International Journal of Physical Distribution & Logistics Management,
Volume 54, Issue 4, May 2024, pp. 355-391
DOI: 10.1108/IJPDLM-06-2023-0222

Who changes what, when & where? Elaborating postponement when integrating hardware and software objects in global supply chains

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Abstract

Purpose – The postponement principle concerns defining *when* and *where* value is added, usually referring to hardware components for physical products. However, in modern supply chains software's importance is increasing, impacting on the timing and location of value-adding operations. Lacking insights of software-driven implications for postponement, we aim at elaborating the postponement principle by contextualizing its evolution when integrating different *objects* (i.e., hardware and software).

Design/methodology/approach – We adopted an abductive approach to elaborate the extant knowledge with original empirical insights. A single-case study, with four subcases, allowed to explore postponement dimensions in the context of a global high-tech enterprise offering products that integrate hardware and software objects. As global supply chains involve multiple jurisdictions with heterogeneous regulations, we also analyzed in-depth the emerging fiscal and legal implications.

Findings – Besides *where* and *when* value is added, the study illustrates that deciding *who* (i.e., what legal entity) is carrying out *what* operation on what kind of *object* is highly important. Moreover, fiscal and legal implications for the various legal entities strongly depend on *what* operations are executed and in which jurisdiction (*where*). The study identifies critical interrelationships among postponement dimensions when integrating hardware and software objects, highlighting the importance of understanding and managing their reciprocity with the emerging fiscal and legal risks.

Originality/value – We elaborate the postponement principle by contextualizing its applications when integrating hardware and software objects in global supply chains which include multiple jurisdictions. By formalizing the impact of the *who* dimension, the study contributes to developing the inter-organizational perspective for postponement. Moreover, it extends the traditional cost perspective for postponement beyond the trade-off between responsiveness and cost-efficiency, suggesting how firms applying global postponement should extend their focus to also examine fiscal and legal risks for all the legal entities involved.

Keywords: postponement, global supply chains, software supply chains, tax implications

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The final published version (version of record) is available online at DOI:10.1108/IJPDLM-06-2023-0222. Please refer to any applicable publisher terms of use.

Introduction

In the ever-evolving landscape of logistics and supply chain management, the principle of postponement has a long history in terms of its practical applications (Alderson, 1950; Bucklin, 1965; Zinn, 2019). Postponement concerns defining *what* manufacturing or logistics operations (such as assembly, packaging, labelling, or finished product distribution) are delayed until more precise market information is available (Boone et al., 2007) or until receiving customers' orders (Zinn and Bowersox, 1988). Firms can decide *when* and *where* value is added (Pagh and Cooper, 1998; Prataviera et al., 2020), delaying changes to either the product's form or the inventory's location to cope with demand uncertainty and improve responsiveness while reducing the total costs related to product customization and the physical movement of goods (Dapiran, 1992; van Hoek, 2001). Although scholars have investigated postponement and its dimensions (*when* and *where* doing *what* operations) for many decades (Prataviera et al., 2020; van Hoek, 2001), they mainly discussed physical high-technology products with a modular structure (e.g., Choi et al., 2012; Lee and Billington, 1994; Pagh and Cooper, 1998). However, academics and practitioners must address novel and multifaceted challenges when products and supply chains (SCs) evolve (Boone et al., 2007; Zinn, 2019). Industries like automotive manufacturing are emblematic of this evolution, where vehicles have evolved into sophisticated computing platforms on wheels (Brown et al., 2000; Jafari et al., 2016). Modern cars are equipped with an array of hardware components, from engines and chassis to sensors and cameras, all intricately linked with advanced software systems for navigation, connectivity, and autonomous driving. A similar transformation can be observed in consumer electronics. Smartphones, once mere communication devices, are now multifunctional hubs seamlessly blending hardware elements with complex software ecosystems (Schulz et al., 2023). Moreover, software enhances customization as applications can be downloaded, installed, and updated on the same hardware device (Autry et al., 2012). As firms enter a more software-related business, the integration of hardware and software components introduces a unique set of challenges and opportunities for supply chain professionals and academics (Norrman and Henkow, 2014) that require to consider a further dimension for postponement: its *object*.

First, software can be downloaded or installed at various temporal and geographical points to unlock or add features to cars or mobile phones (Catalan and Kotzab, 2003; Norrman and Lundberg, 2005), challenging conventional supply chain practices about *when* and *where* adding value to address the complex interplay between physical and digital elements (Norrman and Prataviera, 2023). Moreover, modern SCs are increasingly global and multinational corporations (MNCs) extend their operations across multiple jurisdictions with different fiscal and legal

regulations (Ferdows, 2018; Moradlou *et al.*, 2021). Deciding the location of value-adding operations influences where and how much taxes and duties a company pays (Cohen and Lee, 2020; Prataviera et al., 2022b), but software-related operations introduce further complexity. Some jurisdictions introduced or amended tax laws to address digital services (which can include software licensing and downloads), while differing classifications for hardware and software at customs checkpoints can lead to discrepancies in customs duties and tariffs (Norrman and Henkow, 2014). As different jurisdictions have different regulations, integrating hardware and software introduces significant uncertainty and MNCs need to explicitly analyze fiscal and legal risks when implementing postponement (Norrman and Prataviera, 2023).

In this context, the available academic knowledge offers several studies which however largely ignored software implications for postponement (Norrman and Prataviera, 2023). Also, they mainly adopted a cost perspective, neglecting risks connected to postponement implementation (e.g., Choi et al., 2012; Pagh and Cooper, 1998; Yang and Burns, 2003). This paper seeks to shed light on the implications and intricacies of postponement when integrating hardware and software objects, going beyond a pure cost perspective to also examine the related critical fiscal and legal risks. We propose the following research question (RQ):

How does postponement evolve when integrating hardware and software objects in global supply chains?

We leveraged abductive reasoning (Ketokivi and Choi, 2014; Kovacs and Spens, 2005) with the ambition to gain critical insights about the phenomenon (i.e., the evolution of global postponement when different objects are considered) and elaborate the extant knowledge by combining it with rich empirical data (Dubois and Gibbert, 2010). We developed a single embedded case study (Yin, 2014) analyzing a high-tech MNC implementing global postponement to offer products which integrate hardware and software objects. As subcases, we considered four of its global supply hubs (GSHs) as they represent distribution centers in different jurisdictions where postponed value-adding operations can take place according to different regulations. Conducting single-case research allowed us to analyze the company's context and real-life challenges for deeper understanding (Flyvbjerg, 2006; Stake, 2008), focusing on the fiscal and legal challenges related to postponement implementation. Moreover, examining the four subcases allowed to improve findings' generalizability against the natural limitations of a single case (Yin, 2014).

The study contributes to knowledge by elaborating the postponement principle in the wake of the increasing importance of the considered *object*, i.e., reflecting the critical impact of the integration of hardware and software components to deliver customers' value. By contextualizing this phenomenon in global supply chains and thereby considering explicitly country specifics among multiple jurisdictions, we also detail the related fiscal/legal implications. We highlight how different legal entities are involved in various jurisdictions and emphasize the importance of a further dimension for global postponement, i.e., *who* is accountable for postponement execution. This contributes to developing the inter-organizational perspective for postponement. Moreover, in global scenarios managing fiscal and legal risks for all the legal entities involved has become as important as cost minimization and responsiveness. The study thus extends the traditional view for postponement and brings it forward in the software-based business of the 21st century, discussing how managers must go beyond the trade-off between responsiveness and cost-effectiveness to consider also the risks related to postponement implementation.

The remainder of the paper is organized as follows. In the next section, we summarize the related academic literature, followed by a discussion of our methodological approach. We then describe the study's findings before discussing their implications and summarize the contribution to knowledge and managerial practice in the concluding remarks.

Related literature

The principle of postponement and its traditional dimensions: what, when, where

The principle of postponement was first proposed 70 years ago to increase firms' responsiveness to customer demands while containing supply chain costs (Alderson, 1950; Boone et al., 2007; Zinn, 2019). Over the decades, scholars proposed several frameworks (e.g., Cooper, 1993; Pagh and Cooper, 1998; Yang et al., 2004) to study and classify postponement strategies according to *what* operations are delayed. Among the others, Pagh and Cooper's (1998) formalized manufacturing and logistics postponement. Manufacturing postponement refers to delaying final manufacturing operations, while logistics postponement refers to the place where the inventory is held and consists of deferring in time any change to the inventory location occurring downstream in the supply chain (for instance, stock centralization in a single warehouse). Postponement strategies can thus be defined according to *what* operations (manufacturing, assembly, packaging, labeling) could be postponed, and to the delayed movement of inventories along supply chains (Zinn and Bowersox, 1988). Most of the existing literature examined postponement through a cost minimization lens (Pagh and Cooper, 1998; Yang and Burns, 2003), trading-off transportation and inventory carrying

costs with manufacturing costs and investments (Cooper, 1993; Lee and Billington, 1994; Twede et al., 2000). Scholars also widely debated the drivers influencing postponement decisions, linking cost factors to product (e.g., customization degree, value density, obsolescence rate), market (e.g., demand volume and uncertainty, delivery lead-time requirements), and process characteristics (e.g., distribution lead times; scale economies, required knowledge and/or capabilities) (Battezzati and Magnani, 2000; Brun and Zorzini, 2009; Pagh and Cooper, 1998). For example, production at central factories increases scale economies and makes quality control easier (van Hoek, 1998; Yang and Burns, 2003), especially when specific knowledge and capabilities are required (Jafari et al., 2022).

In its essence, postponement determines the place and time utility of goods or services by deciding *when* value is added (van Hoek, 2001; Yang et al., 2004). By delaying products' final configuration or movement downstream, firms delay their commitment to specific customers or markets until real information about the markets is available (Bucklin, 1965; Pagh and Cooper, 1998). By implementing postponement, firms can be responsive and cost-efficient while coping with demand uncertainty (van Hoek, 1998; Yang and Burns, 2003). Zinn and Bowersox (1988) further introduced the concept of delaying the final form/configuration of a product or its delivery until receiving the customers' orders, rather than generically delaying to the latest possible point in time. Postponement thus constitutes the decision taken by a company to delay the manufacturing of a specific product until the customers' orders are received, or until demand is certain or can be pinpointed more accurately (Bowersox and Closs, 1996; van Hoek, 2001). However, this clear link to the temporal dimension (*when*) also encompasses that different operations could happen at various SC tiers (Chiou et al., 2002; Yang et al., 2004). SC tiers include entities as factories, distribution centers, and other logistics facilities where operations can be postponed (according to more precise forecast or to customers' orders) (Autry et al., 2013; Ernst and Kamrad, 2000). Because of the various SC tiers involved, some scholars suggested the adoption of an inter-organizational perspective for postponement to analyze when value should be added to minimize costs across all the considered SC tiers (Garcìa-Dastugue and Lambert, 2007). Postponement might reduce inventories at factories (Waller et al., 2000), yet inventory costs are likely to increase at other SC tiers (Garcìa-Dastugue and Lambert, 2007).

Therefore, although postponement is usually related to *when* value is added (van Hoek, 2001), another important dimension concerns defining *where* operations take place (Autry et al., 2013; Bowersox and Closs, 1996). This is particularly relevant when examining global supply chains (Cohen and Lee, 2020; van Hoek, 1996). MNCs need to be globally efficient and locally responsive simultaneously, which requires trading off scale economies (through the centralization of

operations) (Abukhader and Johnson, 2007; Yang and Burns, 2003) with local responsiveness through decentralized operations (Cooper, 1993). MNCs operating in multiple international markets can customize and localize products closer to distribution markets, according to customer demand and local market circumstances (Chiou et al., 2002). Due to long international transportation times, geographically postponing value-adding activities closer to the final markets could reduce the lead time to customers (van Hoek, 1996; Yang et al., 2004). However, other studies claim that additional factors and costs should be considered (Cohen and Lee, 2020). Different countries and jurisdictions mean that global SCs must also consider duties, taxes, and other country-specific elements (Prataviera et al., 2020), which can become additional drivers and inhibitors of postponement practices (Lee, 2010; van Hoek, 2001). Increasing protectionism and cross-border trade complexity can also motivate companies' decision of undertaking some operations downstream in distribution facilities (Prataviera et al., 2022a). To formalize this discussion, Lee (2010) coined the term *postponement boundary problem* to define what portion of a product is assembled in the factory and what in global distribution, thus focusing on *what* operations occur in different jurisdictions (*where*). Table I summarizes how the extant literature examined and reviewed the aforementioned postponement dimensions.

