

Causal Impact Analysis of the Implementation of Single Window Systems: The Case of Ghana

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Abstract

This study investigated the impact of the Integrated Customs Management System (ICUMS) on the time required to generate a Delivery Order (DO) in Ghana's cargo clearance process, addressing a gap in quantitative evaluations of Single Window (SW) systems by focusing on this specific aspect of trade facilitation. Utilizing Causal Impact Analysis. The research analyzed 2026 DOs from July 2020 to July 2023 through Bayesian Structural Time Series models, comparing the DO creation time before and after ICUMS implementation using R statistical software. The findings reveal a reduction in DO creation time from 11 to 9.22 days following the implementation of ICUMS; however, this decrease is not statistically significant, with considerable uncertainty in the estimated impact. The relative effect analysis and *p*-value suggest that this observed increase may be attributable to random variation rather than the impact of the intervention. The study recommends the adoption of more robust trade facilitation strategies aimed at addressing bottlenecks in DO issuance and advocates for qualitative research to better understand operational challenges and pinpoint areas for improvement. The findings challenge the widely touted benefits of SW systems and call for a reassessment of their role in trade facilitation. This research contributes to the limited quantitative literature on the impact of SW systems, particularly through the lens of DO creation time, an essential but often overlooked element of trade facilitation.

Keywords

Cargo Clearance, Container Dwell Time, Single Window, Trade Facilitation

1. Introduction

Since the establishment of the International Convention on the Simplification and Harmonization of Customs Procedures (Kyoto Convention), which outlines a framework for simplifying, harmonizing, and modernizing customs procedures to facilitate international trade, numerous countries have attempted to establish various forms of single window environments (Mwajita, 2016; Njatrijani et al., 2022; Peynirci, 2023). This trend is attributed to the benefits of simplification, harmonization, modernization, transparency, and cooperation as documented by the United Nations Economic Commission for Europe (UNECE) in 2005. UNECE defines a single window as “a system that allows traders to lodge information with a single body to fulfill all import and export-related regulatory requirements”. Prominent examples of single window systems include the Association of Southeast Asian Nations (ASEAN) for Southeast Asian countries, TradeNet in Singapore, and Asycudaworld in about 102 countries across different continents, including African nations such as The Gambia, Côte d’Ivoire, Mali, Mauritania, Malawi, and Madagascar.

Even though the idea of single window implementation is well-intended with documented benefits, the outcomes of the various implementations outlined above are varied depending on the countries and continents. Whilst the ASEAN and Tradenet have been touted to have had greater impact (Dionisius et al., 2021; Suvannaphakdy & Guo, 2023; Teo et al., 1997), asycudaworld, implemented in 38 countries in Africa has not yielded the anticipated impact. A survey conducted by UNCTAD in 2021 after the COVID-19 pandemic suggests that a lot of paper submissions and lack of electronic signatures are still associated with transactions involving several Customs administrations and these affect the ease of doing business (UNCTAD, 2021).

In the 1990s, with funding support from the World Bank, the United States, and the International Monetary Fund, Ghana embarked on introducing Information and Communication Technology (ICT) in trade facilitation. This led to the entry of Ghana Community Network (GCNet), introducing the Ghana Integrated Cargo Clearance System (GICCS), modeled after Singapore’s TradeNet. Subsequently, West Blue Consulting launched Ghana’s first strategic action plan for the implementation of the Ghana National Single Window (GNSW) and operated alongside GCNet until their exit. GCNet was replaced by the Integrated Customs Management System (ICUMS) in April 2020, a GNSW system implemented by Ghana Link Network Services Limited on behalf of Ghana Customs.

The introduction of ICUMS, considered a game-changer in trade facilitation, aimed to address the challenges leading to Ghana’s decline in the World Bank’s Ease of Doing Business Index from 60.4 in 2019 to 60 in 2020. Despite its significance, assessments of such systems have often been limited, focusing on Container Dwell Time (CDT) and Revenue Generation using basic descriptive analysis. This study seeks to explore the impact of ICUMS on a specific yet crucial aspect of the clearance process—the time taken to create a Delivery Order. This time frame,

from the completion of container discharge to the submission of the Delivery Order for terminal/ICD release, is vital for cargo clearance (Ghana Link Network Services, 2020). The study applies causal impact analysis to evaluate the effect of ICUMS on this key component of total cargo clearance time.

