function in healthy business conditions. Transparent financial mechanisms lead to fair markets and extensive opportunities for better business development. The capabilities of the stakeholders in running the operation and distribution network foster the achievement of sustainable supply chains. The operation and distribution processes include transportation, warehousing, inventory control, and marketing processes. To protect and facilitate the collaboration process, policy and legislation help regulate the partnership and business system.

5.1.3 Stakeholder requirements

Stakeholder requirements refer to the expectations of the stakeholders in supply chain collaboration. A stakeholder is a person or organization with interests in the supply chain and needs to be involved in the system (direct or indirect) and expect benefits from it [21]. The organization joins in collaboration to obtain other value proposition, capabilities, and assets. Stakeholder expectations sometimes support each other or result in conflicting interests. Stakeholders will have similar goals if they commit to being a part of a collaboration network. Therefore, understanding the stakeholder requirements is required to minimize conflicts, risks, and losses. The requirements refer to positive impacts that the parties expect when they collaborate. By considering requirements of others in planning their action and process, all parties have a high sense of belonging to the system and give the

best contribution that will result in the maximum benefits for all stakeholders.

The analysis of the stakeholder requirements can be organized through several approaches, such as literature reviews, historical data, surveys, and brainstorming with experts in the organizations. Some scholars focus on analyzing the expectation of the stakeholders in joining the collaboration [22-33]. Since the boundary and context underlying the system is sustainability, the stakeholder requirements have to represent the needs in a sustainability context that consists of economic, environmental, and social aspects. Stakeholder requirements in sugar supply chains can be seen in Table 1.

Table 1. Typical Stakeholder Requirements

Categories	Requirement	Definition
Economic	Low operational cost	Any costs, including production, energy and fuel, labour, transportation, distribution and overtime costs
	High revenue	The total amount of after-sales income
	High productivity	The total amount of product/service that is produced in a certain time that fulfils the standard
	High yield	The total product that is produced from given materials
	High efficiency of internal operation process	The extent to which the process generates the desired output in a given time
	High service level	The condition in which the percentage of number of filled units meets expectations
Environmental	Low solid waste	The total amount of solid waste is below the standard
	Low water waste	The total amount of water waste is below the standard
	Low energy consumption	The total amount of energy that is used in the operational process
	Low air pollution	The total amount of air pollution as the result of the operational process
Social	Low GHG emissions	The total amount of carbon emissions as the result of the operational process
	Increase in social welfare	The involvement of stakeholders in taking any action that increases the quality of life in the community

Support to local business	Support that is gained from the environment by buying the local product to ensure local business continuity
Fair trade and transparency	A fair price and transparent transaction process in supply chain activities
High social protection and justice	The condition in which basic human rights and economic equity are protected
Easier access to financial and non-financial support	The ability to obtain information and access financial and non-financial support provided by any organisation

5.1.4 Collaboration system requirements

After the expectations of each stakeholder are identified, the next phase is to determine the possible collaboration strategy to address the stakeholder requirements. Since humans and organizations are the main subjects of the collaboration, organizational behavior is considered as the most appropriate strategy in bridging the cooperation among the supply chain members. Organizational behavior is one of the functional requirements that describes how to respond to stakeholder needs [21].

Ten collaboration behaviors are important to support health collaboration among stakeholders in sustainable sugar supply chains, which are [34]:

Joint effort: any activities that involve the participation of two or more stakeholders to achieve strategic, tactical, and operational goals, such as in planning, problem solving, and performance measurement activities.

Sharing activities: the agreement to share the assets (man, material, money, machine, and infrastructure) and any risks and losses.

Collaboration value: interpersonal characteristics in the organizations to increase the value co-creation in the sugar supply chains.

Adaptation: the capability of the organization to become accustomed and flexible in the planned or unplanned disruptions, changing in technology, behaviors, and goals.

Trust: the willingness to believe in other organizations, build a good relationship, and ensure the stability is maintained.

Commitment: the willingness of being dedicated to activities and partnership and put more effort to achieve the main goals.

Power: the capability of an organization to regulate, persuade, and inspire other organizations in decision-making activities.

Continuous improvement: the willingness to enhance the performances and capabilities continuously in achieving greater targets.