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Integrating hardware and software objects

Traditionally, postponement implementation concerned physical goods and most of the previous academic studies focused on high technology physical products with a modular structure (Lee and Billington, 1994; Choi et al., 2012). When focusing on the hardware components of physical products, ranging from high-technology computers and printers (Lee and Billington, 1994; Pagh and Cooper, 1998) to canned tomatoes (Zinn and Bowersox, 1988) and textiles (Yang and Burns, 2003), firms can postpone manufacturing (e.g., assembly, packaging, or labelling) and logistics operations (Pagh and Cooper, 1998; Prataviera *et al*., 2020). However, the boundary between goods and services has progressively been blurring, with customers often acquiring a "product pack" of integrated goods and services (Catalan and Kotzab, 2003; Lightfoot *et al*., 2013). In many industries, the hardware part of customer value is increasingly accompanied if not replaced by software, which determines much of the differentiation, customization, and upgrade capacities (Autry et al., 2012; Favoretto *et al*., 2022; Kreye, 2022). Therefore, transitioning from a hardware-focused SC to one where software is also important can create new challenges (Brown et al., 2000). For postponement, this suggests that a new dimension should be considered along with the more

traditional ones (i.e., *when* and *where* doing *what* operations): the type of *object* which is involved with postponement implementation.

When hardware and software are integrated, two operations become crucial: *bundling*, that is, combining and preconfiguring the integrated software and hardware, and *testing*, which might occur before bundling and at a central location or somewhere in the global network (Norrman and Lundberg, 2005). The higher the share of software code being modified to meet unique customer needs, the higher the complexity (Norrman and Lundberg, 2003). For highly complex systems, a firm could use the distribution network to handle code adaptation for different countries and customers' requirements and distribute software to the actual user locations (Brown et al., 2000; Norrman and Lundberg, 2005). For products with lower complexity—due to lower customization needs—the hardware and software are usually integrated at a central plant, which is typically a controlled environment and thus facilitates quality and efficiency (Norrman and Lundberg, 2003).

Therefore, combining hardware, embedded software, and other product-specific knowledge or upgrades can further develop the postponement principle (Brown et al., 2000; Jafari *et al*., 2016). Firms may postpone value-adding operations downstream to multiple global distribution points, instead of integrating products in factories (Lee, 2010). For high-technology products, this would prevent long lead times which might imply high inventory capital immobilization, low responsiveness to customers, and rising product obsolescence risks (Cohen and Lee, 2020). Moreover, when limiting postponement analysis to hardware objects, operations typically have a logical sequence as packaging follows assembly, and finished product distribution requires proper labeling (Cooper, 1993; Pagh and Cooper, 1998). However, software is an intangible object which can be downloaded or installed at various temporal and geographical points (Brown et al., 2000; Norrman and Lundberg, 2003). Companies can develop innovative postponement strategies for products that integrate hardware and software objects, deciding when and where operations like bundling or testing take place but independently from the traditional postponement sequence of operations (Norrman and Prataviera, 2023). Although this complex interplay between physical and digital elements (i.e., hardware and software objects) significantly challenges postponement as we know it, deepening software implications for postponement strategies is a largely unexplored topic in the current academic conversations (Norrman and Prataviera, 2023).

Fiscal and legal implications for global postponement

When designing global postponement strategies, MNCs decide *what* value-adding operations it performs, *when*, and *where* (Norrman and Henkow, 2014). From a total cost perspective, this also

determines the direct and indirect taxes to be paid (Lee, 2010; Yang et al., 2004). However, when integrating hardware and software MNCs need to carefully examine implications for various jurisdictions related to customs duties (Henkow and Norrman, 2011; Norrman and Prataviera et al., 2023) and corporate income taxes (Norrman and Henkow, 2014; Shunko et al., 2017).

First, national agencies often divide hardware and software into different customs classes and tax codes. The duty rate for a product can change depending on whether the product refers to hardware alone or to integrated hardware and software (Lee, 2010). Furthermore, various countries define software differently, making it essential to know *where* (point of origin) value is added (Norrman and Henkow, 2014). Given the blurring hardware–software boundary, postponing operations such as bundling or testing might determine different product combinations, thus influencing how products are classified for tax codes and customs duties (Henkow and Norrman, 2011). The jurisdiction in which those operations are performed is increasingly important because it can determine the goods' origin, which in turn determines import duties (Adams, 2008). Moreover, trading blocs' preferential trade agreements may entail lower customs duties or special treatment for some products and trading partners upon meeting specific requirements (Dong and Kouvelis, 2020).

Second, MNCs could decide to locate the operations for hardware and software integration in different jurisdictions to take advantage of heterogeneous tax rates and maximize after-tax profits (Norrman and Prataviera, 2023). However, friction may arise because the SC and fiscal domains are based on different principles (Norrman and Henkow, 2014). To achieve fiscal benefits while maintaining compliant SC structures, SC managers must increase their understanding of fiscal and legal elements (Norrman and Prataviera, 2023). A first key element is *permanent establishment* (PE) (Petriccione *et al*., 2007), which is the creation of a fixed place of business that typically gives rise to tax liability in a particular jurisdiction (Norrman and Henkow, 2014). PE is a cornerstone of international taxation aimed at reducing uncertainty for taxpayers with cross-border operations and guaranteeing a fair sharing of taxing rights among jurisdictions (Petriccione *et al*., 2007). A subsidiary company, that is an independent legal entity for taxation purposes, does not necessarily constitute a PE of the parent company. However, subsidiaries can trigger a PE through conducting different kind of activities in a fixed place of business, which include integrating hardware and software. This relates to another critical element which is *economic (or tax) substance,* which helps determine the actual operations (*what*) taking place in a given jurisdiction and avoid that operations are established only for fiscal reasons (Prataviera *et al*., 2022b). Nevertheless, further fiscal and legal risks could emerge related to the potential lack of compliance with existing regulations across various jurisdictions. For example, conducting operations in a free trade zone (FTZ) could

encompass cost savings but also lead to unexpected tax liabilities, as FTZs often have specific (but ambiguous) regulations (Henkow and Norrman, 2011). When goods exit FTZs, their customs values might not change even if value-adding operations are performed; different software versions might not matter to customs authorities. Determining the proper tax code is also subjective, as it depends on the FTZs' specific regulations which rely on national authorities.

Table II offers an overview of the previous academic studies contributing to postponement dimensions, also highlighting the lack of research around the *object* of postponement and the resulting fiscal and legal implications in global contexts.

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Methods

To explore the evolution of global postponement when considering different *objects*, we adopted a case study approach to extend the existing knowledge and elaborate the postponement principle when integrating hardware and software (Fisher and Aguinis, 2017). Developing a case study allowed us to advance knowledge and cope with contemporary practices and challenges (Corley and Gioia, 2011; Ketokivi and Choi, 2014), including fiscal and legal implications emerging from applying postponement in global settings. We collected and analyzed rich empirical examples to combine them with the extant literature in an abductive approach (Dubois and Gadde, 2014; Kovacs and Spens, 2005) (Figure 1). This approach was appropriate to compare the existing knowledge about postponement with the novel elements within a context where hardware and software integration is increasingly important. Abduction facilitated the transition between data collection, analysis, and previous knowledge (Fisher and Aguinis, 2017; Ketokivi and Choi, 2014; Russo et al., 2023). We investigated and explained postponement contextualization for hardware and software integration, contributing to knowledge development by illuminating the relationship between empirical data and the literature (e.g., concerning inter-organizational postponement) (Kovacs and Spens, 2005; Dubois and Gibbert, 2010).

-Insert_Figure_1-

Research design

We designed a single embedded case and examined postponement across four global SC nodes (the four subcases). A single-case study research design was adopted because it was suitable to support

exploratory research focused on identifying and describing key concepts and their relationships (Voss et al., 2002). It allowed to focus attention on a specific setting where such concepts could emerge clearly, gathering rich and detailed data to generate deep insights into the investigated phenomenon (Dyer and Wilkins, 1991). The single case study offered rich insights into real-life challenges (Flyvbjerg, 2006), allowing us to explore unique elements for postponement related not only to hardware and software integration but also to comparing their fiscal and legal implications in different jurisdictions. Although a single-case approach can reduce transferability, it is appropriate for practically investigating unexplored phenomena (Stake, 2008). Moreover, using four subcases helped enhance transferability and generalizability (Lincoln and Guba, 1985). To improve rigor, we subjected the data to intensive questioning and multiple testing rounds; this was compatible with abductive reasoning, which typically includes interpreting or recontextualizing individual phenomena to develop understanding (Dubois and Gadde, 2014; Kovacs and Spens, 2005). We followed general guidelines proposed by Yin (2014) (see Figure 2), Gioia *et al*. (2013), and Voss *et al*. (2002). We developed a research protocol to guide data collection and analysis and support knowledge elaboration through research findings. The research protocol included a semi-structured interview guide (available in Appendix A) which started with broad, open-ended questions to enhance conversation and then continued to more specific questions to explore specific issues emerged during the interview (Yin, 2014). To help respondents prepare (Voss *et al*., 2002), we sent the questions before any interview and continuously updated them.

-Insert_Figure_2-

Case selection and context

Our units of analysis were "global postponement dimensions and related fiscal and legal implications concerning the integration of hardware and software objects." To maximize conceptual insights and information richness (Flyvbjerg, 2006), we sampled purposefully and information-oriented rather than looking for generalization properties (Patton, 1990). We thus searched for cases:

1. applying postponement in their global operations.
2. with experience of integrating hardware and software objects and operations.
3. with a structured approach to fiscal/legal issues (e.g., harmonizing their global SCs from a fiscal/legal perspective).
4. providing access to rich information (Flyvbjerg, 2006; Gammelgaard, 2017).

Our case –HighCorp– is a European high-tech company serving different geographical markets through its global SC. The selection of HighCorp is motivated as it can be a rare and extreme case (Flyvbjerg, 2006) due to its long experience (30+ years) about postponement implementation and the integration of hardware and software objects in global settings. As selection strategies are not mutually exclusive (Flyvbjerg, 2006), HighCorp could also be considered as a critical case because the vast experience HighCorp accumulated about the phenomenon, which could be beneficial for other companies experiencing issues related to the global integration of hardware and software. Lastly, case selection was motivated by the accessibility to the company and by the acquisition of rich information, as the authors had access to extensive documentation and key decision-makers in the logistics and legal/fiscal interface.

We studied four of HighCorp's GSHs (Table III) as subcases to explore and contextualize tax implications related to postponement dimensions for different global postponement strategies. GSH were chosen from the regions Latin America, Central Europe, the Middle East, and the Asia-Pacific (APAC). To keep confidentiality, we label each GSH by region instead of the specific country of location, although the specific country matters.

-Insert_Table_III-

We purposefully selected the subcases to adhere to the boundaries of our research purpose (Miles and Huberman, 1994) while also representing diverse types (Voss *et al*., 2002). The GSHs are similar as they belong to the same organization (HighCorp) and can perform similar operations. However, they serve different markets/jurisdictions across the world with different laws and requirements. This allows to examine and compare fiscal and legal implications related to hardware and software integration across heterogeneous regulatory frameworks. For example, the same value-adding operation could be allowed or not in a GSH depending on the country's fiscal/legal rules. These similarities and differences support the exploratory nature of this study (Fisher and Aguinis, 2017), mitigating possible problems with our single case selection.

Data collection

We involved multiple respondents from distinct functions to increase confirmability (corresponding to internal validity; Yin, 2014) and to maximize conceptual insights and understanding. The respondents were selected based on their potential to provide details about the investigated unit of analysis, and we used few respondents to collect rich descriptions (Gioia *et al*., 2013). The principal

respondent and main point of contact with HighCorp (Voss *et al*., 2002) was a senior SC architecture manager with extensive experience working with the legal interface. To increase the study's credibility and dependability, we also involved the head of the legal department and a senior global trade compliance manager. We interviewed (using the English language) all the respondents several times, and all contributed equally. The legal department head had extensive experience managing global operations. Having supervised legal details and procedures for all four subcases, he provided vital information about subcases' regulatory framework. The senior global trade compliance manager had worked in software development and delivery in several countries worldwide, being highly familiar with the implications of merging hardware/software objects and the evolution of such operations over time.

Two investigators made joint group interviews to increase the team's creative potential and converge observations to improve confidence in the findings (Eisenhardt, 1989; Voss *et al*., 2002). Between October 2018 and February 2019, we made five interview rounds, including two in-person, in-depth group interviews (3 hours each) at MNC's headquarters and three Skype meetings (average of 1.5 hours each). While the interviews followed a semi-structured approach, conversational questions were posed when needed to reduce potential biases in responses (Yin, 2014). All meetings and interviews were recorded and transcribed. To improve credibility, additional telephone interviews were held and documents exchanged to clarify issues when necessary (e.g., to understand legal constraints to specific operations in different jurisdiction).