Defined by the World Customs Organization (WCO) as the simplification, modernization, and harmonization of export and import processes, Trade Facilitation (TF) aims to reduce constraints and streamline regulatory aspects of international trade. Chapter 7 of the revised Kyoto Convention specifically recommends the adoption of Information Communication Technology (ICT) for trade facilitation. The implementation of Single Window (SW) systems within single window environments has been a primary method for applying ICT in trade facilitation, as noted by the United Nations Economic Commission for Europe (UNECE) in 2005. According to UN/CEFACT Recommendation 33, a SW allows involved parties to lodge standardized information at a single-entry point for all regulatory requirements related to import, export, and transit. This approach has led to the implementation of various SW systems globally, driven primarily by customs authorities in countries such as Singapore (TradeNet), Sweden (Virtual Customs Office), Britain (UK International Trade Single Window), and the USA (Automated Commercial System), among others. In Africa, implementations include Ghana (GCNet system), Mauritius (TradeNet), and Nigeria (Nigeria Integrated Customs Information System), to name a few (Mwajita, 2016).

Studies like (Cha, 2017; Gabriel et al., 2022) and others have consistently demonstrated the positive benefits of TF systems, including cost reduction, revenue increase, and reduction in bureaucratic processes and crime. However, the methodologies applied in these studies, such as the Causal Impact Analysis, have been underutilized in assessing the impact of SW systems. This analysis is defined as a statistical method used to assess the impact of a specific intervention on an outcome, considering other influencing factors. Examples include (Brodersen et al., 2015) on computer simulated data, (Carbo & Graham, 2020) in transportation, and (Kim & Chung, 2022) on environmental policies.

Despite the known benefits of Causal Impact Analysis, there is a notable absence of its application in assessing SW systems. Impact assessments have predominantly been qualitative, relying on respondent opinions, as seen in (Mwajita, 2016) and others. These studies often overlook time-related measurements influencing total cargo clearance time, as indicated in research by (Raballand et al., 2012; Moini et al., 2012), and others. Additionally, previous studies have focused on downstream factors like terminal capacity and equipment availability, neglecting critical variables such as the time to obtain a Delivery Order (DO).

The World Customs Organization's TRS guidelines recommend computing the time for Customs to release consignments. Countries like Malawi and The Gambia have implemented TRS, with recommendations for integrating computerized systems and investing in modern port operations technology.

To bridge the methodological gap in assessing the impact of SW systems, our

study applies Causal Impact Analysis to evaluate the impact of the Ghana National Single Window (GNSW), specifically the Integrated Customs Management System (ICUMS), on the time required to create a Delivery Order.

2. Methodology

The study applied Causal Impact Analysis, a quasi-experimental design to a dataset of 2026 Delivery Orders, consisting of 924 orders created by ship agents before the implementation of ICUMS and 1102 orders created after its implementation between July 2020 and July 2023. Following the methodology outlined in Brodersen et al. (2015), the approach included pre-intervention and post-intervention data collection, selection of a control group, model specification, estimation of causal effects, and statistical inference using R statistical software.

SN	Name of Variable	Description	Data Type
1	Discharge Completion Date	The date and time the stevedore company completes the discharge of all cargo on the voyage	TimeStamp
2	Delivery Order Date	The date and time the Delivery Order is created by the ship agent	TimeStamp
3	Before	The number of days it took each DO to be created before the implementation of ICUMS	Numeric
4	After	The number of days it took each DO to be created after the implementation of ICUMS	Numeric

Method

The method involves fitting a Bayesian Structural Time Series (BSTS) model to the target and control time series observation of the time it takes to create a delivery order followed by the subsequent performance of posterior inference on the counterfactual. The following pair of structural time-series state-space models underpin the proposed BSTS model (Qiu et al., 2018):

$$y_t = Z_t^T \alpha_t + \beta X_t + G_t \epsilon_t \tag{1}$$

$$\alpha_{t+1} = T_t \alpha_t + R_t \eta_t \tag{2}$$

where

$$\epsilon_t \sim N(0, \sigma_t^2) \tag{3}$$

and

$$\eta_t \sim N(0, Q_t) \tag{4}$$

Equation (1) is the observation equation which links the observed data y_t to a latent d-dimensional state vector, α_t . Equation (2) is the state equation which is responsible for governing the evolution of the state vector α_t , through time t . In other words, the alpha variable refers to the “state” of the time-series, and y_t is a linear

combination of the states, plus a linear regression with some explanatory covariates, X , plus ϵ , of noise that is normally distributed about a mean of 0. ϵ_t and η_t are independent of all other unknowns.

