National Logistics Performance Benchmarking

A Process-based Approach Using World Bank Logistics Performance Index Database

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This paper develops a national logistics benchmarking process based on the Logistics Performance Index (LPI) database maintained by the World Bank. The process adopts a business process management (BPM) logic with two core benchmarking analytic steps to compare LPI performance metrics data of the chosen benchmarked countries against the focal country to better identify key area(s) for the national logistics performance improvement of the focal country. Using Taiwan as an example, this paper presents how to benchmark other countries and validates the designed benchmarking process.

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I. INTRODUCTION

Global flows have been a common thread extending through the mercantilist and colonial eras, from old trade routes such as the renowned Silk Road through the industrial revolutions that swept across Europe and North America in the 18th and 19th centuries to the more recent rise of emerging economies. But today the web of cross-border exchanges has exploded in scope and complexity (Manyika et al., 2014).

Given the twin forces of rising prosperity in emerging markets and the increasing impact of digital technologies, a growing share of the world's economic activity involves cross-border flows. In 2012, 35 percent of goods cross borders, up from 20 percent in 1990. Although services sectors now account for roughly two-thirds of world GDP, trade in goods (including commodities) remains by far the largest type of flow, at $17.8 trillion in 2012, or 24 percent of global GDP (Manyika et al., 2014). As goods flows have increased, their direction has also changed. Developed economies used to dominate global trade—54 percent of all goods traded in 1990 were between developed economies—but in 2012 these flows accounted for only 28 percent. This shift has been offset by the increasing participation of emerging economies in global goods trade, both as exporters and as importers. Emerging economies now account for 40 percent of goods flows, and 60 percent of those go to other emerging economies—so-called South-South trade (Manyika et al., 2014).

Crucially, logistics is not only a private endeavor, but also a public policy concern. The performance and reliability of supply

chains depend on an array of interventions, ranging from trade facilitation at the border to infrastructure and regulations and to urban planning and skills. Empirical evidence confirms that logistics- and connectivity-related interventions have the highest potential to reduce the cost of trade and to boost integration in global value chains (Arvis et al., 2016). The "logistics performance gaps" evident between advanced and lagging nations has caused the disconnectivity in the world trading routes and underscores the importance of consistent policies across relevant sectors (trade, customs, and transportation, for instance) for nations (Arvis et al., 2014).

Logistics disparity among nations or economies has caused connectivity problems in trade routes and subsequent time delay and additional logistics costs in the global supply chains. The World Bank has recognized the critical role of national logistics performance in the effectiveness of world trade and also the gaps of logistics performance among nations (Arvis et al. 2007). Thus, since 2007, the World Bank has initiated a bi-annual global survey on national logistics performance for most countries in the world and has developed a logistics performance index (LPI) database, i.e. WB LPI (Arvis et al., 2007, 2010, 2012, 2014, 2016). The World Bank encourages countries to utilize the LPI database to benchmark against countries of their choice to further identify weak areas for improvement. Even though many countries use WB LPI database to examine their national logistics performance and pursue opportunities for improvement (Arvis et al., 2016), how WB LPI database can be utilized to its best extent is still a gray area for many countries.

Logistics/supply chain process integration is positively related to firm's competitiveness (Mellat-Parast and Spillan, 2014). If organizations are investing in logistics and supply chain as a source of competitiveness, they should pay close attention to process integration in global logistics and supply chain activities. The global relevance of humanitarian supply chains is highlighted by the fact of all governments being involved in humanitarian aid as either donors or recipients, not to speak of the number of commercial organizations involved in humanitarian supply chains as product suppliers and third party logistics providers (Kova´cs and Spens, 2007). Challenges of humanitarian logisticians depend not only on the disaster at hand, but also on the local presence of their organization. The most emphasized challenge is the coordination of the domestic and international logistical activities and the support of the logistics infrastructures (Kova´cs and Spens, 2009; Su and Ke, 2015).

Improving national logistics performance is a complex, unfinished, cross-cutting, and evolving agenda (Arvis et al., 2016). A national logistics system is under ongoing development by its government to support the logistical flow of the businesses and non-profit organizations (Arvis et al., 2014; Kova´cs and Spens, 2007). National logistics is not a stand-along system, rather it is a complex inter-organizational, and oftentimes cross-country processes prone to degenerate if not managed on a continuous improvement basis (Su and Ke, 2015). However, due to its inter-departmental nature in many government organizational designs, national logistics is often the most segregated and disintegrated activities (Su and Ke, 2015). Even with the existence of the World Bank multiple years LPI database, there is still very limited literature or methods regarding the practical application of WB LPI database for national logistics performance benchmarking (Su and Ke, 2015).

With these backgrounds in mind, the purpose of this paper is to explore and design a process-based practical approach for a country (or an economy) in WB LPI database to conduct its national logistics performance benchmarking study with an embedded

continuous improvement mechanism to unlock the domestic and international connectivity bottlenecks. The research question is thus defined as: *how can a country utilize the most recent World Bank LPI database to improve her national logistics system?* This research uses mainly business process improvement method (Goldkuhl and Lind, 2008) and data analytics approach (LaValle, et al. 2011) for the investigation. This study intends to complement to the extant literature regarding the national logistics benchmarking approach for governments. Taiwan is used as a case to validate the national logistics performance benchmarking approach regarding its application in prioritizing key improvement areas and developing a relevant national logistics policy. The case study also presents the practical results of a sample country applying the national logistics performance benchmarking method.

II. LITERATURE REVIEW

In this section, the relevant literature about this study are reviewed and synthesized.

There are several indices developed for measuring a country's trade connectivity and logistics performance. Trade connectivity is defined as how central a country is to the global trade networks. That is, it reflects the importance of a country in terms of its geographic location in the global structure of transportation and logistics networks (World Bank, 2014). Some international organizations have been dedicated to developing indicators for trade connectivity such as a Liner Shipping Connectivity Index (LSCI) developed by the United Nations Conference on Trade and Development (UNCTAD) and the Air Connectivity Index (ACI) developed by the World Bank.

To complement the existing indexes that focus on connectivity to global transportation networks, the World Bank first introduced the Logistics Performance Index (LPI), which is a comprehensive index for supply chain performance, in 2007. From then on, the World Bank's LPI surveys have been conducted in 2010, 2012, 2014, and 2016. Each survey involved more than 800 professionals of multinational freight forwarders and express carriers in more than 125 countries. The panel database including six logistics performance indices and an overall LPI score for each country enables a country to benchmark its performance with leading countries and its rivals and, thus, identify the challenges and opportunities for improvement. Section 3 will discuss the methodology and components of the World Bank's LPI.

Some studies examined the relationship between countries' LPI scores and logistics performances. Arvis et al. (2007, 2010) found that countries with a low LPI are associated with high logistics costs. To be more specific, the costs related to delivery failure are lower in high-LPI countries, while the relationship between direct freight costs and LPI scores appear to be a U-shape curve (Arvis et al., 2007). Hoekman and Nicita (2010) found a significantly positive relationship between the LPI scores and trade intensity. An increase in the average LPI score of low-income countries to the average of middle-income countries leads to 15% more trade, and such effect is stronger than that due to the removal of tariffs. Hausman et al. (2013) studied the impact of logistics performances on global bilateral trade. They found that shorter export time, lower importer's total costs, and less variability in the export time lead to more trades. Generally previous studies find that better LPI scores are associated with more trades and lower logistics costs, while a few studies indicated the relationships are nonlinear.