A case study database was developed to strengthen a formal chain of evidence (Voss *et al*., 2002). It included additional notes taken outside the interview guide, external data sources (e.g., industry reports and other public documents) and internal materials like company presentations (Yin, 2014). We then summarized and returned all collected data to respondents for fact checking and accuracy verification (Gioia *et al*., 2013). All respondents were available to answer questions or provide any context needed for the analysis. Two additional senior managers, one at the corporate level of supply strategy management and another being the head of contract accounting and governance, thoroughly reviewed (and confirmed) the collected data used in the manuscript. Finally, the study's findings and implications, and a late version of the manuscript were presented and discussed at a workshop held at HighCorp in January 2022, including the previously involved respondents plus eight other senior representatives from different functions. Informants' details are summarized in Appendix B.

Data analysis

We abductively examined the academic understanding of postponement dimensions and the original empirical data to elaborate extant knowledge against real-worlds insights (Ketokivi and Choi, 2014). Our data analysis followed well-known qualitative research procedures (e.g., Gioia *et al*., 2013) to enhance rigor and ensure transparency, systematically combining empirical evidence with previous knowledge (Dubois and Gadde, 2014; Kovacs and Spens, 2005). Data were analyzed and coded in several iterations, including concurrent data reduction, display, and interpretation (Miles and Huberman, 1994). This helped explore how and why differences existed between subcases and later reconcile findings within the broader perspective of the overall case study (Voss *et al*., 2002).

The first interview gave a *preliminary understanding* as we captured respondents' perceptions of the considered phenomenon. We first coded the collected data for within-subcase analyses, and by examining the empirics we strengthened existing constructs and developed new categories and first-order codes (Gioia *et al*., 2013; Miles and Huberman, 1994). By analyzing the increasing software contents and the related operations in contexts (i.e., jurisdictions) characterized by different regulations, we could start identifying implications for business as either opportunities or challenges related to the fiscal/legal regulations in different jurisdictions. We then iteratively compared the results of within-subcase analyses against available secondary sources (e.g., public reports about tax planning and SC design developed by consultancy companies) and against the academic literature (e.g., Norrman and Henkow, 2014; Cohen and Lee, 2020). The preliminary patterns, findings, and reflections surfaced many contextual factors related to hardware and software integration and its fiscal and legal challenges in global settings (e.g., the importance of legal compliance for global postponement and how significant legal risks can emerge). HighCorp respondents also shared internal documents providing important details of HighCorp's specific rules and their application for different GSHs. Previously formalized operations (including software-related ones) were ordered in a temporal sequence to identify potential interdependencies and relate them to each subcase. We then refined the initial codes (e.g., postponement dimensions) according to the themes that emerged from the data and grouped the codes into higher-level categories (Appendix C). These categories encompassed second-order themes (Gioia *et al*., 2013) and moved data to a more theoretical and abstract level of interpretation. In addition to *when* and *where*, *what* was important given the different operations that might take place (e.g., bundling or testing) on different *objects*. Thus, we expanded the range of operations related to postponement (Pagh and Cooper, 1998; Zinn and Bowersox, 1988). We then elaborated on the various legal entities involved to identify the *who* as another key second-order theme. We then compared the findings from individual subcases in a

cross-subcase analysis to match patterns and describe global postponement for the different subcases (Eisenhardt, 1989; Yin, 2014). First, we developed tables and diagrams to summarize subcases' critical information about postponement and the related dimensions (Appendix D). These tables and diagrams were instrumental in organizing and displaying data (Miles and Huberman, 1994), supporting pattern matching and leading to cross-subcase tables and diagrams (cf. Table IV).

Issues identified through coding were examined in an iterative process, systematically comparing the emerging patterns and results from the analysis with the research framework and the information our respondents provided (Gioia *et al*., 2013). We shared our findings with different respondents to reduce misunderstandings and better interpret the field data (Voss *et al.*, 2002). Whenever discrepancies emerged concerning data interpretation, we carefully noted them. Then, we shared those discrepancies with our informants (both via email and via telephone) to reconcile differences and sharpen our reasoning. This process supported the generation of our findings by comparing evidence from alternative applications of global postponement, improving the understanding of the interrelations between the postponement dimensions and paving the way for third-order coding of implications. To elaborate knowledge, we compared our findings through iterative contextualization within the research framework to sharpen the data significance and identify undisclosed patterns (Dubois and Gadde, 2014; Kovacs and Spens, 2005) and develop propositions.

Research trustworthiness

To increase research rigor and trustworthiness (credibility, dependability, transferability, and confirmability (Lincoln and Guba, 1985), we applied different actions in different research phases (see Figure 2). Despite all measures to increase transferability, generalizability limitations naturally exist, and we elaborated on them when discussing further research avenues.

Findings

Here, we first describe traditional postponement dimensions (*what, when, where*) for the HighCorp case. We contextualize them within the increasing importance of the integration of hardware and software, later elaborating on how the *object* of postponement is also a critical dimension. We illustrate how heterogeneous regulations influence *what* operations are allowed and *when* and *where* value is added on the different *objects*, emphasizing the related fiscal and legal implications. Moreover, our findings highlight the importance of a further critical dimension for postponement, concerning *who* (i.e., what legal entity) conducts operations and adds value in global supply chains.

Table IV summarizes for each sub-case *what* operations are to be considered, at which functional SC tiers (*when*) and in which region (*where*) they could take place, also detailing the considered *objects* and the legal entities involved (*who*).

-Insert_Table_IV-

"What"

HighCorp is a leading provider of networking infrastructure globally, with a market share of about 40%. It offers "integrated products" from bundling different entities: hardware, software, services, civil works, and other locally supplied commodities. Figure 3 summarizes *what* operations characterize HighCorp's SC, detailing which ones concern hardware only, software only, or involve their combination. Raw materials are first processed (operation 0) into components (such as chips and memories) for hardware. These are then assembled (1) into parts, modules, and sub-products (such as antennas or cabinets). "Pick-and-pack"—placing sub-products or parts into small boxes and combining them into pallets for specific customers—can occur at different logistics facilities before integrating products (2). For software, three additional operations are included: software development (3), software sourcing (i.e., where software parts are stored or where they "live" either physically or digitally before they are delivered to customers) (4), and software testing (5). Then, software must be installed on the hardware (either modules or sub-products) (6). Once installed, the software license is activated (7). Finally, software is not only integrated with hardware parts but also civil works and other local supplies into products (8). Then, the complete product must be tested (9), and any additional software updates/upgrades are delivered to customers (10).

-Insert_Figure_3-

"When"

HighCorp serve different markets through several GSHs, aiming to delay operations to the latest possible moment. Goods in GSHs are assigned only regionally (or to a specific trading bloc). Then, they replenish two types of local logistics facilities: SC warehouses and fulfillment assignment stock (FAS) warehouses, both of which hold goods assigned to a specific country—and, in the FAS case, also to a specific customer site. Occasionally, products are completed and customized to meet customer requirements at SC/FAS warehouses or on the customer site. However, HighCorp

generally postpones labeling until products are sent to a GSH or a local warehouse, while products' final assembly increasingly occurs at the customer site. Because a mix of hardware and software needs to be sourced, produced, and distributed, they can be integrated at different geographical points. While software integration with hardware can occur at various nodes, software license activation typically happens at the customer site. However, the logical sequence of software-related operations is less straightforward than hardware-related ones. Pick-and-pack operations can occur both before and after software installation and might occur in FTZs (at the MS or GSH) or later at the customer site. This also applies to software activation, and many more alternatives exist for testing and updating/upgrading. Moreover, differences exist between new or already running products. For new products, the software is typically integrated with the hardware at a central location (usually a factory) before shipment to the site. For installed systems already running or for updates, the software is typically delivered to the customer's site and integrated with the hardware already in use.

"Where"

HighCorp assigns countries to different GSHs mainly due to geographical proximity to reduce delivery lead times. For example, HighCorp chose to locate a GSH in a Latin American FTZ to supply three markets: the US, Canada, and Latin America. HighCorp decided on the exact location and jurisdiction after considering geographical proximity to the US market, which is a crucial priority for HighCorp. A logistics facility in Latin America helps consolidate shipments to the three target markets from any global location. The chosen jurisdiction offers lower labor costs than the US or Canada, and its authorities allow many value-adding operations (which encompass tax code changes) in their FTZs. However, tax authorities in different countries have different views on what operations could be allowed or not, making the choice of GSH location extremely critical. Moreover, FTZs' regulations can further differ from standard regulatory frameworks, opening to new challenges and opportunities. Some FTZs allow companies to add value (i.e., change their goods' tax code) by shipping components from factories, assembling the goods in the FTZ (i.e., completing the hardware sub-product), and integrating them with software later. If value-adding is not allowed, the factories must send the completed hardware sub-products to the GSH, where only pick-and-pack operations are permitted.

Our subcases show how hardware-related assembly operations can occur at manufacturing sites (MSs) in Latin America and the Middle East GSHs, but not in the APAC GSH. Pick-and-pack operations can occur at the GSHs in Latin America and Central Europe but not in the Middle East

or APAC. All subcases allow pick-and-pack operations and software license activation at national SC or FAS warehouses. Hardware sub-products can be bundled with software into products at plants or GSHs in all four locations, but all software-related operations are more restricted. Software installation can occur only at an MS in Latin America and only at the GSH in Central Europe. Furthermore, only the Latin America FTZ allows software testing; software license activation can occur at all GSHs except the APAC.

As reflected in Latin America, the Middle East, and APAC, positioning GSHs in FTZs help streamline flow management and offer legal advantages when different regions and trade agreements are involved. In contrast, while the Central Europe GSH was previously located within an FTZ, HighCorp later moved it outside the FTZ, as products from a European Union (EU) country can be shipped duty free to anywhere in the EU. As with all GSHs, deciding *where* to add value is influenced by tax implications and the related risks, which are affected by the origin of supply flows. By supplying materials from another EU jurisdiction, HighCorp's imports are duty free. Conversely, the few components supplied by Chinese factories are subject to import duties. However, staying outside the FTZ releases HighCorp from specific regulations about what is allowed or not. Today, any operation (manufacturing, assembly, or pick-and-pack) can take place in the GSH without issues relating to tax code changes.

"Object"

HighCorp's broad portfolio of high-volume and site/consumer-specific products are characterized by different lifecycles. To reduce scope, we focused on one integrated product type being typical for HighCorp and essential to its future business. This product type includes various hardware parts with differentiated designs to provide specific functionalities for a given market or customer-required capabilities. While the same hardware can be delivered to different customers, software increasingly handles most of the products' differentiation, customization, and upgrade capacity. As the HighCorp senior SC architecture manager noted, "Hardware is now becoming very generic, and the value is added on the software local adaptation." Software typically includes license, product keys, and software adaptation code, and software customization is typically achieved using a new software code or right-to-use license. Customization can thus refer to hardware, software, or their combination, but the increased software focus has transformed HighCorp's traditional SC into one better reflecting software aspects. Software is often categorized as an intangible, non-storable product. Therefore, its delivery represents the process of getting the pre-configured software into the hardware or providing customers licenses, executable codes, and other vital documents.

However, as our analysis shows, several fiscal and legal considerations can arise for global postponement of hardware and software. Fiscal/legal regulations have recently increased their importance until becoming the "key force behind global distribution", according to the head of the legal department. Customs regulations might make it preferable to upgrade software in GSHs, in local warehouses, or both (creating resource duplication). Software-based operations can take place in different jurisdictions, but also in different SC tiers. Various tax authorities and customs consider software releases differently, and MNCs must make complex tax-related decisions about the SC tier where operations should be performed. The different views of tax authorities on various *objects* must be understood, because (depending on the jurisdiction) the SC tier in which software operations occur may or may not encompass the creation of a PE or duty liabilities. The company's senior SC architecture manager noted that "unwise decisions affecting cross-border flows might lead to unnecessary tax consequences" and "risk from a taxation perspective is different from risk from a business perspective." Moreover, tax regulations differ enormously between countries and vary over time. For example, customs duties may apply to hardware, but not software, unless the software has been installed on the hardware before crossing national borders. Therefore, as reported by HighCorp's head of the legal department, "it is vital for HighCorp that all flows—i.e., hardware, and software deliveries, services, invoicing, and payment—are made with due consideration to their fiscal consequences."

"Who"

Beyond the importance of the *object* in focus for postponement, the HighCorp case emphasizes that multiple legal entities are involved in global postponement strategies. This is instrumental to introduce and formalize a new critical dimension for postponement, i.e., *who* is conducting the various operations.

In more detail, HighCorp chose to locate a GSH in a Latin American FTZ and established a manufacturing site (MS) in the same FTZ and Latin American country as its GSH. The MS is operated by a third-party provider (3PP) contract manufacturer. HighCorp created the MS because of the legal constraints and tax liabilities related to *where* operations occur and *who* is legally accountable for them. While pick-and-pack operations are allowed at both the MS and GSH, assembly is permitted only at the MS. Moreover, HighCorp legally owns the inventories in the FTZ (which entails significant obsolescence risk), but its operations are managed and executed by the 3PP. This feature allows HighCorp to comply with local requirements and avoid the need to have a license to conduct business in the FTZ. This arrangement also allows the hardware components

supplied by European factories to be assembled at the MS. After pick-and-pack, finished sub-products are often fully configured and shipped to local warehouses or directly to customers. Because it has a contract manufacturer and GSH within an FTZ, HighCorp pays duties at the border when importing and avoids any payment in advance, which is another benefit of establishing within an FTZ.