3. Results

The study analysed 2026 observations, comprising 924 observations with a mean of 11 days and a variance of 88.09 days before the introduction of ICUMS, and 1102 observations with a mean of 9.22 days and a variance of 19.34 days after its introduction (Table 1). Table 1 presents a lower mean for the “Before” group, raising questions about the significance of the difference between the two groups.

Table 1. Descriptive statistics of the two groups.

Statistic	Before	After
Observations	924	1102
Mean	11.00	9.22
Variance	88.09	19.34

The causal impact analysis, which looks at the difference between the actual outcomes and what would have been expected without the intervention, indicates an estimated effect of 1.55 days’ increase in the time to create a DO. However, this estimate, with a 95% confidence interval ranging from –31 to 38 days, does not conclusively point to a significant impact caused by the ICUMS implementation. The large range of this confidence interval suggests a high degree of uncertainty in the estimate.

Table 2. Causal impact output.

Parameter	Average	Cumulative
Actual	8.5	1016.4
Prediction (s.d)	6.9 (19)	8754.7 (24509)
95% CI	[–29, 40]	[–36839, 50415]
Absolute effect (s.d)	1.6 (19)	1961.7 (24509)
95% CI	[–31, 38]	[–39698, 47556]
Relative effect (s.d)	–147% (850%)	–147% (850%)
95% CI	[–664%, 317%]	[–664%, 317%]
<i>P</i> -Value	0.483	

When we consider the cumulative figures, the post-intervention period shows a total of 1016.4 days taken to create DOs, compared to a hypothetical scenario without the intervention, where it would have been 8754.7 days. Again, the wide confidence interval of this prediction, ranging from –36,839 to 50,415 days, underscores the uncertainty and suggests that the observed changes could be due to

random fluctuations rather than the intervention itself (Table 2).

More strikingly, the relative effect analysis shows a -147% change, with a highly variable confidence interval of -664% to $+317\%$. This extreme range and the relative effect value itself suggest a complex interplay of factors, where the intervention might not be the sole or even primary cause of the observed changes. Additionally, the p -value of 0.483 further diminishes the statistical significance of the findings, indicating that the observed effects could very well be due to chance.