Cross-national benchmarking is the process of comparing one country's performance to the best practices from other countries. Rantasila and Ojala (2012) reviewed the studies on aggregate logistics costs at the

country level. They found that these studies were conducted in different methodologies like questionnaire-based surveys, econometric analysis, and case studies. Due to the lack of coherent terminology and methodology in data collection and analysis, a cross-country comparison is difficult without a coherent and longitudinal study like the World Bank's LPI surveys.

The World Economic Forum (WEF) used cross-national benchmarking to compare countries' logistics performance and estimated the impact of reducing supply chain barriers and removing tariffs on economies (World Economic Forum et al., 2013; Ferrantino et al., 2013). They simulated the impact of two alternative plans on GDP: (1) all countries improve their performance halfway to the global best practice on two primary supply chain barriers: border administration and transport and communications infrastructure, and (2) all countries completely eliminate tariffs. The result of the simulations shows that the former leads to an increase in global GDP of $2.6 trillion or 4.7 percent and $1.6 trillion or 14.5 percent in global exports, while the latter contributes only $400 billion or 0.7 percent to GDP and $1.1 trillion or 10.1 percent to global exports. It shows that reducing supply chain barriers is more effective than removing tariffs. However, because previous studies do not consider regional competitive position of a country, their findings fail to provide specific national logistics policy suggestions for a country to improve its national competitive advantage.

In summary, in the literature there are several existing indices and indicators measuring trade connectivity and only a few for national logistics competency. Previous studies have shown that improvement in trade connectivity and national logistics performance can have a profound impact on a country's trade and economy. However, none of previous studies provide a systematic method to identify the weaknesses of a country and improve its national logistics system.

To bridge the gaps shown in the literature, this study aimed to develop a new national logistics benchmarking process. We designed a process-based practical approach for a country to examine its national logistics performance through cross-country benchmarking and used an embedded continuous improvement mechanism to identify and unlock the connectivity bottlenecks. Given that the World Bank's LPI database is the only source that offers a cross-country, time-series database in logistics and supply chain performance and enables cross-country benchmarking, this study has selected the LPI database to explore a practical approach for a focal country to identify its weaknesses in logistics and supply chain and develop national policies to improve its national logistics performance.

III. WORLD BANK LOGISTICS PERFORMANCE INDEX

Since the benchmarking method designed in this study is based on WB LPI data, it is necessary to introduce the basics of LPI to be able to understand the LPI benchmarking analytics steps to be followed in the next section.

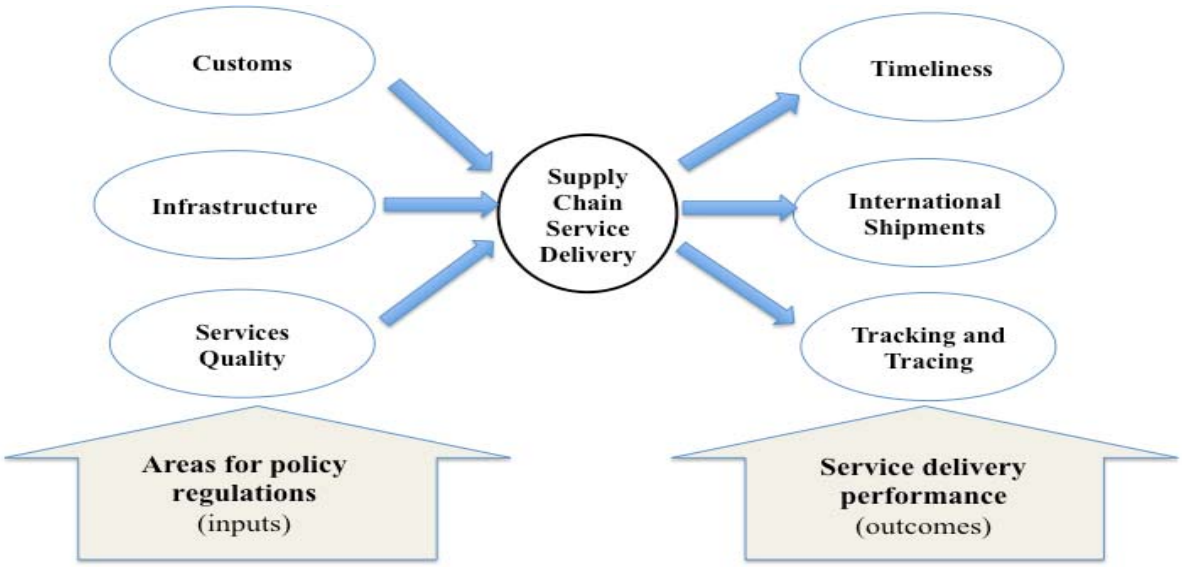
3.1. Overview

With the decreasing costs of international transportation and communication and liberalizing trade policies, multinational companies can design their supply-chain network from a global perspective. To optimize supply chain performance, they compare the advantages of different countries and allocate their resources accordingly. As a result, international logistics play an important role in the success of global supply chain management. However, the inconsistent service levels of national logistics

performance become an obstacle to international logistics operations.

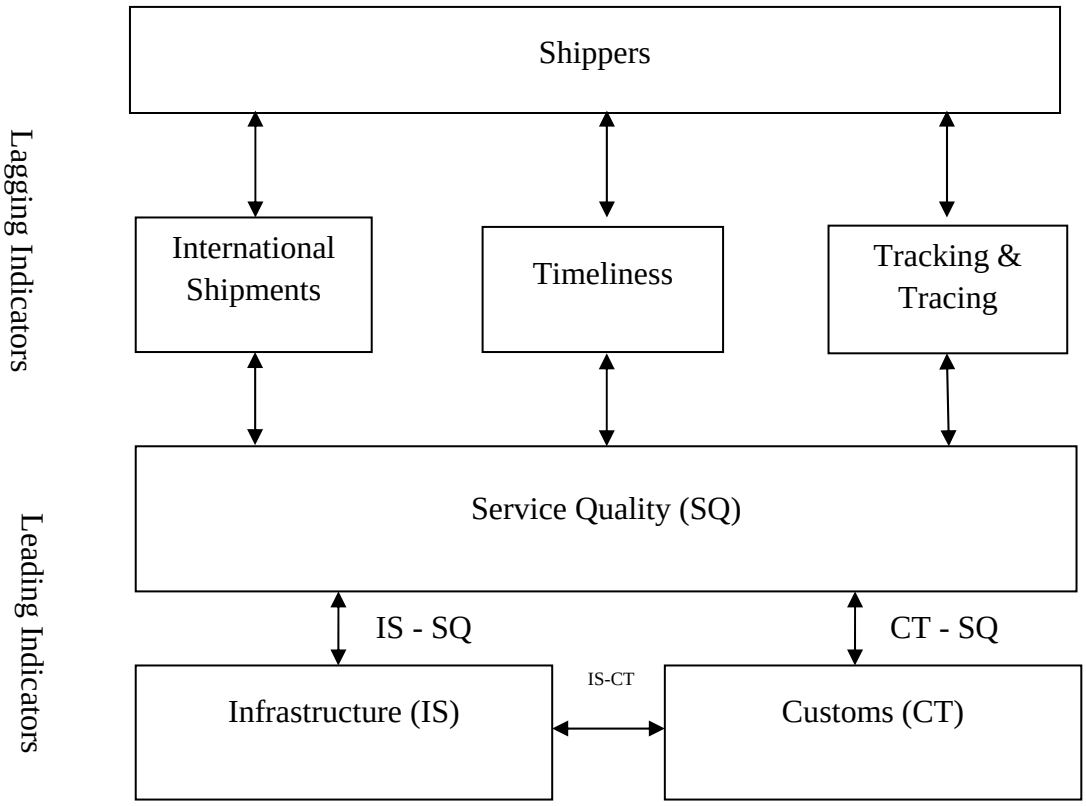
To assess the logistics gaps between countries and regions, the World Bank initiated a LPI survey in 2007 and continued it in 2010, 2012, 2014, and 2016. A standardized questionnaire was sent to respondents through an online survey. The LPI survey asks respondents to assess the performance of six key LPI indicators in eight of their primary overseas markets on a five-point Likert scale. These six LPI indicators include (Arvis et al., 2014):