The analysis of the other subcases illustrates different implications related to *who* conducts operations. The GSHs in the Middle East and APAC regions have total cost advantages like those for the Latin America GSH in terms of trapped duties avoidance. Still, while the Middle East and APAC GSHs are both located in FTZs and flanked by MSs, each has its own peculiarities. In the Middle East, where hardware components are mainly supplied from Europe, HighCorp benefits from a somewhat open regulatory environment. Although stricter than in Latin America, local regulations allow for some value-adding operations (including assembly and pick-and-pack) although both must occur exclusively at the MS. Some operations are allowed at the GSH, including software license activation and testing. Conversely, the APAC GSH, which uses goods supplied from China, has stricter rules. HighCorp established this GSH to improve logistics flows to serve the APAC region (excluding China, which is served by local factories and distribution centers) and optimize freight costs by improving shipment utilization rates. It also reduces inventory costs by supporting inventory pooling between different APAC countries. However, value-adding operations are not allowed in the FTZ nor in the MS. Consequently, hardware assembly is performed after customs clearance in local warehouses or on the site where the integrated product is bundled. We provide visual summaries of the explored subcases and the corresponding postponement dimensions – including the *who* one - in the diagrams presented in Appendix D.

Discussion

Our analysis proceeded through different levels from raw data to 1st order concepts, 2nd order themes, and aggregate dimensions (as illustrated in the coding tree provided in Appendix C). The conceptual framework offered in Figure 4 summarizes how integrating hardware and software objects develops postponement and its dimensions but also creates new challenges, where fiscal/legal risks emerge as crucial elements for inter-organizational global postponement.

-Insert_Figure_4-

Integrating different objects creates new opportunities for postponement

Extant postponement literature (e.g., Pagh and Cooper, 1998; Prataviera et al., 2020, van Hoek, 2001) suggests that companies must decide on *what* operations should be performed, and *when* and *where* value is added. Recent contributions (e.g., Cohen and Lee, 2020; Norrman and Prataviera, 2023) emphasize that companies should also carefully examine what type of *object* they are considering. In this context, the HighCorp case highlights that integrating hardware and software objects extends the scope of traditional postponement dimensions as new operations must take place and could be postponed, creating new opportunities for MNCs to enhance customization offerings. For purely physical goods that consider hardware object only, operations to be postponed usually include assembly, packaging, labeling, and distributing the finished product (Pagh and Cooper, 1998; Prataviera *et al*., 2020; Zinn and Bowersox, 1988). These operations typically take place in a predefined sequence as packaging and labelling follows assembly, then distributing the finished products to customers (Cooper, 1993; Pagh and Cooper, 1998). As described in the HighCorp case, embedding software components involves several new operations, including software development, sourcing/storing, installation, activation, testing, and updating/upgrading. These operations can happen at various SC tiers, and companies can develop new and different postponement strategies for products that integrate both hardware and software components. They might delay testing or license activation, and sometimes provide and install software updates and upgrades even after concluding the sale. Table V illustrates the evolution from a hardware-based context to one where software is also important, summarizing the impact of the integration of different *objects* on the other postponement dimensions.

-Insert_Table_V-

However, our findings also highlight that considering both hardware and software objects complicates postponement reasoning as its different dimensions are characterized by increasing reciprocity and can influence each other.

Increasing reciprocity among postponement dimensions and with fiscal/legal implications

In global settings, the increasing reciprocity among postponement dimensions is deeply linked to the fiscal and legal implications due to the regulatory frameworks in place in the involved jurisdictions (Figure 5).

-Insert_Figure_5-

The HighCorp case illustrates that impacts due to fiscal/legal compliance can be so significant to overshadow customers' requirements in terms of responsiveness and delivery lead times. If the *object* dimension determines *what* operations are to be performed, the HighCorp case further displays that the *what* dimension influences *when* operations might occur (including the SC tier). Due to economies of scale and specialization, operations cannot occur invariantly in any SC tier as specific infrastructure/resources might not be available. The *when* dimension also significantly impacts the *where* dimension because the jurisdiction where operations occur can change to satisfy stricter delivery lead times from customers. However, our findings also show that the *where* dimension might reciprocally affect the *when* dimension. Having a facility in a certain jurisdiction (e.g., that of the end customers) may allow MNCs to change the time/SC tier *when* operations occur. The *where* dimension (jurisdiction), in turn, determines significant fiscal legal implications which however could influence back location decisions, displaying reciprocal interrelations. A first proposition is thus developed:

P1: When integrating hardware and software objects, the additional operations to be performed (what) influence the time point of value-adding (when) and the related location (where), creating reciprocal fiscal and legal implications based on their combination.

Furthermore, different jurisdictions can classify hardware, software, or the result of their integration differently. This is important because the *object* in focus determines the tax code, driving substantial fiscal/legal implications. For example, depending on the jurisdiction and if the software is loaded into hardware before crossing customs borders, duties may change. Therefore, decision-makers can move operations across SC tiers to take advantage of how individual jurisdiction assess duties for different objects but also define economic substance and PE creation. A second proposition is developed:

P2: When integrating hardware and software objects, tax code definition (object) driven by the location of value-adding operations (where) not only affects the value-adding operations (what) to be performed but can also motivate moving those operations across SC tiers (when).

As previously highlighted, the *object* dimension determines *what* operations are to be performed. In the HighCorp case, this is also critical to decide *who* is adding value. Although the *object*

dimension does not directly affect the legal entity (*who*) in charge of various operations, operations on different objects (hardware, software, or products integrating hardware and software) could have serious fiscal and legal implications related to *who* is accountable for them. The HighCorp case shows that MNCs must carefully review their operations in jurisdictions where they lack a PE and how local authorities define the concepts of economic substance. For example, HighCorp outsourced several operations to 3PP contract manufacturers. However, this requires careful understanding and management of *who* the legal entity is that owns the goods and is responsible for handling or performing different operations, as described for the Latin American GSH. Software downloading into hardware could create a PE in a country, while a fundamental operation, such as product testing, might not (as the tax code, *object*, might not change). Outsourcing (change of *who*) can sometimes lead to PE avoidance. At other times, an MNC might retain ownership of goods but outsource operations to 3PPs, which might create a PE in some jurisdictions.

Because of these fiscal and legal implications, deciding *who* does, can, or should conduct different operations becomes highly critical. This is dependent on the specific jurisdictions involved (*where*), yet the HighCorp case also shows the significant impact of trade agreements and transit through FTZs. Our sub-cases displayed several differences among what was allowed in the different GSHs, and companies like HighCorp must design their postponement strategies to comply with various customs authorities. This is complicated because, as HighCorp's head of the legal department said, "A huge gray zone exists, related to the way rules enforced by individual jurisdictions (and their FTZs) can be interpreted and then applied." To acknowledge the critical importance of the *who* dimension, we developed a third proposition:

P3: When integrating hardware and software objects, fiscal/legal implications driven by what operations are performed in different jurisdictions (where) are critical to decide who is adding value in global postponement.

By formalizing and discussing the who dimension, this study contributes to developing the inter-organizational perspective for postponement (Garcìa-Dastugue and Lambert, 2007). Despite the numerous studies discussing postponement in supply chains, previous scholars mainly focused on its implementation within individual organizations or considered the supply chain as a whole–bundled–entity (Zinn, 2019). In this perspective, single firms typically select the most suitable postponement strategy based on product, market, and process characteristics (Brun and Zorzini, 2009; Pagh and Cooper, 1998). Postponement might reduce inventories for manufacturers as little

or no finished goods could be replaced by undifferentiated materials and parts at a lower cost (Waller et al., 2000) yet impact should be extended to all the members of the supply chain (Garcìa-Dastugue and Lambert, 2007). As postponed activities do not happen within the boundaries of a single organization or within unified ownership (Yang et al., 2007), the lack of an inter-organizational perspective can worsen the overall supply chain performance (Garcìa-Dastugue and Lambert, 2007). They analyzed when and where value should be added to maximize the performance of the entire supply chain to minimize costs for all the organizations involved. However, the HighCorp case illustrates that the scope of inter-organizational postponement extends beyond cost minimization. If postponement may be key to global efficiency and local responsiveness (van Hoek, 1998), it also involves multiple legal entities distributed across multiple jurisdictions. This creates new fiscal and legal risks that must be adequately understood and managed.

Fiscal/legal risks and compliance emerge as crucial elements for global postponement

As software's importance increases, the contextualization of the postponement principle must be advanced to examine not only costs, but also the increasing risks related to legal compliance. Tax regulations differ among jurisdictions and evolve over time, and the resulting uncertainty introduces new challenges.

First, postponing software-related operations can be critical depending on how customs authorities view cross-border flows. Tax codes usually determine whether a product is hardware, software, or a service. However, a product might be integrated to such an extent that it is difficult to classify it as hardware or software. While the EU has a relatively homogeneous approach to such matters, outside the EU the procedures and principles for product tax classification can differ dramatically from country to country (as exemplified by the GSHs in the other three sub-cases). Different operations can also be subject to heterogeneous tax liabilities by various authorities worldwide. According to HighCorp's senior global trade compliance manager, "tax code is important especially when products are sold across borders or when the legislation demands that sale of goods (i.e., hardware) and services (i.e., software) should be reported separately." Even the traditional concept of assembly (Zinn and Bowersox, 1988) can acquire a different—and sometimes ambiguous—meaning: Is it referring to hardware, software, or its integrated combination?

Moreover, hardware and software flows must comply with all customs authorities involved, as there could be restrictions on where products can be delivered based on the origin of supplies. The country of origin is a function of how individual jurisdictions classify the specific *object* (Cohen and Lee, 2020) but other critical tax implications can emerge according to the countries and

jurisdictions in which products are distributed. The HighCorp case emphasizes that examining multiple jurisdictions (including from where goods are sourced and to where goods are distributed) is required to make postponement decisions aligned and compliant with various regulatory frameworks. In a figurative sense, our case recommends focusing on a "geographical foot trail" rather than on a more static "geographical footprint" which can be quite common across MNCs. However, tax codes, customs duties, and corporate income tax rates are not static. They are subject to political changes (and the related instability) which not only affect individual jurisdictions but also cross borders and influence trade agreements. The US-China trade conflict started in 2018 well exemplifies the dynamicity and the unpredictability of fiscal and legal items, as well as the significant impact they can have on supply chains (Rogers et al., 2024). Compliance with all the various legal frameworks, encompassing tax laws, customs regulations, data privacy rules, and more, is paramount. Non-compliance can lead to penalties, litigation, and operational disruptions that dwarf initial cost considerations. Thus, it is essential to understand that risks associated with a lack of compliance with extant regulations can be as important as traditional costs linked to postponement practice, as emphasized in the fourth proposition:

P4: When integrating hardware and software objects, opportunities for total cost-oriented tax optimization must be traded-off with the risks related to legal compliance for all the legal entities involved in each jurisdiction.

Such challenges urge MNCs to include fiscal/legal risks and legal compliance as crucial elements for global postponement, in addition to the more conventional cost minimization perspective (Pagh and Cooper, 1998; Yang and Burns, 2003). As the fiscal environment is increasingly governed by a mosaic of legal frameworks, the integration of hardware and software components across diverse jurisdictions necessitates thus a comprehensive approach for postponement that extends beyond cost considerations to also embed risk considerations. Such an approach would be consistent with a Total Cost of Ownership (TCO) perspective (Gaudenzi et al., 2021). TCO examines costs and risks associated with the acquisition, use, and maintenance of goods and services across the entire supply chain (Dupont et al., 2018; Ellram and Siferd, 1993). While a TCO perspective is overlooked within postponement research, it is well known in the sourcing literature to acknowledge that organizations should look beyond the purchasing price to include many other purchase-related costs and risks (Ellram, 1995). It has become increasingly popular in the last decades as organizations have been experiencing incremental sourcing risks, especially in global supply chains (Pellegrino et al., 2023). Similarly, the HighCorp case shows that managing fiscal and legal risks is equally integral to

successful global postponement as cost minimization. In an interconnected world, where software and hardware converge seamlessly, failure to address these risks can result in financial liabilities, legal disputes, and damage to reputation, often surpassing the immediate cost concerns. We argue that an approach to postponement akin to a TCO perspective is nowadays imperative for organizations to better understand and adequately manage their costs and risks. As MNCs that integrate hardware and software components must grasp deeply international tax and legal intricacies to properly adhere to evolving regulations, we formulated a last proposition:

P5: When integrating hardware and software objects, global postponement implementation urges MNC to develop comprehensive fiscal and legal risk assessments, leading to rigorous compliance with diverse legal frameworks.