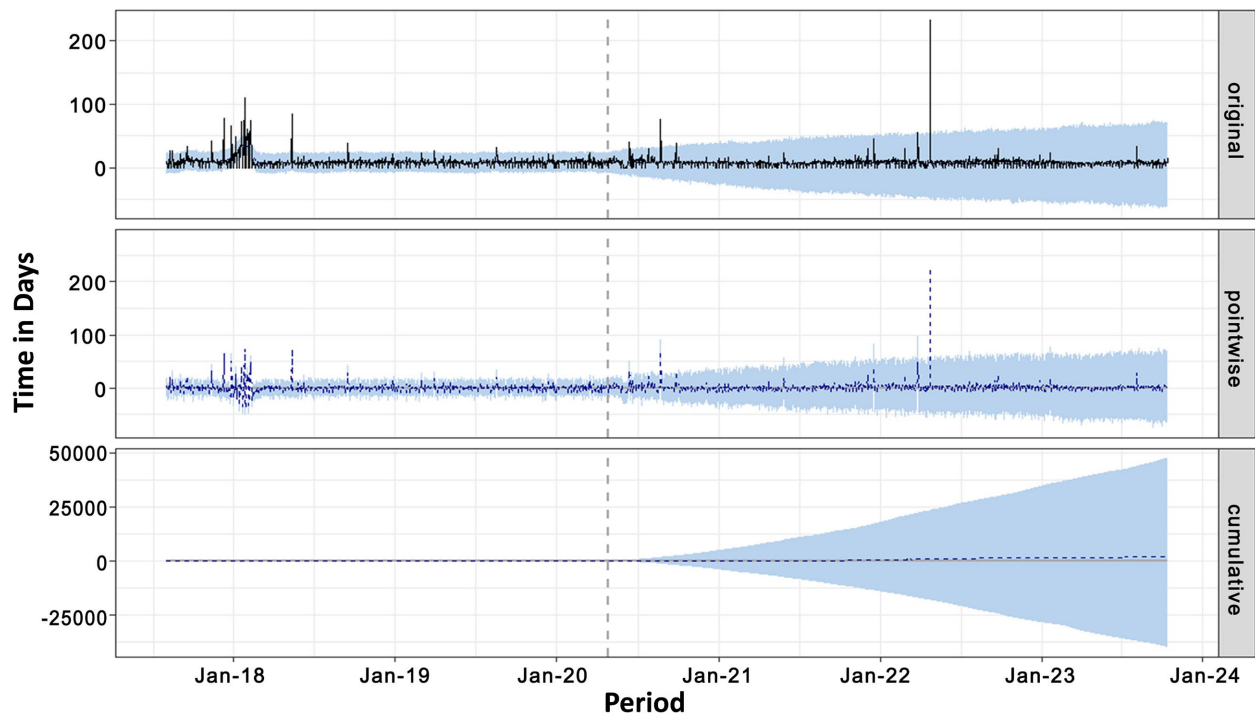


Figure 1. Causal impact plot of the implementation of ICUMS on the time it takes to get a delivery order.

Visual representation through Figure 1 reinforces these findings. The lack of a distinct trend changes in the time taken to get a DO before and after the introduction of ICUMS suggests that the system's implementation did not markedly alter the efficiency or speed of the process.

4. Discussions

The discourse around the effectiveness of Single Window (SW) systems, particularly in the realm of Trade Facilitation (TF), has been largely positive, as highlighted in various studies (Mwajita, 2016). However, the findings from our study present a nuanced perspective, especially when considering the case of Ghana's implementation of the Integrated Customs Management System (ICUMS). While there is an apparent improvement in the time taken to obtain a Delivery Order (DO), reducing from 11 to 9 days, this change doesn't significantly deviate from the pre-implementation period.

These findings challenge the widely acclaimed benefits outlined by the United

Nations (UN) regarding the implementation of Single Window (SW) systems within SW environments. The three primary recommendations presented in (UNECE, 2003), which include the initial proposal for developing a framework and guiding principles for SW implementation, the subsequent guidelines for SW implementation (UNECE & UN/CEFACT, 2020), and the most recent revised guidelines (United Nations (UN), 2013), all emphasize the importance of a single authority, a unified system, and an automated system to enhance trade outcomes, such as reducing the time required to conduct business. However, this study's findings highlight the necessity to re-examine the key components of this framework, with a focus on identifying and rectifying potential flaws in its application, especially, given the comprehensive Trade Facilitation measures introduced alongside ICUMS, including the introduction of Pre-Manifest Declarations, simplified payment regimes, and enhanced grievance management systems.

The expectation would be that these sweeping reforms would have led to a significant decrease in the Container Dwell Time (CDT), as there's a direct relationship between CDT and the cargo clearance process (Al-Haddad et al., 2021). However, the reality presents a more complex picture, suggesting that other latent factors might be at play, diluting the expected positive impact of these reforms. This complexity is reflected in the disparity between the reduction in DO issuance time and the more significant improvements in Customs revenue post-ICUMS implementation (Business Ghana, 2022).

Moreover, while the introduction of ICUMS and related measures was anticipated to improve Ghana's position in global rankings like the World Bank's Ease of Doing Business Index and Time Release Study (TRS), the actual impact appears to be more muted. The goal of achieving a CDT of around 4 days, as reported in other contexts (Kgare et al., 2011), still seems distant. This suggests that while the implementation of ICUMS and other Trade Facilitation measures have made some positive strides, there are underlying inefficiencies and challenges that need to be addressed. These might include infrastructural bottlenecks, policy gaps, or even systemic issues within the trade and customs ecosystem, which continue to hinder the full realization of the benefits associated with such digital transformations in the trade facilitation domain.

From a policy point of view, these findings necessitate a concerted effort by all stakeholders in the sector, led by Customs, to review and refine regulations, laws, and trade facilitation processes. This is crucial for identifying and addressing potential bottlenecks that prolong cargo clearance time as effective and efficient Customs procedures play a pivotal role in clearance time, as evidenced in (Gabriel et al., 2022). Addressing these issues is key to enhancing port competitiveness and achieving the exemplary levels of efficiency as described in (Kgare et al., 2011).