1) Customs: the efficiency of customs and border clearance.
2) Infrastructure: the quality of trade and transport infrastructure.
3) International shipments: the ease of arranging competitively priced shipments.
4) Service quality: the competence and quality of logistics services including trucking, forwarding, and customs brokerage.
5) Tracking and tracing: the ability to track and trace consignments.
6) Timeliness: the frequency with which shipments reach consignees within scheduled or expected delivery times.



Source: Arvis *et al.* (2014)

FIGURE 1. CATEGORIZATION OF LPI INDICATORS.



Source: Analysis based on Fig. 1.

FIGURE 2. RELATIONSHIP OF LPI INDICATORS.

3.2. Relationship between Six LPI Indicators

Arvis et al. (2014) proposed a conceptual framework about the relationship between the six logistics performance indicators. As shown in Fig. 1, customs, infrastructure, and service quality are indicators related to policy regulations and categorized as the inputs for supply chain service delivery. Timeliness, international shipments, and tracking and tracing are indicators related to service delivery performance and considered outcomes of supply chain service delivery.

A recent research defines the service quality, the efficiency of customs clearance and infrastructure as "leading indicators" which are the key contributors to a country's competiveness of international logistics services (IOT, 2014). The research argued that the performance of these three indicators have a profound impact on each other's. A government should prioritize its investments contributing to the performance of these three indicators, and, as a result, the performance of the other three "lagging indicators" including timeliness, international shipments, and tracking and tracing will be improved as well. Fig. 2 presents the conceptual framework.

IV. A PROCESS-BASED METHODOLOGY FOR NATIONAL LOGISTICS BENCHMARKING

4.1. Process Methodology Overview

A process-driven organization is geared towards meeting and satisfying customer needs while a functionally driven organization is one that is geared towards meeting its targets. Right now, many countries, even advanced economies, still manage their national logistics by functionally driven organizations. Only scant country examples such as Singapore that adopt process-driven organizations to run their national logistics systems.

The move to process orientation is important for organizations keen on breaking down barriers within the structure, improving communications for problem solving and increasing customer value (Sever, 2007). It is even more important today for the move to face the emerging and complex sustainability challenges (van Buren et al., 2016). A process-centric organization is focused on documenting, managing, monitoring and improving the performance of their process outcomes. Business process management or BPM is a management philosophy for organizations to move towards becoming a process-centric organization. The central theme to the concept of BPM is the management and improvement of processes as organizations have accepted that a process-based approach in executing operational activities can bring about a certain degree of consistency and create a common language across the organization (Goldkuhl and Lind, 2008; Lee and Dale, 1998; Zairi, 1997).

4.2. National Logistics Performance Benchmarking Process

Adopting a BPM logic and the pioneering work done by Su and Ke (2015), an eight-step continuous improvement process-based national logistics performance benchmarking approach for a focal country is developed. This approach can serve not only as a benchmarking tool but also as a structure for the inter-departmental coordination in the government of the focal country to improve national logistics performance. Since WB LPI database contains the most comprehensive and aggregated global survey data on the logistics performance of most countries in the world, it provides a good data source for the national logistics performance benchmarking work (Arvis et al., 2016) and will be applied in the benchmarking analytics steps for the country comparison. The generic process for the national logistics performance benchmarking designed in this study is shown in Fig. 3.

The benchmarking process in Fig. 3 is triggered by WB LPI announcement and then the benchmarked countries are selected by the focal country considering factors that are most relevant such as the ‘role model’ of the focal country, major competing countries, et al. The analytics developed in step 3 and 4 will then be used to extract WB LPI data of the focal country and the benchmarked countries from WB LPI database for the benchmarking analysis.

Once the poorest LPI indicators are identified, a formal national logistics policy making procedure in the focal country needs to be ready at the inter-departmental level and the improvement initiatives must be developed, implemented and monitored at a due pace. If the initial cycle from step 1 to step 5 is managed properly, the improvement initiatives would have one and half years to be implemented according to our estimate.