Conclusions and research implications

Contributions to the extant literature

Postponement typically focuses on deciding *when* and *where* to add value (Yang et al., 2004; van Hoek, 2001; Zinn, 2019), aiming to minimize supply chain costs while increasing responsiveness to customers (van Hoek, 1998; Yang and Burns, 2003). This research extends the traditional view of postponement by exploring its evolution for products that integrate hardware and software objects, in the context of global SCs where fiscal and legal implications are also highly important (Lee, 2010; Prataviera et al., 2020). By conducting a single embedded case study characterized by an abductive approach, we elaborated the extant literature (e.g., Pagh and Cooper, 1998; Zinn and Bowersox, 1988) through the contextualization of relevant postponement dimensions. First, the study emphasizes that the *object* of postponement (i.e., hardware, software, or their integration) is highly important, as fiscal and legal implications depend on how different authorities define the *object* of the operations in focus. Moreover, it shows that in a MNC operations might be internally managed by different legal entities or outsourced to 3PPs, and the organizational and legal entity accountable for such operations (*who*) is critical (Henkow and Norrman, 2011). Fiscal and legal implications for various legal entities strongly depend on the considered jurisdiction (*where*) and *what* operations are executed. The study illustrates how different postponement dimensions are interrelated when integrating hardware and software objects, formalizing three propositions (P1, P2, P3) which describe their reciprocity. However, reciprocity also exists between postponement dimensions and fiscal and legal implications. The study discusses how these implications are often the outcome of MNCs' decisions but they also reciprocally influence *what* operations might be

allowed in different jurisdictions (*where*), if such operations determine tax code changes on various *objects*, and if they create tax liabilities for different legal entities (*who*).

Moreover, the study contributes to developing the inter-organizational perspective for postponement, which is largely underexplored in the academic literature (Garcìa-Dastugue and Lambert, 2007; Zinn, 2019). Significant fiscal and legal implications can arise related to the countries and jurisdictions where different legal entities implement postponement. The study thus highlights that modern approaches to postponement require to broaden its typical cost perspective and examine fiscal and legal risks for the all the legal entities involved. We suggest a more comprehensive approach to postponement that extends beyond responsiveness and cost-effectiveness, proactively analyzing the potential risk situations related to make postponement decisions and explicitly linking postponement research to the extant literature about TCO. Based on our research, we offer two propositions (P4, P5) that contextualize postponement challenges in the realm of the increasing importance of the software–hardware relationship for delivering value to global customers, arguing that such comprehensive approach is required for MNCs to conduct global postponement managing both costs and risks.

Managerial implications: Guiding decision-makers to navigate global postponement

Our study illustrates to SC managers how they could widen their approach towards postponement by offering insights into the interactions between SC and fiscal/legal systems. Both SC managers and tax lawyers can make decisions influencing global postponement, but they consider different principles. SC managers are rarely educated in law or tax issues, while lawyers are rarely educated in SC (Norrman and Henkow, 2014). These misaligned perspectives create problems in many areas and contribute to strengthening silo mentality (Henkow and Norrman, 2011). Differing classifications for hardware and software at customs checkpoints can lead to discrepancies in customs duties and tariffs. Also, determining the correct tax treatment for software-related operations can be complex and varies significantly between countries. Therefore, clear understanding and proper classification of products based on their physical and digital components (i.e., hardware and software objects) are essential to navigate these fiscal and legal challenges. Nowadays, MNCs should acknowledge that managing fiscal and legal risks is equally integral to successful global postponement rather than a sole focus on cost minimization. Compliance with these tax regulations is essential to avoid legal disputes and penalties, as different jurisdictions can hold different views about the legal entity (*who*) accountable for each operation, and thus the tax liabilities that might emerge. If MNCs want to avoid unexpected tax implications related to

postponement, both SC and tax people must be involved to jointly decide from where various types of products are sourced, where value is added, which legal entity is adding value, and where the products are distributed. SC managers should also increase their knowledge about key fiscal elements related to value-adding operations such as *economic substance* and *PE*, and how different jurisdictions understand them differently.

However, today's turbulent times highlight that these elements are dynamic and can rapidly evolve. Fiscal and legal issues driven by policy changes are increasingly relevant in software-driven business environments, as exemplified by the US-China trade conflict. Determining the "point of origin" for software objects in an era of rising protectionism can create significant risks, as companies might be forced to host and maintain databases in each jurisdiction and ensure that no data is transferred globally across a common enterprise-wide network. Although it may not directly impact the flows of goods across jurisdictions, it might be a hindrance to MNCs operating in multiple markets and reinforce the competitive advantage of locally based companies.

Research limitations and future research recommendations

It is essential to recognize that the reliance on a single case study design inherently presents limitations that must be properly acknowledged. First, case studies do not offer the statistical generalizability achievable through large-scale quantitative research and should not be seen as representative (Yin, 2014). Moreover, the selection of a single case study approach, while conducive to in-depth analysis, may restrict the applicability of the study's findings to a wider population of logistics and supply chain contexts. However, our embedded single-case study with four subcases allowed us to explore geographical and temporal elements and created opportunities for knowledge elaboration, following consolidated approaches suggesting that case findings are best used in connection with theoretical discussions (Yin, 2014). As the scope of our findings may not capture the full spectrum of variability in logistics and supply chain management practices, future work could investigate other contexts (e.g., other countries and industries) to leverage abductive reasoning (Kovacs and Spens, 2005) and further extend elaboration and transferability (Lincoln and Guba, 1985) of our framework and propositions. Moreover, this study points towards several future research avenues related to the investigated phenomenon, driven by the emerging interrelationships among postponement dimensions and concerning the limitations of our research.

First, our findings indicate a significant reciprocity between *when* and *where* operations can occur. Moving operations across jurisdictions can allow firms to delay their commitment to specific customers or even change the SC tier where operations take place. However, fiscal and legal

implications must be carefully examined as cost drivers but also risk elements could change significantly. This is also deeply intertwined with the legal entities involved (*who*), due to the impacts linked to PE creation or the economic substance connected to logistics operations. Promising research avenues might concern the exploration of the interrelationships identified in this study, e.g. by developing scales to measure the reciprocity among postponement dimensions which could be included in survey studies involving a wider audience of companies and managers.

Moreover, the increasing integration of hardware and software objects calls for further SC research aimed at investigating if other well-known SC principles, strategies, and models are evolving and need to be refined (and how) to adequately incorporate the different *objects* included in product flows and analyze the legal entities accountable for such flows. Global supply chains are inherently complex (Franke et al., 2024), but this study illustrates how fiscal and legal challenges can move software issues to the forefront for many products. In this context, scholars could explore the evolution of contemporary supply chains concerning their breadth (i.e., their geographical dispersion) and strength (i.e., the tight coupling and interdependence among supply chain members), also examining the complexity driven by postponement dimensions such as *who*, *what* and *where* (jurisdiction). Future studies could take a snapshot of the existing scenarios but also go beyond the analysis of static elements to encompass their dynamic changes over time. The role of hardware and software in the upcoming years deserves further scrutiny, as the field is rapidly evolving and emerging technologies like AI (Richey et al., 2023), chatbots (Durach and Gutierrez, 2024) or quantum computing (Núñez-Merino et al., 2024) could lead to supply chain re-configuration because of the critical implications associated to software development and intellectual data property.

Further, our planet's future and its global environmental crisis are top priorities among academics, professionals, and policymakers. It is thus important to investigate postponement strategies' impact on environmental sustainability, which previous literature generally overlooked. Delaying customization and differentiation can affect global shipping volumes and related greenhouse gas emissions through reducing inventory levels and mitigating demand uncertainty (Varsei et al., 2017). Transportation has clearer implications for hardware objects, while software is unexplored. The triple-bottom-line influence of software-based postponed customization of standard modules could complement (or outweigh) other solutions' operational or fiscal performance, and this could raise relevant implications for SC design that deserve to be further explored.

Lastly, the organizational and legal status of the different subjects involved (e.g., companies with their local subsidiaries, but also suppliers and customers) is crucial for postponement decisions.

Inter-organizational postponement is an underexamined research problem, and postponement implications for multiple SC members need to be further explored. Inventories could increase for some firms while improving the cost performance for the entire SC, but other critical issues would concern the concept of economic substance or the creation of PE. Examining *who* is accountable for various operations in postponement strategies is a fundamental research problem for the SCs of the upcoming future, and we humbly hope to pave the way for impactful research in this domain.

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Postponement dimensions	Dimensions' details	Main references
What	manufacturing: assembly, packaging, labelling, finished product distribution	Zinn and Bowersox (1988); Cooper (1993); Lee and Billington (1994); Bowersox and Closs (1996); van Hoek (1997); Pagh and Cooper (1998); van Hoek (1998); Battezzati and Magnani (2000); Ernst and Kamrad (2000); Twede et al. (2000); van Hoek (2001); Skipworth and Harrison (2004); Boone et al. (2007); Brun and Zorzini (2009); Guericke et al. (2012)
	logistics: inventory positioning	Bowersox and Closs (1996); van Hoek (1997); van Hoek (1998); Battezzati and Magnani (2000); van Hoek (2001); Yang and Burns (2003); Wong et al. (2009); Choi et al. (2012)
When	after receiving customers' orders	Zinn and Bowersox (1988); Bowersox and Closs (1996); van Hoek (1997); Pagh and Cooper (1998); van Hoek (1998); van Hoek (2001); Boone et al. (2007); Brun and Zorzini (2009); Wong et al. (2009); Guericke et al. (2012)
	as late as possible	Alderson (1950); Bucklin (1965); Boone et al. (2007); Garcıa-Dastugue and Lambert (2007); Choi et al. (2012)
	in which SC tier	Battezzati and Magnani (2000); Ernst and Kamrad (2000); Chiou et al. (2002); Yang et al. (2004); Garcìa-Dastugue and Lambert (2007); Yeung et al. (2007)
Where	closer to customers to increase responsiveness and local adaptation	Lee et al. (1993); van Hoek (1996); Twede et al. (2000); Chiou et al. (2002); Yang and Burns (2003); Abukhader and Johnson (2007); Boone et al. (2007); Guericke et al. (2019); Jafari et al. (2022)
	coping with fiscal implications (tax, duties, regulations) related to global postponement	Lee and Billington (1994); Lee (2010); Henkow and Norrman (2011); Choi et al. (2012); Norrman and Henkow (2014); Prataviera et al. (2020); Prataviera et al. (2022a); Norrman and Prataviera (2023)

Table I. Traditional postponement dimensions as discussed in the extant literature.

Contribution	What	When	Where	Object (*integrating hardware and software*)	Fiscal/legal implications for global postponement	Products considered
Zinn and Bowersox (1988)	x	x				canned tomatoes, laundry detergent, hairdryers, soft drinks, electronic components
Cooper (1993)	x	x	x			lift trucks, toothpaste, cigarettes, television receivers, computers, printers
Lee et al. (1993)	x	x	x			high-technology products (printers)
Lee and Billington (1994)	x	x	x		x	high-technology products
Bowersox and Closs (1996)	x	x	x			high-technology products
van Hoek (1996)	x	x	x			high-technology products (computers)
van Hoek (1997)	x	x	x			food products
Pagh and Cooper (1998)	x	x				high-technology products
van Hoek (1998)	x	x	x			automotive supply, electronics, food products, clothes
Battezzati and Magnani (2000)	x	x				FMCG goods
Brown et al. (2000)	x	x		x		high-technology products (printers)
Twede et al. (2000)	x	x	x			high-technology products
Waller et al. (2000)	x	x	x			high-technology products
van Hoek (2001)	x	x	x			high technology products, food, cars
Chiou et al. (2002)	x	x				high-technology products (PCs)
Norrman and Lundberg (2003)	x	x	x	x		mobile phones, radios
Yang and Burns (2003)	x	x				high technology products, textile
Yang et al. (2004)	x	x	x		x	high-technology products
Norrman and Lundberg (2005)	x	x	x	x		high-technology products (mobile phones, radios)
Abukhader and Jonson (2007)	x	x				food products
Boone et al. (2007)	x	x	x			apparel products, consumer electronics, washing machines
Garcìa-Dastugue and Lambert (2007)	x	x	x			high technology products, textile

(Continues…)

Contribution	What	When	Where	Object (*integrating hardware and software*)	Fiscal/legal challenges for global postponement	Products considered
Yang et al. (2007)	x	x	x			apparel products, consumer electronics
Yeung et al. (2007)	x	x				high-technology products (ATMs, MP3s), apparel goods
Brun and Zorzini (2009)	x	x				food and beverage, wood and furniture, chemical, consumer electronics, textiles, and apparel
Lee (2010)	x	x	x		x	high-technology products (PC, printers), cars, apparel products
Henkow and Norrman (2011)	x	x	x	x	x	high-technology products
Choi et al. (2012)	x	x	x		x	high-technology products
Guericke et al. (2012)	x	x	x		x	high-technology products
Norrman and Henkow (2014)	x	x	x	x	x	high-technology products
Jafari et al. (2016)	x	x	x	x		high-technology products, food products
Fan et al. (2017)	x	x	x			high-technology products
Varsei et al. (2017)	x	x	x			food and beverage (wine)
Weskamp et al. (2019)	x	x	x			high-technology products
Zinn (2019)	x	x	x			high technology products (computers, printers), food products (coffee), cars
Cohen and Lee (2020)	x	x	x	x	x	high-technology products (printers, workstations), cars, apparel products
Prataviera et al. (2020)	x	x	x		x	printers, trucks, laptops, cars, food products (wine, dairy, orange juice), consumer electronics,
Jafari et al. (2022)	x	x	x			retail products
Prataviera et al. (2022a)	x	x	x		x	food products (olive oil)
Prataviera et al. (2023)	x	x	x	x	x	high-technology products (radios)

Table II. Summary of previous postponement studies and their contribution to traditional postponement dimensions, with further focus on the *object* dimension and the fiscal and legal challenges for global postponement.