Coordination: the interaction among organizations to arrange and organize the system to reach harmonization.

Stability: the ability to keep the collaboration system remain stable and unchanged.

The ten collaboration behaviors are synergized and support one to another. Within these behaviors, the stakeholder has the basic skill in proposing the interaction with the partners and managing a healthy partnership.

5.1.5 Quality indicators

The quality of the collaboration among the stakeholders needs to be assessed. Measurement is based on several reliable indicators. Quality indicators express the significant measurable variables that represent the quality level in sustainable sugar supply chains. Quality indicators cover input and output of the collaboration system. The inputs of collaboration are organization behaviors, while the outputs of collaboration are the sustainability factors, such as revenue, reduction of waste, and social benefits. Each organization possibly has different output indicators, depending on which factors have the most impact on the system and the availability of the data.

The function of quality indicators is to measure the impact of the collaboration on sustainability aspects, whether collaboration gives positive impacts or brings drawbacks to the stakeholders. Some of the factors are undesirable such as environmental impacts. The maximum economic and social outputs are expected. Therefore, this model will give solutions on how to maximize desirable outputs while minimizing undesirable outputs based on given inputs. As a result, the improvement strategy can be arranged to achieve the maximum target. The result can be used to select the potential partner organizations and eliminate stakeholders that do not give valuable benefits.

5.1.6 Common goals

Common goals are central to all activities in supply chain collaboration. These represent the focus and mutual objectives that derive from the alignment process of the needs and interests of farmers, the miller, and distributors by considering and respecting other preferences and limitations. Therefore, collaboration gives benefits to all stakeholders involved in sustainable sugar supply chains and minimize unfair collaboration.

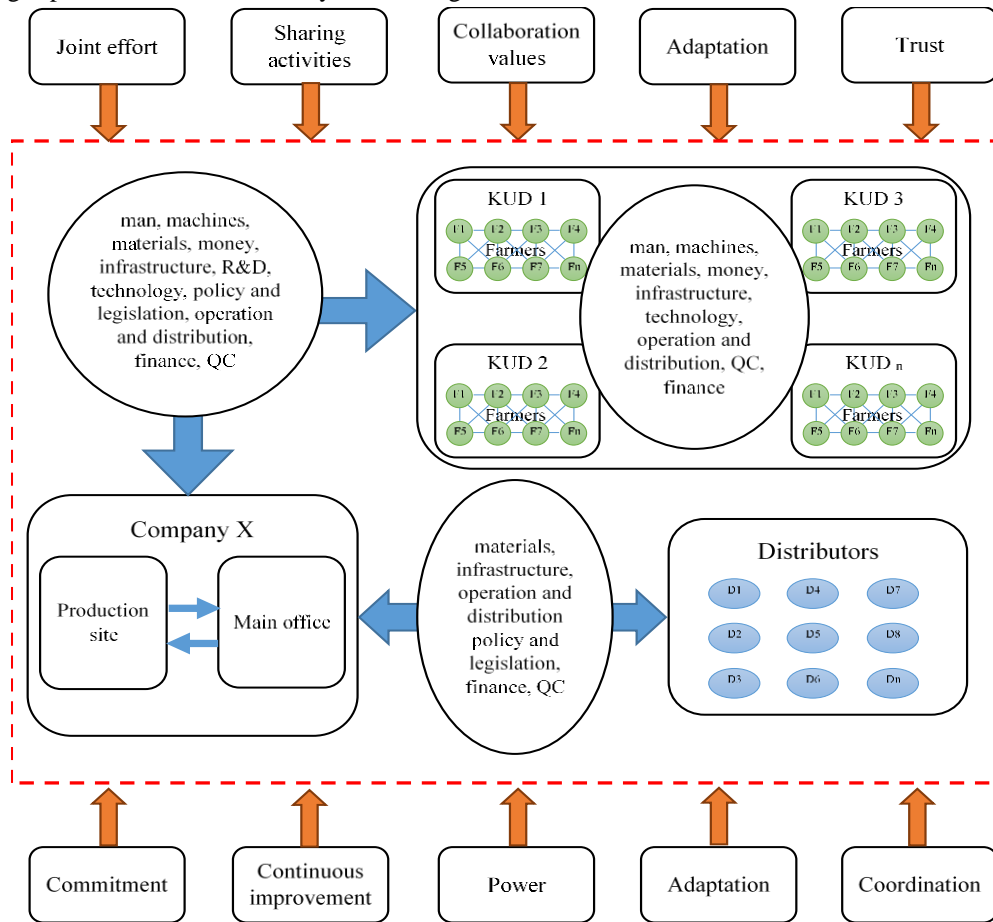
Practically, the common goals represent the triple bottom line. How the collaboration gives positive impact to economic, environmental, and social aspects in achieving high efficiency is a pathway to reach competitive advantage. Consequently, all activities must consider common goals as the objectives function. As a result, the benefits are not only for the local enterprise needs but also for the entire global supply network.