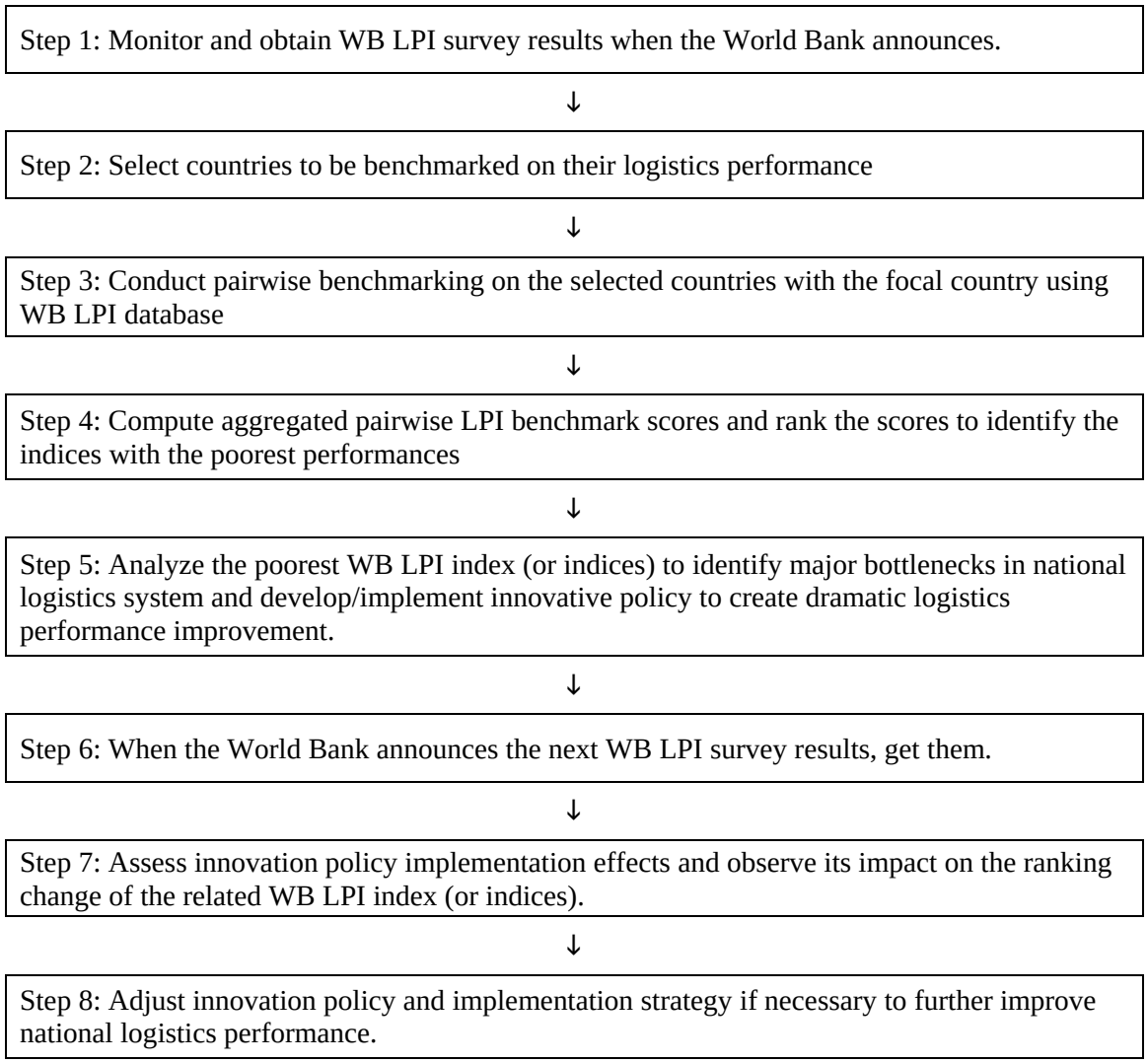


FIGURE 3. A GENERIC PROCESS FOR THE NATIONAL LOGISTICS PERFORMANCE BENCHMARKING.

The process then moves to the second cycle triggering by the next World Bank LPI announcement at step 6. The new WB LPI information allows the focal country to examine whether its WB LPI scores have improved or not and begin another round of the benchmarking process. At the same time, a thorough assessment of the effects regarding the national logistics improvement initiatives must be conducted and adjusted if the planned goals are not met.

4.3. Overview of the Benchmarking Process Steps

Each step in the national logistics performance benchmarking process will be introduced in this sub-section. Step 3 and step 4 include LPI-based benchmarking analytics

which will be discussed in further detail with the computational illustrations.

Step 1:
Conduct logistics performance assessment of *the focal country* using the most recent WB LPI database.

The focal country can access WB LPI database and retrieve its logistics performance ranking/score and trend regarding its composite LPI index and six LPI indicators' scores. Table 1 and 2 illustrate with Taiwan as the focal country its LPI rankings and scores from the past surveys.

TABLE 1. TAIWAN'S WORLD BANK LPI RANKINGS.

		Ranking						
Country	Year	LPI Rank	Customs	Infra structure	Int'l shipments	Logistics competence	Tracking & tracing	Timeli-ness
Taiwan	2007	21	25	21	16	23	24	15
	2010	20	25	22	10	22	12	30
	2012	19	22	21	16	20	21	14
	2014	19	21	24	5	25	17	25

Source: extracted and compiled from World Bank LPI database

TABLE 2. TAIWAN'S WORLD BANK LPI SCORES.

		Scores						
Country	Year	LPI Score	Customs	Infra-structure	Int'l shipments	Logistics competence	Tracking & tracing	Timeli-ness
Taiwan	2007	3.64	3.25	3.62	3.65	3.58	3.6	4.18
	2010	3.71	3.35	3.62	3.64	3.65	4.04	3.95
	2012	3.71	3.42	3.77	3.58	3.68	3.72	4.1
	2014	3.72	3.55	3.64	3.71	3.60	3.79	4.02

Source: extracted and compiled from World Bank LPI database

Step 2:

Select the country or countries to be benchmarked.

The focal country can actually identify the LPI indicators with lower ranks/scores and develop logistics policy to improve these areas without looking at LPI indicator ranks/scores of the other countries. However, this poses some risks of choosing the wrong areas to improve because a low rank/score of a LPI indicator of the focal country might be higher than that of the competing or benchmarked countries.

Therefore, it is suggested that the focal country selects one or few countries of its choice for logistics performance benchmarking. The logic of selecting more than one benchmarked country is to be able to better identify the most suitable logistics areas for improvement. The criteria for choosing the benchmarked countries may be various for different focal countries. The selection motivation is to identify relatively stronger logistics performance areas of the benchmarked countries, i.e. relatively weaker areas of the focal country, and then in a later benchmarking step to develop national logistics policy to improve these weaker areas. Singapore, for example, has been the benchmarked country for the United Arab Emirates and Malaysia to help them set higher goals to enhance their national logistics performance. This step regarding how a focal country selects its benchmarking country(ies) would be an important research subject for further investigations in the future.

Taiwan selects Hong Kong, Japan, South Korea and mainland China as its benchmarked countries because these countries all locate in East Asia and have close economic and trade ties with Taiwan. Furthermore, they are all very aggressive in developing their national logistics systems to compete in East Asia. Even though Singapore and Netherlands are further away geographically from Taiwan, both are the first tier LPI ranking countries and the role models for many other countries regarding the effectiveness and the efficiency of their national logistics systems. Both countries are benchmarked by Taiwan government in many aspects, the national logistics, in particular.

Step 3:
Assess the logistics performance of the benchmarked country(ies) using the most recent WB LPI database.

Using the same method as step 1, the benchmarked country(ies) is (are) assessed on its (their) logistics performance using the most recent LPI database.

Step 4:
Calculate the ranking gaps of LPI index and six LPI indicators between the focal country and each benchmarked country (i.e. a pairwise comparison for each benchmarked country with the focal country) to obtain the aggregate benchmark scores.

The logic for using rank rather than score can be explained by Table 3, in which Taiwan is the focal country and the other countries are benchmarked. The ranks and scores of the LPI index and indicators are all listed in the table and the range of each column is also calculated in the bottom line. The ranges of rank values of LPI indicators are between 22 (infrastructure) and 35 (customs), while the ranges of score values are between 0.27 (international shipment) and 0.8 (customs). The standard deviations of the rank value range and the score value range are 19.93% and 30.50% of the mean, respectively. Given the higher variability of the score value range with extreme values and for the easier cognition of the information by the analysts, we suggest using rank value in this benchmarking analytics step. Another alternative is to normalize the score values to allow better reading of numbers. However, the

normalization requires more computation and the normalized scores may cause more confusion. Therefore, the rank values seem to be a better choice than the score values or the normalized score values.

With the rank values of the focal country and its benchmarked country(ies) regarding the LPI index and six LPI indicators, the focal country can then calculate the rank value differences of the index and indicators between the focal country and each benchmarked country, i.e. a pairwise benchmarking between the focal country and a benchmarked country on LPI index/indicators' rank values. Within-country benchmarking is done first, followed by cross-country benchmarking. Table 4 illustrates the computation of the within-country and cross-country rank value gaps between LPI index and LPI indicators of Taiwan as the focal country and Japan as the benchmarked country.