CASE CHARACTERISTICS	**HighCorp**			
Type of product	Communications infrastructure (hardware, software, and services)			
SUBCASE CHARACTERISTICS	**HighCorp Global Supply Hubs (located in a specific country in each region)**			
Region	Latin America	Central Europe (in EU country)	Middle East	APAC
Origin of hardware parts	EU	EU, China	EU, China	China
Destination countries/regions served	US, Canada, Central and South America	EU and part of EMEA	Middle East Part of Africa and Saudi Arabia	APAC (except China)
GSH in an FTZ?	Yes	No (but previously yes)	Yes	Yes
Value-adding operations allowed?	Yes	Yes	Yes	No
The hardware-related operations allowed	Manufacturing, assembly, pick and pack	Any kind of operation	Assembly, pick and pack	None

Table III. Overview of case and subcases

Operation / SC node (What & Object / When & Who)	Plant				MS within FTZ				GSH				Warehouses (SC/FAS)				Customer Site			
	Latin America	Central Europe	Middle East	APAC	Latin America	Central Europe	Middle East	APAC	Latin America	Central Europe	Middle East	APAC	Latin America	Central Europe	Middle East	APAC	Latin America	Central Europe	Middle East	APAC
0 (HW) – raw materials → components	Y	Y	Y	Y	Y	N.A	Y													
1 (HW) – components → sub-products	Y	Y	Y	Y	Y	N.A	Y													
2 (HW) – «pick and pack»	Y	Y	Y	Y	Y	N.A	Y		Y	Y			Y	Y	Y	Y				
3 (SW) – software development	Y	Y	Y	Y		N.A														
4 (SW) – software sourcing	Y	Y	Y	Y		N.A														
5 (SW) – software test	Y	Y	Y	Y	Y	N.A														
6 (HW+SW) – software installation	Y	Y	Y	Y	Y	N.A				Y							Y	Y	Y	Y
7 (HW+SW) – software license activation	Y	Y	Y	Y	N.A.	N.A			Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y
8 (HW+SW) – sub-products → solution	Y	Y	Y	Y		N.A			Y	Y	Y	Y								
9 (HW+SW) – solution test	Y	Y	Y	Y		N.A			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
10 (HW+SW) – software update	Y	Y	Y	Y		N.A			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Table IV. Subcases summary: *what* operations (on different *objects*) could take place at which functional SC tier (*when*) and for which legal entity (*who*), in which jurisdiction (*where*) (*N.A. = Not Applicable*)

Postponement dimension	Object (hardware)	Object (combined hardware and software)
What (value-adding operations)	Assembly, packaging, labelling, finished product distribution	Bundling hardware and software parts, and software development, sourcing/storing, installation, activation, testing, updating and upgrading
When (time, SC tiers)	Delaying products' final configuration (assembly or packaging) or movement downstream in a predefined sequence	Software is an intangible object which can be downloaded or installed at various time points across various SC tiers, without a predefined sequence
Where (countries, jurisdictions)	Location of customization operations for physical products	Software is an intangible object which can be downloaded or installed at various locations across multiple jurisdictions
Who (legal entities)	-	Combining hardware and software urges to carefully examine costs and risks for all the legal entities involved. Different objects can influence the assessment of economic substance (what) and thus PE, varying across jurisdictions (where).

Table V. Impact of the considered *object* on the other postponement dimensions

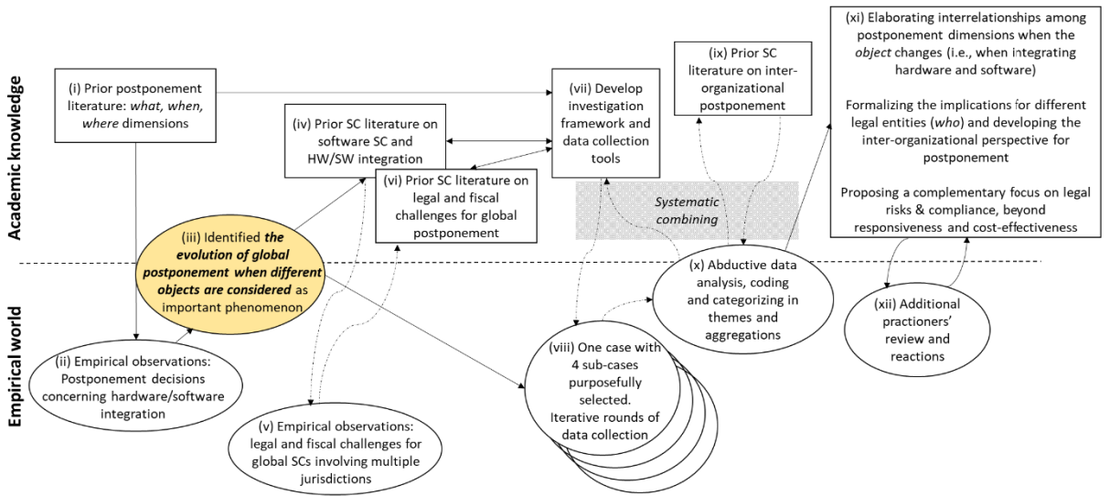
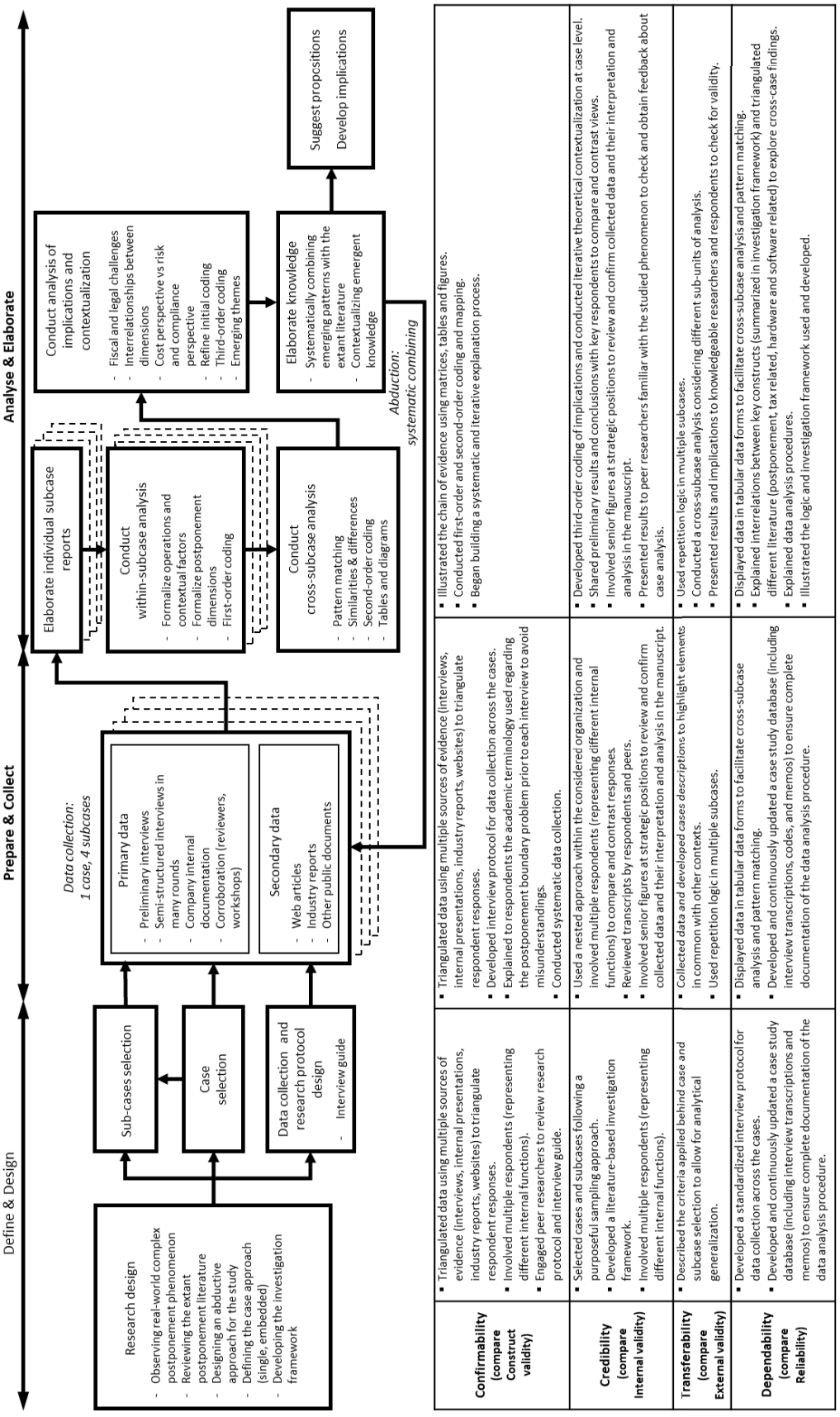


Figure 1. Abductive approach



Confirmability (compare Construct validity)	▪ Triangulated data using multiple sources of evidence (interviews, internal presentations, industry reports, websites) to triangulate respondent responses. ▪ Developed interview protocol for data collection across the cases. ▪ Explained to respondents the academic terminology used regarding the postponement boundary problem prior to each interview to avoid misunderstandings. ▪ Conducted systematic data collection.	▪ Illustrated the chain of evidence using matrices, tables and figures. ▪ Conducted first-order and second-order coding and mapping. ▪ Began building a systematic and iterative explanation process.
Credibility (compare Internal validity)	▪ Used a nested approach within the considered organization and involved multiple respondents (representing different internal functions) to compare and contrast responses. ▪ Reviewed transcripts by respondents and peers. ▪ Involved senior figures at strategic positions to review and confirm collected data and their interpretation and analysis in the manuscript.	▪ Developed third-order coding of implications and conducted iterative theoretical contextualization at case level. ▪ Shared preliminary results and conclusions with key respondents to compare and contrast views. ▪ Involved senior figures at strategic positions to review and confirm collected data and their interpretation and analysis in the manuscript. ▪ Presented results to peer researchers familiar with the studied phenomenon to check and obtain feedback about case analysis.
Transferability (compare External validity)	▪ *Collected data and developed cases descriptions* to highlight elements in common with other contexts. ▪ Used repetition logic in multiple subcases.	▪ Used repetition logic in multiple subcases. ▪ Conducted a cross-subcase analysis considering different sub-units of analysis. ▪ Presented results and implications to knowledgeable researchers and respondents to check for validity.
Dependability (compare Reliability)	▪ Displayed data in tabular data forms to facilitate cross-subcase analysis and pattern matching. ▪ Developed and continuously updated a case study database (including interview transcriptions, codes, and memos) to ensure complete documentation of the data analysis procedure.	▪ Displayed data in tabular data forms to facilitate cross-subcase analysis and pattern matching. ▪ Explained interrelations between key constructs (summarized in investigation framework) and triangulated different literature (postponement, tax related, hardware and software related) to explore cross-case findings. ▪ Explained data analysis procedures. ▪ Illustrated the logic and investigation framework used and developed.