The theoretically proposed model has been applied to analyze one of sugar companies in Indonesia. The discussion of the application of the proposed model in the case study will be explained in the next section.

5.2 Case study: application of the collaboration model in sugar Company X-Indonesia

Company X is a private company in Indonesia that has engaged in sugar production since the early 1900s. Sugar

supply chains related to Company X involves several main players, including farmers in the same district where Company X is located, and local distributors who buy the sugar from the auction process in the company. These stakeholders collaborate to support the continuity of sugar in the market. The supply chain collaboration scheme in Company X is illustrated in Figure 3.



Legend: KUD (Koperasi Unit Desa in Indonesian) refers to a village economic cooperative unit

Figure 3. Supply Chain Collaboration Scheme in Company X

The boundary and context in this case study is sustainability that consists of economic, environmental, and social aspects. The main goal is good collaboration quality among the main players in this supply chain, which are farmers, Company X (miller), and distributors. Farmers have a role in providing sugarcane as the raw material on continuing basis; The miller has a role in processing the sugarcane into sugar, supporting the prosperity of the farmers, and providing the technical and financial assistance to farmers; Distributors have a role in distributing the sugar to the consumer. All of their roles are called value propositions. The assets and supply chain

capabilities that they share, the collaboration behaviors, and the impact on sustainability will be explained in each type of collaboration in the next sub-sections.

5.2.1 Collaboration between Company X and farmers

Based on government regulations, farmers who supply sugarcane to Company X are restricted to farmers from the same district in which the company is located. This sugar company covers 19 zones within one district with a total sugarcane field area of less than 19,000 ha, in the radius of 4–60 km from the Company X. It includes ~ 4,300 farmers

who are incorporated in 300 farmer groups and 21 business units. Farmers in one district are clustered based on the area zone, where they are managed by a village economic cooperative unit (KUD). Each zone consists of a small group of farmers based on the location of the farm. Although KUD has the power and function to manage the farmers and facilitate the distribution of any information and support from the government as well as the company, staff from Company X also visit directly to the farm to communicate with the farmers and control the quality of sugarcane. Therefore, all the information, including knowledge and technology, from the company also directly reaches the farmers to ensure continuous improvement.

In maintaining the continuity of the raw material and ensuring it is processed well, Company X and the farmers collaborate in several ways. First, both parties make an agreement before harvest time regarding the commitment of the farmers to supply sugarcane to Company X. In return, the company promises to offer a higher price. The commitment is formed between them, and both parties try to maintain it to keep the trust and stability of collaboration.

A second collaboration is by maintaining the quality of sugarcane which depends on the seed varieties, planting process, the harvest time, and processing time. All factors have an impact on the total sugar yield. The company gives counseling to the farmers about high quality sugar seeds and the optimum harvest time. The company offers incentives to the farmers that put an effort to follow the suggestions proposed. Both parties need to adapt to any changes in the environment, including different technology, systems, and materials. The company has the power to decide the sugarcane that is allowed to be processed and the price. Although the company sets the quality standard of sugarcane, they also accept sugarcane that has a lower quality at a different price because of their concern for collaboration values in maintaining the relationship with the farmers.

Company X and farmers also collaborate in determining gain sharing. The government has established a general gain sharing standard between sugar companies (66%) and farmers (34%). In practice, the sharing percentage is adjusted depending on the agreement between the company and farmers. Company X has increased the sharing portion for farmers with the expectation that farmers will continue to supply sugarcane to them instead of to other sugar companies. It is the effort of the company appreciates the willingness of farmers to keep the availability of sugarcane in the market in general.