As far as social impact is concerned, an increase in the time required to create a Delivery Order, contributes to longer overall cargo clearance time and has a notable effect on the cost of doing business. This impact has been discussed in various studies, including (Gabriel et al., 2022; Kgare et al., 2011; Raballand et al.,

2012; Refas & Cantens, 2011). Our study's findings suggest ongoing delays in the cargo clearance chain, despite reports of increased revenue (Essel et al., 2022) and other positive indicators. These prolonged clearance times inevitably lead to higher business costs, potentially deterring potential importers from using the ports. As a result, ports and governments could lose crucial traffic and revenue. This loss is particularly significant in a country like Ghana, where approximately 70% of government revenue is derived from seaport activities. As such, the consideration of these findings has the potential to reduce the burden of cost on the trading community.

5. Recommendations

Building on the insights gleaned from our study, which revealed an unexpected outcome regarding the time taken to create a delivery order post-ICUMS implementation, our recommendations focus on enhancing the effectiveness of trade facilitation measures. Firstly, it is crucial to implement more robust trade facilitation strategies that specifically target and eliminate the bottlenecks causing delays in issuing delivery orders. This approach requires a thorough examination and overhaul of existing procedures, policies, and possibly, the technology infrastructure that supports the cargo clearance process. Such targeted interventions are essential to streamline operations and enable smoother progression through the cargo clearance stages.

In addition to these strategic changes, we also advocate for the execution of qualitative studies to delve deeper into the underlying causes of the delays currently being experienced in the acquisition of delivery orders. This research should aim to gather detailed insights from various stakeholders involved in the cargo clearance process, including customs officials, traders, and logistic service providers. Understanding their experiences, challenges, and suggestions would provide a richer, more nuanced perspective on the operational realities, helping to identify specific areas for improvement. These studies could uncover aspects that quantitative analyses might overlook, such as procedural inefficiencies, gaps in stakeholder communication, or training needs for system users. By combining a comprehensive review of trade facilitation measures with in-depth qualitative research, we can develop more effective strategies to optimize the cargo clearance process, ultimately leading to significant improvements in line with the potential offered by systems like ICUMS, as envisaged in the broader context of trade facilitation (Gabriel et al., 2022; Kgare et al., 2011).

6. Conclusions, Limitations and Future Research Direction

The study set out with the clear objective of examining the impact of the Integrated Customs Management System (ICUMS) on a crucial phase in the cargo clearance process: the time taken to create a Delivery Order (DO). This time frame is pivotal, as it stretches from the completion of container discharge to the submission of the DO for terminal or Inland Container Depot (ICD) release. By

employing causal impact analysis, the study aimed to dissect and understand the specific effects of ICUMS on this vital component of the total cargo clearance time.

The conclusions drawn from this study are multifaceted. Firstly, while there was a reduction in the time taken to issue a DO—from 11 days to 9 days—this change was not statistically significant. This finding is intriguing, especially considering the array of Trade Facilitation measures introduced alongside ICUMS, which were expected to streamline and expedite the process. Measures such as Pre-Manifest Declarations, an expanded payment regime, and an integrated platform for inspections and offense management were anticipated to have a more pronounced effect.

This study indicates that the implementation of ICUMS, despite being a significant step towards digitalization and process improvement in Ghana's customs operations, has not drastically altered the efficiency of the DO creation phase as might have been expected. The factors contributing to this could be numerous and complex, ranging from systemic inefficiencies, infrastructural limitations, to possible resistance to change among stakeholders.

Furthermore, the study underscores that the reduction in DO issuance time did not translate into a proportionate decrease in the overall Container Dwell Time (CDT), suggesting that other stages in the cargo clearance process may be contributing to delays. This points to the need for a more holistic approach in reforming the cargo clearance process, addressing all components that contribute to delays.

The primary limitation of this study is its exclusive focus on Delivery Order (DO) data from containers processed at the GPHA terminals. The absence of DO data from Meridian Ports Services, the second of the two main terminals which was occasioned by the unavailability of data may limit the representativeness of the study's findings.

Despite this limitation, our study has demonstrated that the implementation of the Integrated Customs Management System (ICUMS) by Ghana Link Network Services has positively influenced the time required to obtain a DO, an essential part of the clearance process. Given the anticipated positive correlation between our findings on DO creation time and Container Dwell Time (CDT), future research should investigate the impact of reduced DO creation time on CDT. Such research would be valuable for pinpointing the key bottlenecks contributing to the suboptimal performance of DO lead time.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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