Figure 2. Research methodology overview (*including actions taken to improve research rigor and trustworthiness*)

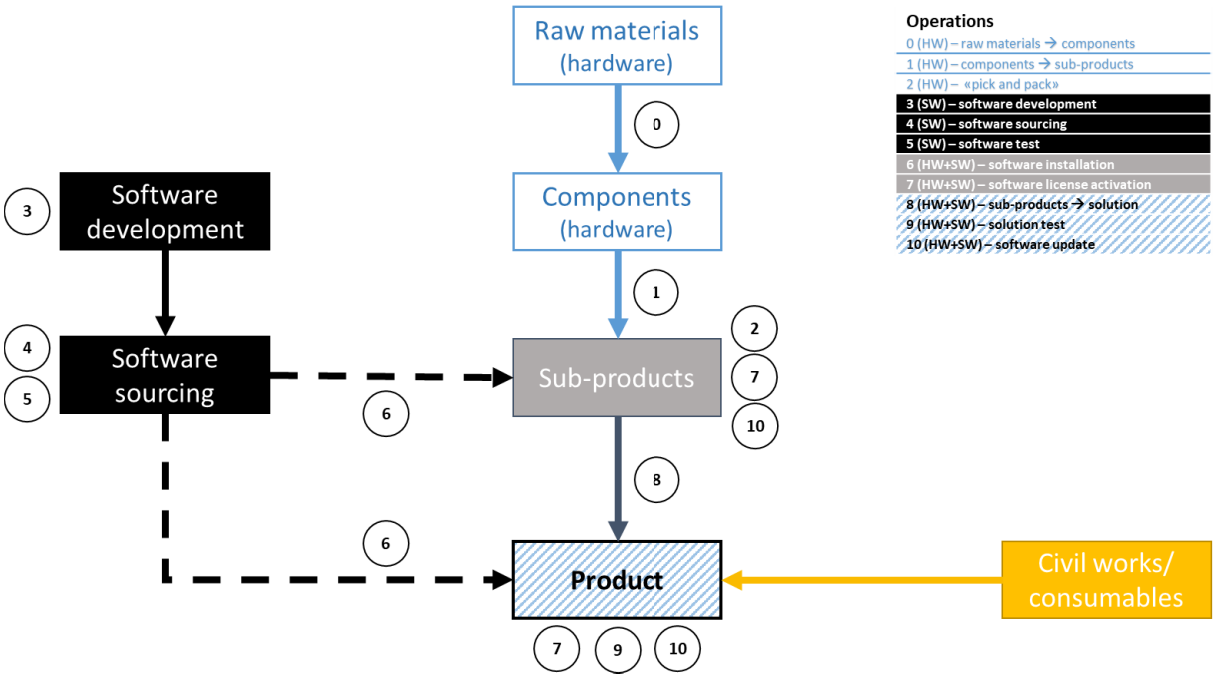


Figure 3 – *What* operations for HighCorp's global postponement

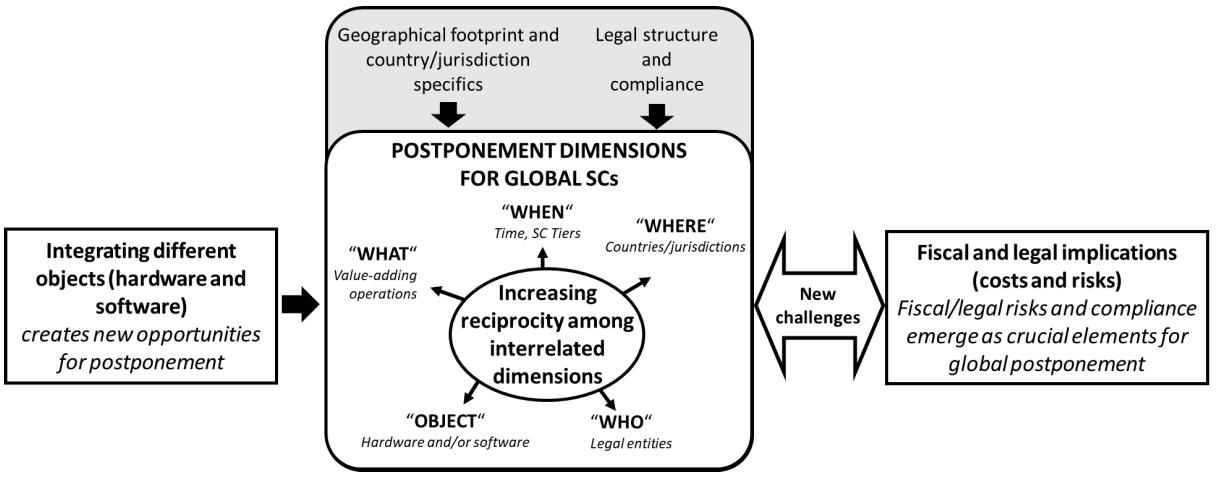


Figure 4. Evolution of the postponement principle when integrating hardware and software objects in global supply chains.

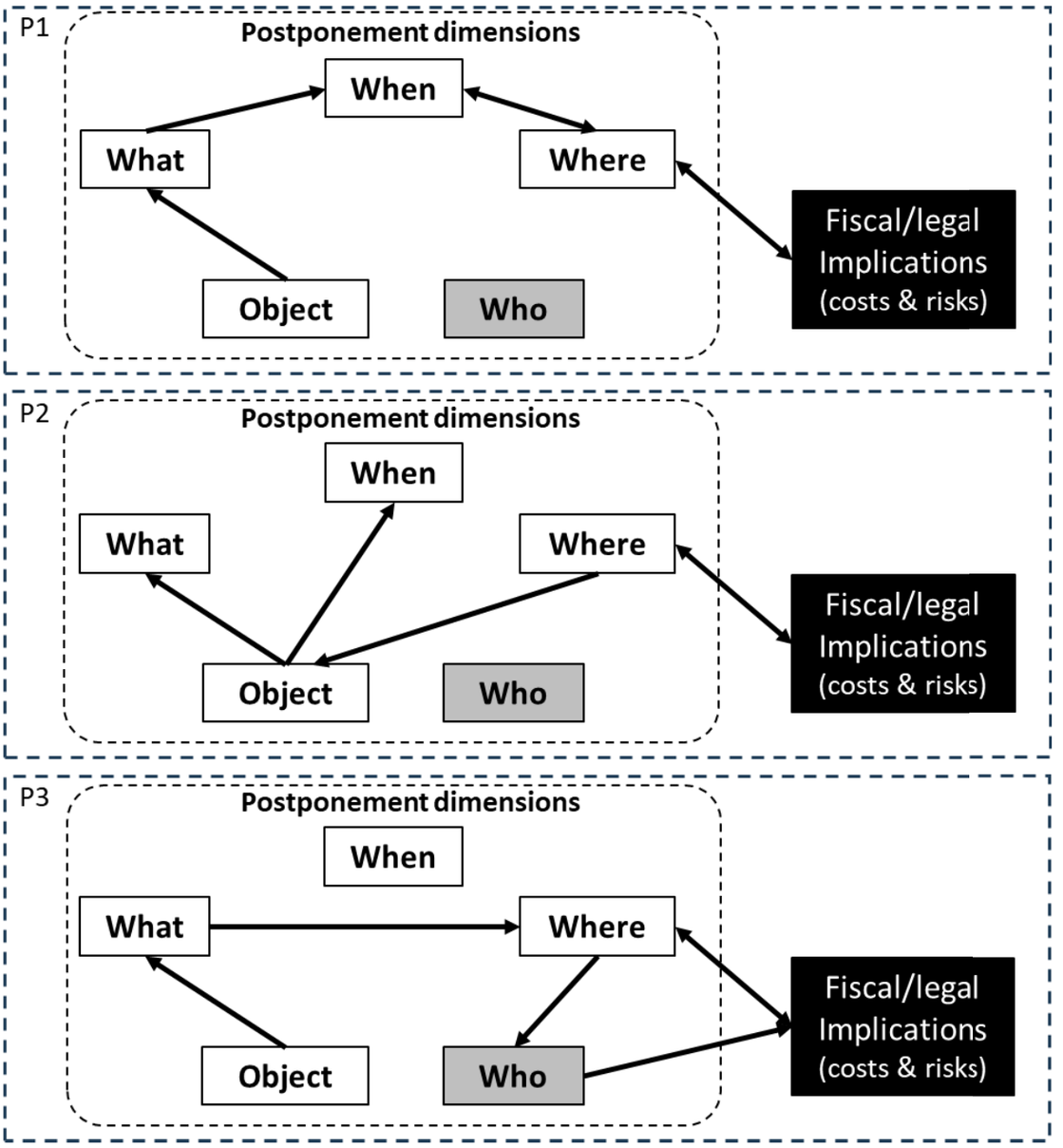


Figure 5. Interrelationships among the identified postponement dimensions and reciprocity with the related fiscal/legal implications (with emphasis on the suggested propositions)

Appendix A: Interview Guide

To explore postponement dimensions (*when* and *where* doing *what* operations) across the different Global Supply Hubs and the related flows, the following elements are required to be identified/defined for each type of flow:

- Kind of destination country (customs union or preferential trade agreements in place)
- Destination country
- Origin country
- Object in focus (e.g., hardware, software, hardware/software)
- Goods ownership issues (who is the owner of the goods in each node/arc)
- Handling issues (who is in charge of handling goods in each node/arc)
- Facility ownership issues
- Sub-contractors and 3PPs involvement
- Differences in managing hardware or software goods
- Trade agreements in place
- Duties (function of goods origin/goods classification [tax code]/goods value)
- Local content requirements and other regulations
- Taxes impact
- Terms of payment
- FTZ (yes/no, then specific regulations)
- Type of distribution network (direct shipment/one-tier/two-tiers)
- Hub location determinants
- Risks other than currency (e.g., obsolescence)
- PE issues and other liabilities
- Trade channel design (i.e., “how to sell locally?”—distributors/agents/local companies, etc.)

Note: Changes, and their motivations should be discussed. Further challenges should be explored.

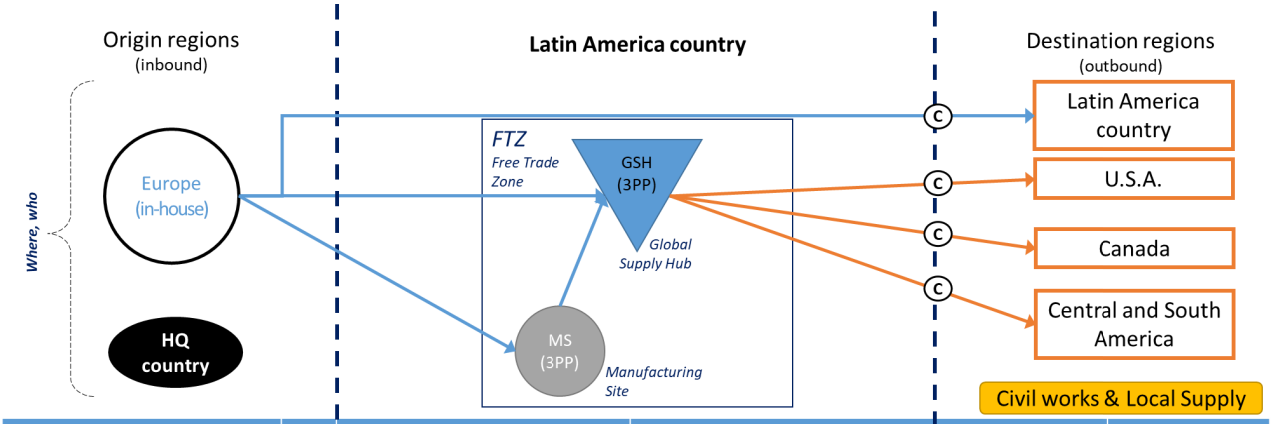
Appendix B: List of informants

Job title	Functional department	Years of experience	Contribution to the study
Senior SC Business Architect	Logistics and SCM	35+	main point of contact; data collection; fact checking and accuracy verification; discussion workshop participation
Senior Global Trade Compliance manager	SW and product development	30+	data collection; fact checking and accuracy verification; discussion workshop participation
Head of Legal Department	Tax and legal compliance	30+	data collection; fact checking and accuracy verification; discussion workshop participation
Head of Contract Accounting and Governance	Tax and legal compliance	25+	fact checking and accuracy verification; discussion workshop participation
Corporate Senior Manager for Supply Strategy	Logistics and SCM	30+	fact checking and accuracy verification; discussion workshop participation
Global Transformation Manager	SW and product development	30+	discussion workshop participation
Chief Architect	Logistics and SCM	25+	discussion workshop participation
Head of Supply Product Integrity and Supply Chain Design	Logistics and SCM	25+	discussion workshop participation
Head of Supply Strategy & Process	Logistics and SCM	30+	discussion workshop participation
Head of Strategy for Digital Services	SW and product development	20+	discussion workshop participation
Head of Core Design	SW and product development	15+	discussion workshop participation
Head of Corporate Supply (EMEA)	Logistics and SCM	20+	discussion workshop participation
Head of Sourcing Compliance (Asia Pacific)	Tax and legal compliance	15+	discussion workshop participation

