**A Strategy of Measuring Carbon Footprint in Supply Chain**

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**Abstract:**

1. **Research background and aim**

Climate change is recognised as one of the most severe global challenges. While traditionally supply chains focus on cost, quality and agility to achieve commercial competitive advantage, the requirement for decarbonisation and sustainability become increasingly more important. Carbon footprint is defined as *"a measure of the exclusive total amount of carbon dioxide emissions that is directly and indirectly caused by an activity or is accumulated over the life stages of a product"* (Wiedmann, 2009 p.175).As generally recognised that only the measurable get managed, a standardised method to measure and report the carbon emission profile become a priority (Pandey, Agrawal, and Pandey, 2011; Rebitzer et al., 2004). Nevertheless, the approaches to measuring carbon emission alongside supply chains are still underexplored, despite the basic steps guided by PAS2050 and ISO14067 based on product life cycle (LCA). Knowledge insufficiency and high cost hinder companies to practise carbon footprinting measurement.

From theory perspective, though supply chain level measurement and coordination are highlighted by a few empirical studies (Lee, 2011; Lee and Cheong, 2011; Matos and Hall, 2007; Montoya-Torresa et al., 2015), the exact processes on how to measure carbon footprint from supply chain perspective is not clear (Gaussin et al., 2013). There is lack of holistic framework (Lee, 2011; Gaussin et al., 2013) to address the complex patterns of carbon footprint and its linkage to complex setting in the entire supply chain (Marti et al., 2015).

Thus our research question is “how can carbon emission be efficiently measured in supply chains?”.

1. **Methodology**

To explore the how type of question, we adopt qualitative method with multiple case studies (Eisenhardt, 1989). Data is collected through interviews with operation managers, sustainability specialists, and consultants of 9 case companies across ICT (Information, Communication & Technology), beverage and steel industries, focusing on the organisational structure, management, procedure, and resources of carbon footprinting process. Thematic content analysis (Braun and Clarke, 2006) follows the steps of open coding, generating the initial codes, continuously analysing until theoretical saturation, and finalising of the themes.

1. **Findings and discussion**

The case studies demonstrate three types of measurement:

* Trial-oriented measurement: aiming to make an attempt on carbon footprint measurement. This is a brief examination of the product carbon emission performance, and usually it is the firm’s first attempt to measure the carbon footprint. The main aim for firms is to initially understand the new carbon footprint requirement and prepare itself for a more detailed measurement in the future. External supply chain partners do not provide any data;
* Process-oriented measurement: The company’s intention is to have a clear mapping of its product’s carbon footprint, which will trigger the improvement of the firm’s supply chain carbon emission. To achieve this goal, primary activity data from multi-tiers suppliers, OEMs (for ICT industry), internal production plants, logistics and product design (for user phase and end-of-life phase) should be collected as much as possible.
* Market-oriented measurement: The company aims to achieve carbon footprint labels. In this type, firms should ensure that the data collection and calculation procedures are solid, activity data are of the appropriate quality, the reported footprint claims have reflected what has been undertaken with sufficient document proof, and that they are delivered in the given reporting period. The measurement process should be conducted under a strict mode following standards and to achieves primary activity data as much as possible.

Also, we propose a process-based model, with five stages: 1) preparation, 2) scoping, 3) data collection, 4) footprint calculation, and 5) interpretation and accreditation. Details of activities are identified for each stage, and around each of the three measurement types. This model adds operation-oriented mini-steps into the basic steps of PAS2050, making the guideline more practical.

1. **Conclusions/implications:**

The reconfiguration of supply networks, from the current high-carbon-emission state to a low-carbon-emission one, is a long-term process, starting from the measurement of carbon emission. The process model of measurement we propose can help practitioners to implement carbon footprinting project, generating a primitive ‘work book’ to follow. This paper also furthers the life cycle assessment research to a supply network context, and supply network coordination under external pressures.

**Key words:** *Carbon footprint measurement, Life cycle assessment*

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