TABLE 3. 2014 RANKS AND SCORES OF LPI INDEX AND SIX LPI INDICATORS OF TAIWAN AS THE FOCAL COUNTRY AND ITS SIX BENCHMARKED COUNTRIES.

Country	LPI Index		LPI Indicators											
	LPI		Customs		Infra-structure		Int'l shipments		Logistics competence		Tracking & tracing		Timeliness	
	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score
Netherlands	**2**	**4.05**	4	3.96	3	4.23	11	3.64	**2**	**4.13**	**6**	**4.07**	**6**	**4.34**
Singapore	5	4.00	**3**	**4.01**	**2**	**4.28**	6	3.70	8	3.97	11	3.90	9	4.25
Japan	10	3.91	14	3.78	7	4.16	19	3.52	11	3.93	9	3.95	10	4.24
Hong Kong	15	3.83	17	3.72	14	3.97	14	3.58	13	3.81	13	3.87	18	4.06
Taiwan (focal)	19	3.72	**21**	**3.55**	**24**	**3.64**	**5**	**3.71**	25	3.60	25	3.79	25	4.02
Korea	21	3.67	24	3.47	18	3.79	**28**	**3.44**	21	3.66	21	3.69	28	4.00
Mainland China	**28**	**3.53**	38	3.21	23	3.67	22	3.50	**35**	**3.46**	**29**	**3.50**	**36**	**3.87**
Range	26	0.52	35	0.80	22	0.64	23	0.27	33	0.67	23	0.57	30	0.47

Source: extracted and compiled from World Bank LPI database

TABLE 4. PAIRWISE BENCHMARKING RANK VALUE COMPUTATION FOR TAIWAN AS THE FOCAL COUNTRY AND JAPAN AS A BENCHMARKED COUNTRY.

Country		LPI Index	LPI Indicators					
		Index	Customs	Infra-structure	Int'l shipments	Logistics competence	Tracking & tracing	Timeliness
Taiwan (focal)	Rank	19	21	24	5	25	17	25
	Within-country difference	(0)	(-2)	(-5)	(+ 14)	(-6)	(+2)	(-6)
Japan	Rank	10	14	7	19	11	9	10
	Cross-country difference	(-9)	(-7)	(-17)	(+14)	(-14)	(-8)	(-15)
Benchmark score		(-9)	(-9)	(-22)	(+28)	(-20)	(-6)	(-21)

Source: extracted and compiled from World Bank LPI database

For within-country benchmarking, the bracket numbers in the row of Taiwan in Table 4 are the rank value differences between Taiwan's LPI index and itself or each LPI indicator. Within-country benchmarking of Taiwan LPI index has a value of (0) because it does a self-benchmarking, i.e., the difference between 19 and 19 is zero. Within-country benchmarking of Infrastructure indicator, for example, is (-5) which is the difference between 19 and 24. This can be explained as the ranking of infrastructure is dragging down Taiwan's LPI ranking by 5. While for international shipments indicator, the rank value difference is (+14) representing its uplifting the ranking by 14, which is the difference between 19 and 5. From the rank value difference calculating results, it can be seen that four indicators with negative values drag down Taiwan's LPI index ranking while two indicators with positive values raise up Taiwan's LPI index ranking.

In Table 4, for the pairwise cross-country benchmarking, each value in the rank row of Japan is subtracted by the corresponding value in the rank row of Taiwan. This will calculate the rank value differences of the LPI index and indicators between two countries with Taiwan as the focal country. It is clear Taiwan has a rank value difference of 9 behind Japan on the LPI index. Similarly, five LPI indicators are behind and one LPI

indicator is ahead Japan with the rank value difference shown in the brackets. Adding the cross-country rank value differences and within-country rank value differences, the benchmark scores are obtained as shown in the bottom line in Table 4.

Adding each cross-country rank value difference to the corresponding within-country rank value difference will augment the benchmarking effect. For example, the benchmark score of the Customs indicator at (-9) in Table 4 is obtained by adding within-country difference (14-21 = -7) and cross-country difference (19-21 = -2), i.e. (-7) + (-2) = (-9). With the addition of two difference values, the benchmark score of the Customs indicator between Taiwan and Japan has clearly augmented, that is, the Customs' performance is poorer than using just within-country or cross-country rank value difference as the benchmark score.

TABLE 5. BENCHMARK SCORE TABLE AND AGGREGATE BENCHMARK SCORE WITH TAIWAN AS THE FOCAL COUNTRY AND ITS SIX BENCHMARKED COUNTRIES.

	LPI index	LPI Indicators					
Benchmark Score / Country	Index	Customs	Infra-structure	International shipments	Logistics competence	Tracking & tracing	Timeliness
Netherlands	-17	-19	-26	20	-29	-9	-25
Singapore	-14	-20	-27	15	-23	-4	-22
Japan	-9	-9	-22	28	-20	-6	-21
Hong Kong	-4	-6	-15	23	-18	-2	-13
Taiwan (focal)	0	-2	-5	14	-6	2	-6
South Korea	2	1	-11	37	-10	6	-3
Mainland China	9	15	-6	31	4	14	5
Aggregate Benchmark Score	-33	-40	-112	168	-102	1	-85

Source: extracted and compiled from World Bank LPI database

If more than one country is selected for national logistics benchmarking, the focal country would need to conduct a pairwise benchmark score calculation for each country as illustrated in Table 4. After all pairwise benchmark scores are obtained, the aggregated benchmark scores of the focal country can then be calculated by adding up benchmark scores of all benchmarked countries with respect to the LPI index and the corresponding LPI indicators as illustrated in Table 5.

An aggregate benchmark score (ABS) can be interpreted as an augmented benchmark score on the related measure when the benchmarked countries are more than one. Infrastructure indicator, for example, has the lowest ABS in Table 5; the next one would be logistics competence, followed by timeliness and customs. The ABSs of these four LPI indicators all get negative values showing the weaker areas of Taiwan's national logistics performance.

Step 5:
Identify LPI indicators with lower aggregate benchmark scores as the weak areas of the logistics performance and develop national policies to improve these weak areas.

With the aggregate benchmark scores of the six LPI indicators, the focal country can rank these scores from the lowest to the highest. The indicators in the top of the ranking list, particularly for those with extremely high negative scores, are weak areas that the focal country should emphasize with its improvement efforts. In Table 5, for example, both infrastructure and logistics competence have extremely high negative aggregate benchmark scores. They are the best candidates for the development of Taiwan national logistics improvement policies.

Once the weak areas are identified in Step 5, the focal country needs to set up a special task force at the right governmental level, normally with inter-departmental nature, to develop proper national logistics policies and designate the proper departments to implement the policies and improve these weak areas. This may be a challenge for countries or economies such as U.S., mainland China, or Taiwan since the value of logistics at a national level may not be well understood or even worse is logistics activities are divided into and administered by different departments with poor coordination. With the strong evidence of the weakest areas identified in step 4, it is a matter of the government to either grasp or let go of the improvement opportunities. In our opinion, no more than two weakest LPI indicators should be chosen for improvement since it may be too challenging to tackle the problems of all LPI indicators at the same time.