Appendix C: Summary of data structure for coding and categorizing

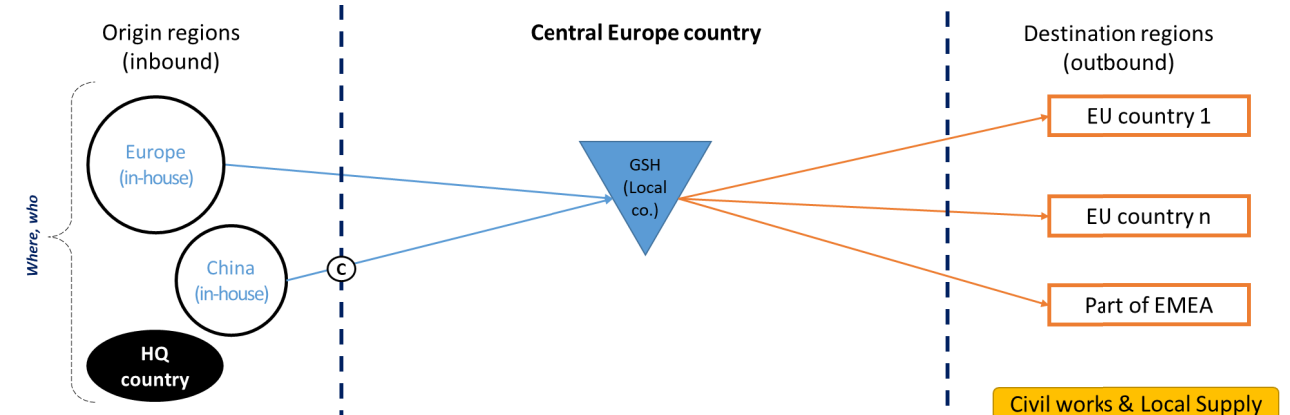
Examples of raw data	Within-subcase level	Cross-subcase level	Case level
	First-order codes	Second-order themes	Aggregate dimensions
the increasing software importance makes it necessary to adequately examine and address software handling issues, including bundling, installation, and testing	integrating SW with HW involves additional operations	integrating different objects (HW and SW) increases the number of postponement alternatives for value-adding	**integrating different objects (HW and SW) creates new opportunities for postponement applications**
hardware and software present different characteristics concerning sourcing, development, and worldwide distribution	HW and SW operations are significantly different		
software intangibility encompasses that the operations sequence related to hardware parts can be changed according to where and when software is bundled/installed/tested, thus making	SW operations can change the sequence of HW operations		
the logical sequence of software-related operations is less straightforward than hardware-related ones. hardware and software can be integrated at different SC tiers, where operations like bundling or installation can take place	SW operations (as well as operations to integrate SW with HW) can take place at different SC tiers		
integrating different components (hardware, software, services, civil works, and other locally supplied commodities) allows for offering more customized solutions to customers	customization relates to a plurality of components/objects	integrating different objects (HW and SW) enhances customization opportunities related to postponement	
hardware is in some ways less important today, as most of the value is added through software local adaptation	SW is increasingly important for customization		
tax implications are significantly driven by what operations are performed in each jurisdiction	legal/fiscal implications are affected by what operations are performed	what (operations)	**increasing reciprocity among postponement dimensions and with fiscal/legal implications**
tax implications related to hardware and software integration differ according to how the physical and financial flows are seen by tax authorities	hardware and software operations have different fiscal/legal implications		
when carrying out operations depend on the customers' lead time requirements but also on the jurisdictions where any kind of legal entity might be present (or not)	when (SC tier) executing operations depends also on the jurisdictions and legal entities involved	when (SC tier)	
when conducting operations is influenced by what kind of flows are managed and distributed (and the related rising tax implications)	when (SC tier) executing operations depends on the objects considered and their fiscal/legal implications		
where adding value is influenced by tax implications, but they are also influenced in turn by the origin of supply flows thus making relevant not only where operations occur, but also from where flows are sourced and to where they are headed	where executing operations depend on fiscal/legal implications related to multiple jurisdictions	where (region/jurisdiction)	
tax implications are not only related to where and when operations take place, as the considered objects influence how postponement strategies are and could be arranged	different objects encompass heterogeneous fiscal/legal implications	object (product type)	
tax implications related to how hardware and software parts are integrated together affect postponement decisions, being postponement design and the rising tax implications mutually interrelated	fiscal/legal implications reciprocally influence what objects can be involved in postponement operations		
regulatory frameworks affect where and when (SC tier) operations take place, but also what objects and legal entities can or should be involved	who conducts operations is subject to regulatory frameworks and the rising fiscal/legal implications	who (legal entity)	
different legal entities could be related to any SC tier involved in the SC processes and postponement operations, and operational substance concept could drive decisions about what legal entity is accountable for them	fiscal/legal implications reciprocally influence what legal entity (who) executes postponement operations		
cross-border flows can have unexptected fiscal/legal implications that relate to the legal entities involved in different jurisdictions	having multiple legal entities in different countries requires careful cross-border planning	fiscal/legal implications related to postponement are often unpredictable and uncertain	**fiscal/legal risks and compliance emerge as crucial elements for global postponement**
each country/region present unique regulatory frameworks, and the same operation could be legal or feasible in some jurisdictions and not in others	fiscal/legal implications vary widely across jurisdictions		
tax regulations differ enormously between countries and vary over time	fiscal/legal implications vary widely over time		
unwise decisions affecting cross border flows might lead to unnecessary tax consequences, in terms of both extra-payments and penalties/fines	lack of knowledge about fiscal/legal implications produces negative cost outcomes	important compliance risks emerge for multiple legal entities across jurisdictions	
fiscal and legal regulations are now so important and critical to be the key force behind global distribution	fiscal and legal regulations are increasingly important		
it is vital for all the legal entities involved that all flows—i.e., hardware, and software deliveries, services, invoicing, and payment—are made with due consideration to their fiscal consequences	knowledge about fiscal/legal implications is increasingly needed		
according to the different operations/services under examination the tax base may vary, and risk from a taxation perspective is different from risk from a business perspective. A key question is "Which operations mean a change in ownership and/or responsibility, or imply a PE creation?"	fiscal/legal implications encompass significant risk to be adequately managed		

Appendix D: Subcases visual summaries for the four GSHs considered



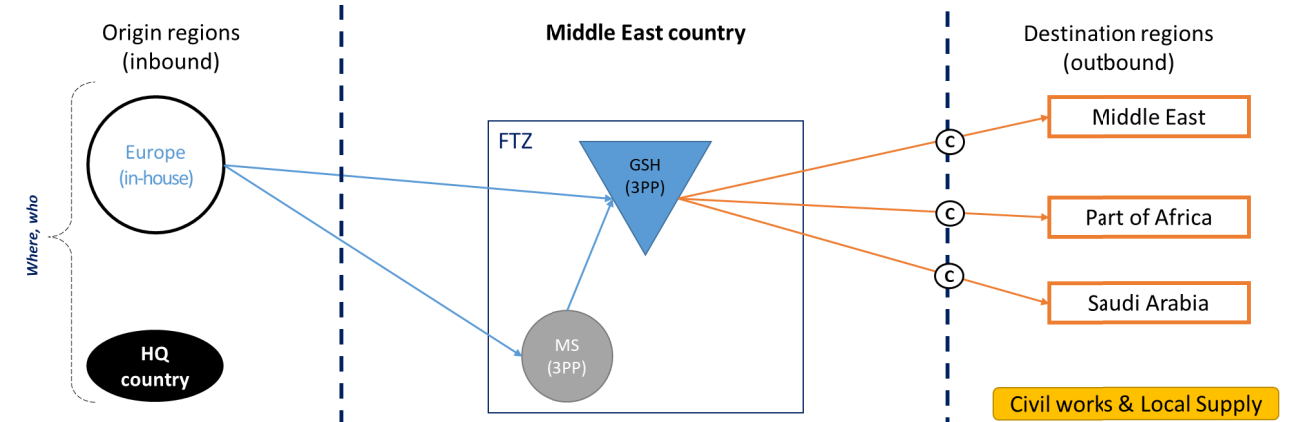
Operation/SC node *(What/When/Object)*	Plant	Manufacturing Site within FTZ (MS)	HighCorp Global Supply Hub (GSH)	Warehouses (SC/FAS)	Customer site
0 (HW) – raw materials → components	Y	Y			
1 (HW) – components → sub-products	Y	Y			
2 (HW) – «pick and pack»	Y	Y	Y	Y	
3 (SW) – software development	Y				
4 (SW) – software sourcing	Y				
5 (SW) – software test	Y	Y			
6 (HW+SW) – software installation	Y	Y			Y
7 (HW+SW) – software license activation	Y	N.A	Y	Y	Y
8 (HW+SW) – sub-products → solution	Y		Y		
9 (HW+SW) – solution test	Y		Y	Y	Y
10 (HW+SW) – software update	Y		Y	Y	Y

Figure D.1. Latin America GSH subcase summary



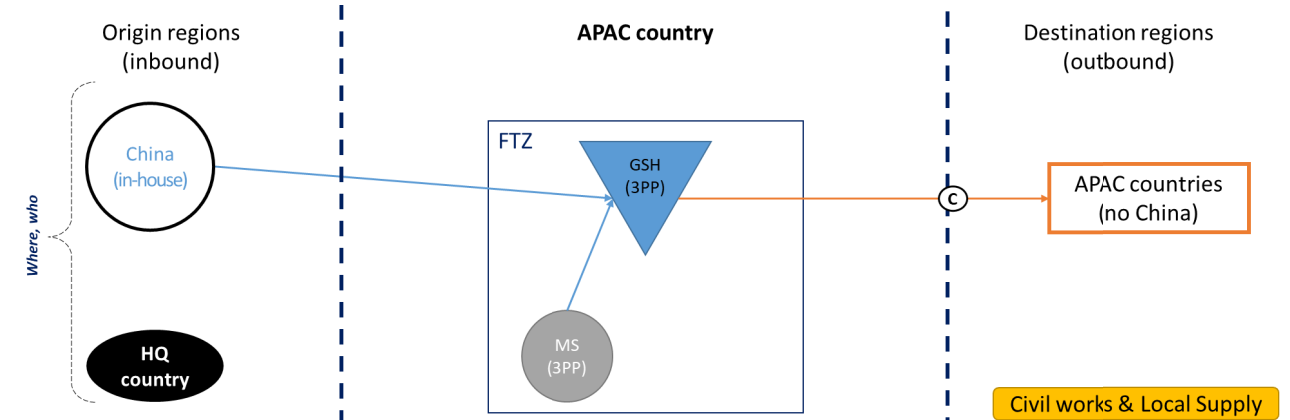
Operation/SC node *(What/When/Object)*	Plant	Manufacturing Site within FTZ (MS)	HighCorp Global Supply Hub (GSH)	Warehouses (SC/FAS)	Customer site
0 (HW) – raw materials → components	Y	N.A			
1 (HW) – components → sub-products	Y	N.A			
2 (HW) – «pick and pack»	Y	N.A	Y	Y	
3 (SW) – software development	Y	N.A			
4 (SW) – software sourcing	Y	N.A			
5 (SW) – software test	Y	N.A			
6 (HW+SW) – software installation	Y	N.A	Y		Y
7 (HW+SW) – software license activation	Y	N.A	Y	Y	Y
8 (HW+SW) – sub-products → solution	Y	N.A	Y		
9 (HW+SW) – solution test	Y	N.A	Y	Y	Y
10 (HW+SW) – software update	Y	N.A	Y	Y	Y

Figure D.2. Central Europe GSH subcase summary



Operation/SC node *(What/When/Object)*	Plant	Manufacturing Site within FTZ (MS)	HighCorp Global Supply Hub (GSH)	Warehouses (SC/FAS)	Customer site
0 (HW) – raw materials → components	Y	Y			
1 (HW) – components → sub-products	Y	Y			
2 (HW) – «pick and pack»	Y	Y		Y	
3 (SW) – software development	Y				
4 (SW) – software sourcing	Y				
5 (SW) – software test	Y				
6 (HW+SW) – software installation	Y				Y
7 (HW+SW) – software license activation	Y		Y	Y	Y
8 (HW+SW) – sub-products → solution	Y		Y		
9 (HW+SW) – solution test	Y		Y	Y	Y
10 (HW+SW) – software update	Y		Y	Y	Y

Figure D.3. Middle East GSH subcase summary



Operation/SC node *(What/When/Object)*	Plant	Manufacturing Site within FTZ (MS)	HighCorp Global Supply Hub (GSH)	Warehouses (SC/FAS)	Customer site
0 (HW) – raw materials → components	Y				
1 (HW) – components → sub-products	Y				
2 (HW) – «pick and pack»	Y			Y	
3 (SW) – software development	Y				
4 (SW) – software sourcing	Y				
5 (SW) – software test	Y				
6 (HW+SW) – software installation	Y				Y
7 (HW+SW) – software license activation	Y			Y	Y
8 (HW+SW) – sub-products → solution	Y		Y		
9 (HW+SW) – solution test	Y		Y	Y	Y
10 (HW+SW) – software update	Y		Y	Y	Y

Figure D.4. APAC GSH subcase summary