In addition, Company X and farmers collaborate in financial and non-financial support. Before the milling period, staff from Company X visits the farm ensure the readiness of the raw material for processing. They explain to the farmers, which sugarcane is mature and ready to be extracted. Also, the staff organizes a milling schedule so

the sugarcane will be harvested based on the planned schedule. The company also provides harvest labor for the farmers who lack human resources. The company gives special treatment to farmers who commit to supply their sugarcane to them, such as borrowing tractors easily, getting seed at the lower price, and providing a guarantee letter for the farmers who need financial support from other institutions. Overall, according to the collaboration model, the collaboration between Company X and farmers comprises sharing assets (man, materials, money, machine, and infrastructures) and supply chain capabilities (finance, technology, operation and distribution, R&D, quality control, policy, and legislation).

Collaboration activities between Company X and farmers bring benefits to sustainability aspects. It supports a better economic outcome by reducing operational costs while increasing the revenue for both parties. Also, the continuity of raw material will improve the productivity and service level. The stability of the sugarcane quality also has an impact on the sugarcane yield. Overall, the efficiency of the internal process is achieved. This collaboration brings positive impact to the environment. It reduces solid and water waste, energy consumption, air pollution, and GHG emissions. Sugarcane quality correlates with the total waste as the higher quality of sugarcane will produce less waste in the process. Solid waste as a result of the production process can be used by farmers for fertilizer. Company X also supports the social development in the farmer's community. The decision to increase gain sharing for farmers supports social welfare and local businesses. Indeed, the company also determines the minimum price of sugar in the auction process for social protection and justice. Fair-trade and transparency also happen since the company facilitates the auction process witnessed by farmers. Company X gives full support to the farmers in term of financial and non-financial support, while the farmers cooperate well and maintain loyalty.

5.2.2 *Collaboration among the farmers*

Among the farmers themselves, collaboration exists both facilitated by KUD and informal collaboration. They share resources such as tractors, seeds, fertilizer, and human resources during the farming process. The farmers work based on family principles which have high mutual understanding and relationship value. They collaborate regarding the planning and operational processes. Facilitated by KUD, the farmers held regular meetings to coordinate during plantation and harvest seasons and share new information, regulations, and technology. They make efforts to improve the plantation system, even if sometimes it is difficult to adapt to the new system or technology due to limitations such as capital, human resources, and the characteristic of the farm. Small-scale farmers also collaborate in collecting sugarcane crops before delivering

them to the sugar company by sharing the infrastructure and cost. This activity reduces the transportation cost and logistical time during the delivery process. In term of the collaboration model, the collaboration among the farmers involves the sharing assets (man, machines, infrastructure, materials, and money) and supply chain capabilities (operation and distribution, quality control, technology, and finance). Among the farmers, the trust and commitment exist. They believe that they will help each other. Large-scale farmers help small-scale farmers to survive by giving financial and non-financial support.

The advantages of this collaboration support sustainability both directly and indirectly. Economically, it increases the revenue while reducing the operational cost since they share some resources. It increases the productivity since the farmers get more resources which possibly have an impact on the improvement of internal process efficiency producing more yield. Environmentally, collaboration helps to decrease energy consumption, air pollution, and GHG emissions due to the reduction of the number of trucks for delivering the sugarcane to the company. The solid waste can be used for other people who need it for animal feed. Socially, the collaboration supports to local businesses and enhances social welfare by giving access to financial and non-financial support and social protection.

5.2.3 *Collaboration between Company X and distributors*

Once sugar is produced, it should be discharged from the warehouse immediately to minimize the handling cost by the miller. The delivery process to the distributors is managed by the main office of the miller which is located in a different city. The main office provides the delivery order documents to the distributor, while the product is available on the production site for picking up. Therefore, coordination among the main office, production site, and distributors must be settled before the collection time. The marketing activities in Company X are performed by an auction process. The marketing department informs distributors who want to participate in the auction process. All the processes including registration, auction, and submitting the documents have been completed online. The winner of the auction and the settled sugar price are also published online. Transparency is maintained to gain trust from the distributors.