Steps 1 to step 5 may take three to six months to complete with the right organizational set-up and central support. The implementation of the national logistics policies can not start until these policies are developed. Thus, the policy implementation time may take from 18 to 21 months before the next bi-annual WB LPI announcement. It is important to develop metrics to measure the policy effectiveness and track these metrics while the policies are being implemented.

Step 6:
Implement the national logistics improvement policy until the World Bank announces the next WB LPI survey results and go back to step 2 to start a new improvement cycle.

National logistics improvement implementation initiatives often require cross-departmental and public-private joint efforts in the focal country. For example, building up a single window web platform to process the electronic documents required by various governmental departments for businesses in the global supply chain would have such requirements. The single window system is an important information infrastructure highly

needed in countries with intensive trade volumes. It has been successfully built by Singapore (i.e TradeXchange) and Hong Kong (i.e Tradelink) but still not widely seen in the world.

Once the World Bank announces the next WB LPI survey results and the focal country can go back to step 2 and start a new improvement cycle for its national logistics system. This recursive cycle is the embedded continuous improvement mechanism in the national logistics performance benchmarking process typically seen in business processes designed based on BPM logic and quality improvement projects (Nicholds and Mo, 2016; Zairi, 1997).

Step 7:
Assess innovation policy implementation effects and observe its impact on the ranking change of the related WB LPI index (or indices).

Due to the improvement efforts put into the weak areas in the national logistics system, it is likely that LPI rankings and scores of the focal country may be improved in the new LPI survey database. The focal country should track and compare those statistics with the previous one when they are available and use the comparison results as a reference for the policy effectiveness assessment.

Step 8: Adjust innovation policy and implementation strategy if necessary to further improve the national logistics performance.

When the logistics improvement initiatives do not achieve their expected results or planned goals, the governmental unit in charge should evaluate the reasons and identify barriers causing the problems. With the understanding of the problems, the focal country may need to adjust the policy and implementation strategy to overcome those barriers and continue to improve the weak areas of its national logistics system.

V. CASE STUDY AND PROCESS VALIDATION

Using Taiwan as the focal country, the national logistics performance benchmarking process designed in this study is validated for its applicability in this section.

Taiwan is an island with constrained natural resources for the industrial and consumer goods production. Nevertheless, Taiwan is also an export-based economy that needs to import many raw materials and machineries for the production of exporting goods. International logistics is the life blood for Taiwan's busy trade with many other countries in major economic blocks. Thus, using Taiwan as an example to illustrate the use of the generic benchmarking methodology developed in this paper should be a proper choice.

Since the publication of the LPI survey report in 2007 by the World Bank (Arvis et al., 2007), the Taiwan National Development Council has been tracking the index and has initiated several studies to understand better the value of LPI information and its implications to the national logistics policy making. With these research outputs available, this is the second reason for choosing Taiwan as the case for the validation of the benchmarking process.

The methodology developed in Section 4 is based on a recent study supported by the Institute of Transportation, Ministry of Transportation and Communications in Taiwan (IOT, 2014). An earlier version of the methodology was published in a conference proceedings (Su and Ke, 2015). In the beginning, this was a research project from Taiwan government conducted by one of the authors and the focus was only on the data analytics and policy analysis aspects (step 2-4 and step 5) without even the concept of a

management process. However, the original research results were good regarding showing the weak areas and designing policies. But it is only a one-time effort not good for the management. Therefore, after further research and dialogue with policy makers and business experts, BPM logics popular in businesses are adopted and additional steps (step 1 and step 6-8 are added to the benchmarking method) are added. The earlier version of the methodology is revised with the BPM theory and the revised methodology is further validated by Taiwan's application in this paper.

Step 2 and step 5 in section 4 will be elaborated using Taiwan as the focal country to validate the national logistics performance improvement policy development process.

First, regarding step 2 in Fig. 5, six countries are chosen for the Taiwan study. All but the Netherlands are from Asia. The reasons to choose the Netherlands are: strong EU logistics gateway status, efficient ocean port and airport, similar size in population and geography, export-oriented nation, and high LPI ranking. Singapore is the only country in Southeast Asia selected for benchmarking. The reasons for choosing Singapore include strong Asian logistics gateway status, efficient ocean port and airport, a major trade hub in Asia, highly efficient customs procedures, and high LPI ranking. Hong Kong is deemed as the direct competitor in the regional logistics business with Taiwan. The reasons for choosing Hong Kong are: leading competitor to learn from, free port status, a major logistics gateway to Mainland China, and geographic proximity. Japan has a close trading and technology business relationship with Taiwan due to the colonial relationship for 50 years in the early 20th century. The reasons for choosing Japan include: an island country similar to Taiwan, good logistics infrastructure and a strong trading country. South Korea and Mainland China rank behind Taiwan in LPI in 2014. Since South Korea and Mainland China are two key players of trade in East Asia and maintain a subtle co-opetition relationship with Taiwan, they are also selected into the benchmarking group for this study. Therefore, the country selection step chooses the countries of interest to the focal country rather than the countries with better LPI scores. This is the major difference between the national logistics performance benchmarking process and the traditional business benchmarking method which chooses only better firms in a study.

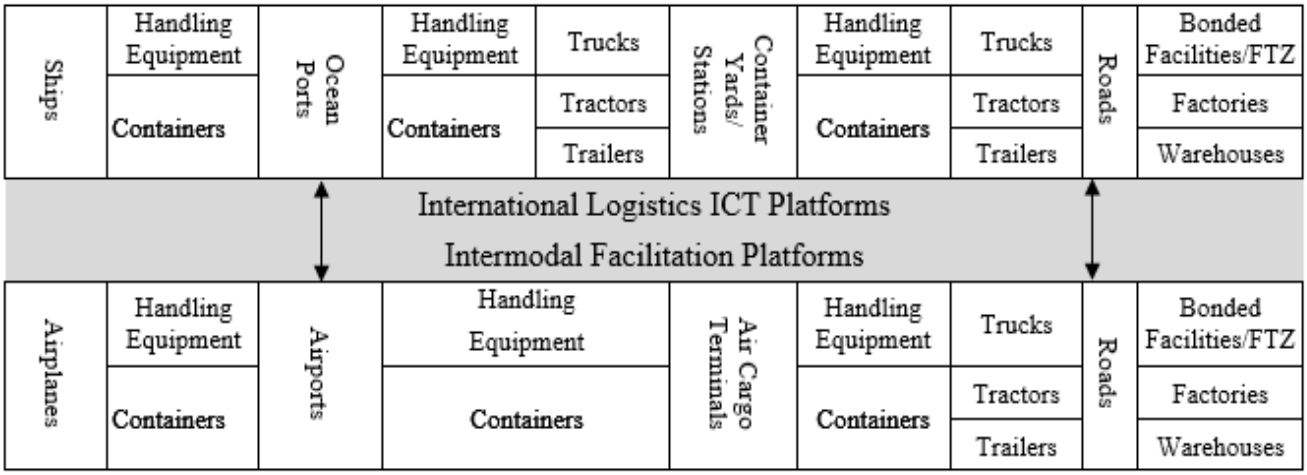
In Table 5, there are four LPI indicators (customs, infrastructure, logistics competence, and timeliness) with negative aggregate benchmark scores. They are all good candidates to select for further policy analysis in step 5 of the benchmarking process. However, should all four indicators be selected for further policy analysis? Our suggestion is not to do so. Since LPI indicators are all defined at the macro-level, the policy analysis of any indicator requires undertaking substantial efforts from the focal country. Therefore, one or two indicators with the lowest scores, i.e., infrastructure and logistics competence in Taiwan's case, should be top candidates for further policy study.