Company X also builds collaboration with the distributors who will allocate the sugar to retailers and end customers. The company informs the distributor of sugar quantity that will be at auction and provides transparency around the auction process and settles price. The company commits to providing high quality sugar to the distributors, while the distributors commit to paying for the product on

time. Both parties have a high level of trust and commitment. They have the same goal to keep the continuity the sugar supply in the market. They are adaptable to the dynamic condition in society, such as the changing market price, supply quantity, policy, and legislation. Despite the power of distributors to set the sugar price, when the price is dropped, the distributor is still willing to buy the sugar through the company at the reasonable price to keep all business players surviving.

The company gives flexibility to the distributors in collecting the product. The distributors are allowed to sell the delivery order documents to retailers, so the retailers who will collect the product from the company based on these documents. Distributors, retailers, and the company need to build excellent communication and coordination to avoid problems during the process. The distributors will report to the company the name of the retailers who will collect the products and the total amount of sugar for each retailer. It will save the transportation and handling costs for both distributors and retailers. Also, it will reduce air pollution and GHG emissions.

The company and distributors also collaborate in the flexibility of warehouse usage. The company has set up the maximum time (two weeks) for the sugar to be stored in the company warehouse before being collected by the distributors. However, the company will be flexible if the distributors need to extend the duration to keep the product in company's warehouse for reasonable reasons. There is a mutual understanding between them. The company understands the difficulties of the distributors to find buyers for taking their stock, and they also must follow some procedures to sell the product to other islands, which may take more time. According to the collaboration model; this collaboration focuses on sharing assets (material and infrastructures) and supply chain capabilities (finance, operation and distribution, quality control, and policy and legislation).

Collaboration between Company X and distributors has positive impacts on the sustainability. It gives economic benefits for them such as profitable income, better service level, low operational cost, and high efficiency of the internal process. Moreover, it contributes to reducing air pollution, energy consumption, and GHG emissions by allowing the third party (retailers) to directly collect the product to the company to save the time and money. Also, regarding the social benefits, they support the local businesses by providing fair trade and transparency.

Currently, no collaboration exists between the distributors. They run their businesses individually and treat other companies as the competitor. Also, among distributors and farmers, there is almost no direct contact because the company facilitates all the transaction among them. Individual contact rarely happens, so the distributors

usually do not contribute much to the farmers. Therefore, both types of collaboration are not part of this case study.

Overall, the purpose of collaboration between Company X and farmers is to maintain the loyalty of the farmers and to support sugar production with the high-quality and the maximal quantity of sugarcane. Farmers are willing to collaborate to get the guarantee that Company X will accept their sugarcane and get more benefits compared to other farmers. The company needs distributors to sell the sugar that has been produced to the customers, while distributors need a product to run their trading business and obtain profits. Therefore, symbiosis mutualism exists between distributors and the company. However, compared to collaboration with farmers, collaboration between Company X and the distributor is more about the business than social development.

6. Conclusion

This paper presents a conceptual modeling approach in creating a collaboration system for the sugar supply chains. This proposed model is adapted from an integrated model for the development of stronger communities which has a similar nature and comprehensive elements. The proposed model consists of six elements that are important to build robust collaboration: boundary and context; drivers (value propositions, assets, and supply chain capabilities); stakeholder requirements; system requirements; quality indicators; and common goals. Each element is interconnected and supports the achievement of global competitive advantage.

This study contributes to the theories by developing the integrated collaboration model for sustainable supply chains. It provides a clear understanding of the collaboration concept and its important elements for enhancing sustainability in the chains. The current body of literature lacks of a comprehensive model for agri-food supply chain in general and sugar supply chain in particular - a model with a holistic view of collaboration behavioural factors, sustainability factors, the drivers (roles, assets and capabilities), quality indicators and common goals. This study fills the gap by proposing a comprehensive collaboration model serving as a guideline to propose and analyse the collaboration in sugar supply chains. This model can be applied to identify the strengths and weaknesses of each stakeholder in the collaboration system and to analyse the possible collaboration opportunities to optimise the benefits.

However, this model focuses on primary stakeholders which open opportunities for further research to cover secondary stakeholders. Moreover, although this model focuses on sugar supply chain, it can be extended to other commodities. In addition, this model can be used as the basis for a collaboration quality assessment model. The elements can be considered as measurement variables to

analyze the collaboration quality for each stakeholder, and the result can be used as the beginning of continuous improvement initiatives for sustainable collaboration supply chain.

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References

- [1] Proches, C.N.G. and S. Bodhanya, "Exploring stakeholder interactions through the lens of complexity theory: lessons from the sugar industry", *Quality & Quantity*, Vol. 49, No. 6, pp. 2507-2525, 2014.
- [2] Laham, J., *Supply chain collaboration in the Malaysian pineapple chains*, in *School of Agriculture and Food Sciences*. 2014, The University of Queensland.
- [3] Jraisat, L., M. Gotsi, and M. Bourlakis, "Drivers of information sharing and export performance in the Jordanian agri-food export supply chain: a qualitative study", *International Marketing Review*, Vol. 30, No. 4, pp. 323-356, 2013.
- [4] Wu, I.-L., C.-H. Chuang, and C.-H. Hsu, "Information sharing and collaborative behaviors in enabling supply chain performance: a social exchange perspective", *International Journal of Production Economics*, Vol. 148, pp. 122-132, 2014.
- [5] López-Milán, E. and L.M. Plà-Aragonés, "A decision support system to manage the supply chain of sugar cane", *Annals of Operations Research*, Vol. 219, No. 1, pp. 285-297, 2014.
- [6] Singh, S., K. Gaikwad, and P. Omre, "Spoilage of sugarcane juice a problem in sugarcane industry", *International Journal of Agricultural Engineering*, Vol. 7, No. 1, pp. 259-263, 2014.
- [7] Solomon, S., "Post-harvest deterioration of sugarcane", *Sugar Tech*, Vol. 11, No. 2, pp. 109-123, 2009.
- [8] Swinnen, J.F. and R. Kuijpers, *Value chain innovations for technology transfer in developing and emerging economies: concept, typology and policy implications*, in *LICOS Centre for Institutions and Economic Performance, Discussion Paper*. 2016: Belgium. p. 1-40.
- [9] Gellynck, X. and B. Kühne, "Horizontal and vertical networks for innovation in the traditional food sector", *International Journal on Food System Dynamics*, Vol. 1, No. 2, pp. 123-132, 2010.
- [10] Leat, P. and C. Revoredo-Giha, "Risk and resilience in agri-food supply chains: the case of the ASDA PorkLink supply chain in Scotland", *Supply Chain Management*, Vol. 18, No. 2, pp. 219-31, 2013.
- [11] Weaver, R.D., "Collaborative pull innovation: origins and adoption in the new economy", *Agribusiness*, Vol. 24, No. 3, pp. 388-402, 2008.