After a careful review of the international logistics infrastructure in Taiwan at a macro-level, a snapshot is depicted in Fig. 4. It includes 17 subsystems such as ships, handling equipment, trucks, containers, air cargo terminals, international logistics ICT platforms, roads, bonded facilities/free trade zones (FTZ), et al. Each subsystem is subject to local regulations, is run by some operators, relates to other subsystems, relies on certain technologies, and is owned by either public or private organizations. It is very challenging to improve the performance of these subsystems as an integrated system. Many factors influencing infrastructure subsystems are intertwined to allow inflow and outflow of international goods to cross national borders. When developing the national logistics policy to enhance the infrastructure performance, the

focal country needs to review not just hard issues but also soft issues to identify key improvement opportunities.

In Taiwan, the soft issues are probably much more critical than hard issues regarding improving the logistics infrastructure performance. Throughout the years, Taiwan government has created many regulations, rules, and organizations to develop its trade-based economy. The older systems exist while at the same time newer systems are developed such that the resources deployed to and the rules set up for the operations of the logistics infrastructure are overlapping and quite often redundant at the expense of the efficiency and effectiveness of the international goods flow. Furthermore, there are many interfaces between the subsystems of the infrastructure with subpar integration and coordination. The transfers of goods among different customs jurisdiction regions, for example, are often slowed down due to the conformance of the additional shipping documents required or the shortage of the bonded trucking services.

Thus, at the highest level of the national logistics policy making, the vision is to "Allow legal trade cargos to enter and exit R.O.C. (Taiwan) national border and arrive at the destination in a faster, better, and more sustainable way." With the vision as the guiding principle, there are many integration needs to be dealt with. Thus, a cross-ministry organization in the government should be established first at the central level to develop the infrastructure integration policies for the infrastructure users, particularly for those heavy users. This organization should be responsible for the integration efforts regarding policy implementations and oversight. One such infrastructure integration issue demanding better policy will be illustrated next.



Source: Analysis based on Taiwan's current International logistics infrastructure configuration

FIGURE 4. A FRAMEWORK OF INTERNATIONAL LOGISTICS INFRASTRUCTURE SYSTEM – TAIWAN PERSPECTIVE.

Taiwan is an isolated island. Therefore, the international goods are shipped either by ocean or by air and then moved by trucks to their destinations. Since there are six international seaports, one major international airport, many types of specialized international trade/industrial zones and domestic industrial parks, the movement of the international goods between these restricted zones and domestic areas are frequent. However, since these goods are subject to the monitoring and regulations of the customs and local authorities, the movements of the goods between the restricted zones and domestic areas must be approved by various regulating bodies before the moving. The movements of the goods often require the use of the licensed bonded trucks. Furthermore, there exists a serious communication problem between the regulating bodies and traders/private logistics operators when interpreting the rules regulating the cargo movements. This phenomenon depicts a problem more of a soft rather than a hard issue, as discussed previously. A good treatment of the problem is in great need by a cross-ministry effort. Only when the above mentioned problems are solved, can the cargo flows between trade-related restricted zones and production facilities be enhanced to the level of the first-tier logistics performance countries.

Semiconductor industry represents the most important industry for Taiwan's economy in the last 10 years. Semiconductor trade has ranked first in the last 10 years in Taiwan's international trade statistics. Table 6 showed the statistics of the semiconductor export/import trades from 1999 to 2013. However, due to the soft and hard infrastructure issues discussed above, the cross-border logistics has become the key barrier or opportunity.

TABLE 6. TAIWAN SEMICONDUCTOR EXPORT AND IMPORT TRADE VALUES IN THE NATION.

Year	Export Ranking	Export (Billion$)	% of Total Export	Import Ranking	Import (Billion$)	% of Total Import	Total Trade Sum
1999	1	377	18.49%	1	247	14.18%	624
2010	1	502	18.28%	1	329	13.12%	831
2011	1	555	18.01%	1	340	12.09%	895
2012	1	579	19.22%	2	315	11.64%	894
2013	1	628	20.57%	2	317	11.76%	945

Source: calculated from the open trade flow database of the Taiwan Customs

TABLE 7. TAIWAN TRADE STATISTICS OF SEMICONDUCTORS IN MAJOR REGIONS AND MAJOR ASIAN COUNTRIES.

Measure / Region	KGM	KGM (%)	Accumulated KGM (%)	Value (US$1,000)
Asia	33,955,686	93.72%	93.72%	59,950,023
North America	1,079,971	2.98%	96.70%	1,398,480
Europe	814,996	2.25%	98.95%	1,158,460
Measure / Country	KGM	KGM (%)	Accumulated KGM (%)	Value (US$1,000)
Hong Kong	11,726,032	34.53%	34.53%	19,014,571
Mainland China	9,500,655	27.98%	62.51%	13,051,806
Singapore	5,741,207	16.91%	79.42%	11,773,454

Source: calculated from the open trade flow database of the Taiwan Customs

After a detail 2013 trade flow analysis of the semiconductor industry, it is found that close to 94% of the produced semiconductors are shipped to Asia and the top three economies in Asia are Hong Kong (34.53%), mainland China (27.98%) and Singapore (16.91%) as seen in Table 7. After the internal discussions and the further consultation with logistics experts in the industry, the findings clearly indicate that after manufacturing in Taiwan, many semiconductors are shipped to Hong Kong and Singapore for the redistribution purpose, rather than value-adding manufacturing due to the lack of regional logistics hub facilities and a poor related cross-border cargo facilitation procedure.

Thus, using the generic benchmarking process in Fig. 3, a modified benchmarking process is developed for Taiwan to focus on developing the national logistics improvement policies for the semiconductor logistics hub facilities and related cross-border cargo facilitation procedure. The modified process is presented in Fig. 5.

In summary, using Taiwan as an example, this section elaborates on two key steps (step 2 and step 5) of the benchmarking process discussed in section 4. Taiwan logistics infrastructure with the highest priority for policy analysis is also analyzed as a large system containing 17 subsystems and discussed in detail regarding the problems and possible resolutions for the international goods movement between trade-related restricted zones and production facilities in domestic industrial zones. The infrastructure supporting the semiconductor industry, the largest industry in Taiwan, is analyzed by the generic benchmarking process with modification to validate and illustrate the benchmarking process applicability.