- [12] Warsanga, W.B., "Coordination and structure of agri-food value chains: analysis of banana value chain strands in Tanzania", *Journal of Economics and Sustainable Development*, Vol. 5, No. 7, pp. 71-78, 2014.
- [13] Bezuidenhout, C.N., S. Bodhanya, and L. Brenchley, "An analysis of collaboration in a sugarcane production and processing supply chain", *British Food Journal*, Vol. 114, No. 6, pp. 880-895, 2012.
- [14] Bustos, C.A., *Towards sustainable food supply chains. Reducing post-harvest losses in the avocado supply chain through innovative collaboration*, in *Sustainable Business and Innovation*. 2016, University of Utrecht: Netherlands.
- [15] León-Bravo, V., F. Caniato, M. Caridi, and T. Johnsen, "Collaboration for sustainability in the food supply chain: a multi-stage study in Italy", *Sustainability*, Vol. 9, No. 7, pp. 1-21, 2017.
- [16] Zhu, Y., H. Lan, D.A. Ness, K. Xing, K. Schneider, S.-H. Lee, and J. Ge, *Transforming rural communities in China and beyond*, Springer International Publishing, 2015.
- [17] Craig, G., "Community capacity building", *Critical Social Policy*, Vol. 27, No. 3, pp. 335-359, 2007.
- [18] Zhang, Y., *China national human development report 2013—sustainable and liveable cities: toward ecological civilization*, G. Luchsinger, Editor. 2013, Beijing: China Translation and Publishing Corporation.
- [19] Manikas, I., K. Hamann, and A. Sentic, *Quality management schemes and connections to the concept of sustainability in the food chain*, in *Supply Chain Management for Sustainable Food Networks*. p. 233-254. 2016.
- [20] Wu, F., S. Yeniyurt, D. Kim, and S.T. Cavusgil, "The impact of information technology on supply chain capabilities and firm performance: a resource-based view", *Industrial Marketing Management*, Vol. 35, No. 4, pp. 493-504, 2006.
- [21] Wiesner, S., M. Peruzzini, J.B. Hauge, and K.-D. Thoben, *Requirements engineering*, in *Concurrent Engineering in the 21st Century*, Springer. p. 103-132. 2015.
- [22] Lin, Y.-H., H.-P. Cheng, M.-L. Tseng, and J.C.C. Tsai, "Using QFD and ANP to analyze the environmental production requirements in linguistic preferences", *Expert Systems with Applications*, Vol. 37, No. 3, pp. 2186-2196, 2010.
- [23] Lam, J.S.L. and K.-h. Lai, "Developing environmental sustainability by ANP-QFD approach: the case of shipping operations", *Journal of Cleaner Production*, Vol. 105, pp. 275-284, 2015.
- [24] Büyüközkan, G. and G. Çifçi, "An integrated QFD framework with multiple formatted and incomplete preferences: a sustainable supply chain application", *Applied Soft Computing*, Vol. 13, No. 9, pp. 3931-3941, 2013.
- [25] Dewan, M.N.A., M.H. Chowdhury, and M.A. Quaddus, *QFD based modelling for e-business: a sustainable approach using blended value dimensions*, in *The Pacific Asia Conference on Information Systems (PACIS)*. 2012: Vietnam.
- [26] Ayağ, Z., F. Samanlıoğlu, and G. Büyüközkan, "A fuzzy QFD approach to determine supply chain management strategies in the dairy industry", *Journal of Intelligent Manufacturing*, Vol. 24, No. 6, pp. 1111-1122, 2013.
- [27] Sancha, C., C. Gimenez, and V. Sierra, "Achieving a socially responsible supply chain through assessment and collaboration", *Journal of Cleaner Production*, Vol. 112, pp. 1934-1947, 2016.
- [28] Kumar, D. and Z. Rahman, "Buyer supplier relationship and supply chain sustainability: empirical study of Indian automobile industry", *Journal of Cleaner Production*, Vol. 131, pp. 836-848, 2016.
- [29] Tavana, M., M. Yazdani, and D. Di Caprio, "An application of an integrated ANP-QFD framework for sustainable supplier selection", *International Journal of Logistics Research and Applications*, Vol. 20, No. 3, pp. 254-275, 2017.
- [30] Hussain, M., A. Awasthi, and M.K. Tiwari, "Interpretive structural modeling-analytic network process integrated framework for evaluating sustainable supply chain management alternatives", *Applied Mathematical Modelling*, Vol. 40, No. 5-6, pp. 3671-3687, 2016.
- [31] Motevali Haghghi, S., S.A. Torabi, and R. Ghasemi, "An integrated approach for performance evaluation in sustainable supply chain networks (with a case study)", *Journal of Cleaner Production*, Vol. 137, pp. 579-597, 2016.
- [32] Nemarumane, T.M. and C. Mbohwa, *Social impact assessment of sugar production operations in South Africa: a social life cycle assessment perspective*, in *20th CIRP International Conference on Life Cycle Engineering*. 2013, Springer: Singapore. p. 711-716.
- [33] Govindan, K., R. Khodaverdi, and A. Jafarian, "A fuzzy multi criteria approach for measuring sustainability performance of a supplier based on triple bottom line approach", *Journal of Cleaner Production*, Vol. 47, pp. 345-354, 2013.
- [34] Dania, W.A.P., K. Xing, and Y. Amer, *System Requirements for Collaboration in Sustainable Agri-Food Supply Chain*, in *14th ANZAM Operations, Supply Chain and Services Management Symposium*. 2016, Australian and New Zealand Academy of Management: Sydney, Australia.