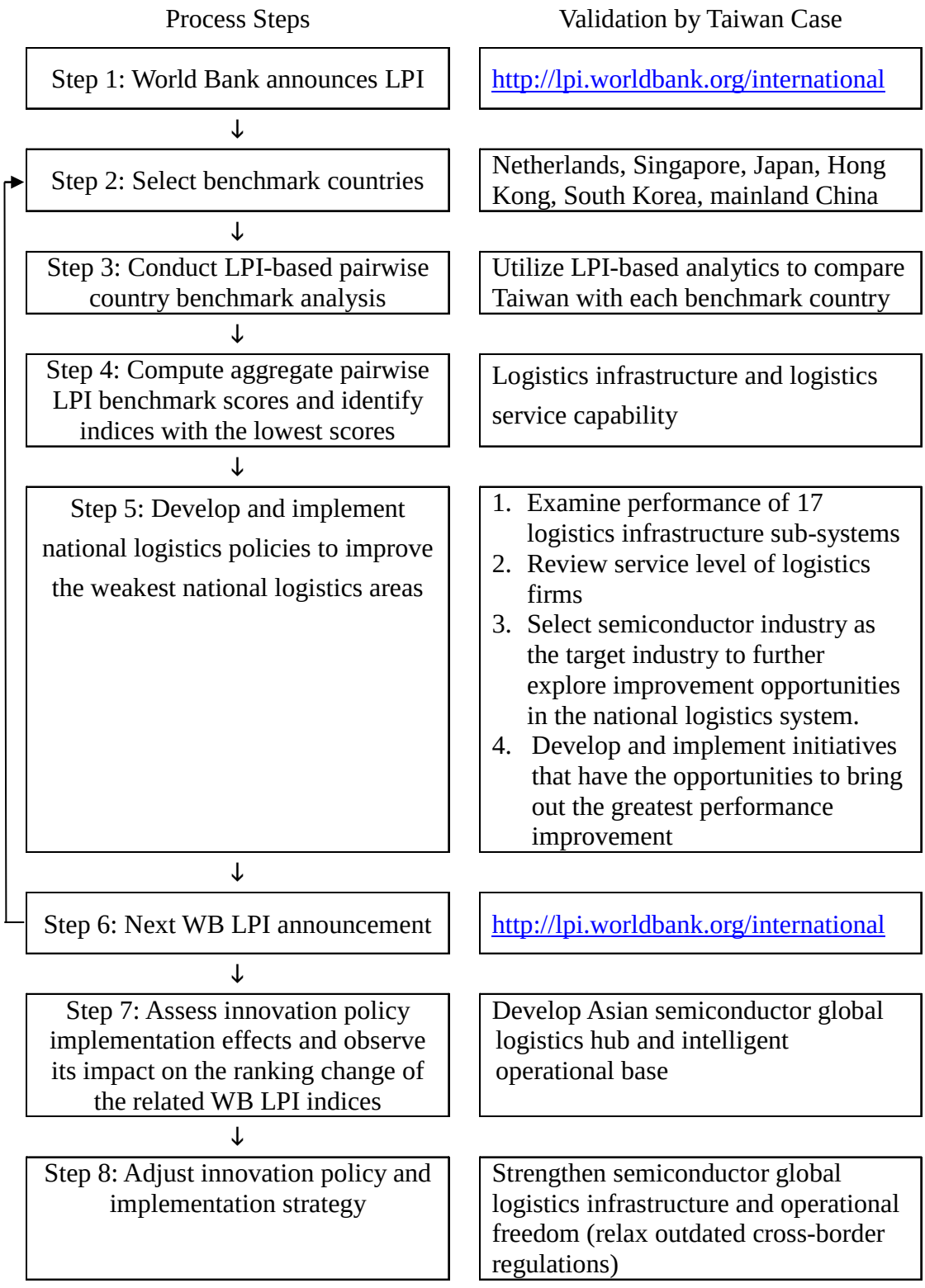


FIGURE 5. VALIDATING THE PROCESS BY THE CASE OF TAIWAN .

VI. DISCUSSION AND CONCLUSION

The most recent LPI survey results (Arvis et al., 2014, 2016) showed that 60% of the surveyed countries are either "logistics unfriendly" or "partial performers" while only 40% are "consistent performers" or "logistics friendly." This result implies strongly that the logistics performance disparity exists as a norm and many countries are performing poorly comparing to the top performers. However, the global trade connectivity relies on the collective logistics performance of each individual country in the world. Thus helping countries with low LPI rankings to identify logistics performance weak areas to develop proper national logistics improvement policies would be critical for a better connected global trade network.

Even until now, for many country, it is still a highly challenging job to measure and manage their national logistics performance due to its cross-ministry administration nature and many other complexities involved in moving international goods across national borders. WB LPI database is currently the only source that provides the national logistics performance measures of most countries in the world. There are critics regarding WB LPI's validity in measuring national logistics performance. Nevertheless, the survey's global coverage and the simplicity of the aggregated metrics still give WB LPI database the reputation as a highly regarded measurement system for national logistics performance.

WB LPI database allows a country to compare its logistics performance to the other country with a radar diagram but it does not provide the performance gap statistics and also not address the national policy concerns. Thus, WB LPI by itself is inadequate to support the benchmarking study for a focal country to identify the weak areas of its national logistics and, thereafter, formulate national logistics policies for improvement. Few literature can be found regarding the national logistics performance benchmarking with or without the use of WB LPI database (Hausman et al., 2013; IOT, 2014; Moise, 2005; Saslavsky and Shepherd, 2013). Even more dissatisfying, these literature do not take a process view that is very important for managing national logistics systems.

This paper has designed a generic national logistics performance benchmarking process applying the BPM logic with an embedded continuous improvement mechanism. This is a major contribution of the paper that adds to the extant literature of the national logistics management and, in particular, provides a process-based practical approach for countries lack of a systemic national logistics management experiences to exercise and learn how to better manage their national logistics systems.

Not all business process improvement (BPI) projects are successful, as experienced by Whittaker (1999) where 45 per cent of improvement projects did not deliver the expected benefits. BPI requires a good project management approach to coordinate and decide on a range of factors in a structured manner (Chattopadhyay and Mo, 2011). The benchmarking process developed in this paper takes a structured and continuous improvement process utilizing the WB LPI benchmarking analytics to aid the focal country to prioritize the weak areas of its national logistics system for the improvement efforts. The BPM logic designed into the benchmarking process increases the probability of success of the logistics performance improvement initiatives (Rohleder and Silver, 1997).

The WB LPI analytics developed in step 4 and step 5 of the benchmarking process (see Table 4 and 5) provide a more robust benchmarking result than that of the traditional country LPI indicator ranking and scores (see Table 1 and 2). The augmented effects delivered by WB LPI analytics allows the

focal country to identify the weak logistics performance areas with more confidence. Thus, developing and validating WB LPI analytics is another major contribution of this study.

This study also extends the WB LPI researches of the Taiwan government and use Taiwan as a case to validate step by step the applicability of the benchmarking process. This effort has increased the understanding of the benchmarking process and, thus, the value of the process to the potential countries interested in applying the benchmarking method. This is also a major contribution of the study. Since the 2016 result is already available, Taiwan government should conduct its second cycle analysis to examine the effects of its past efforts and develop plans for the improvements of the new weak areas in the future.

Since the benchmarking process developed in this paper is still in its novelty stage, there are not many practical experiences a country can learn from. However, it is a systematic methodology with an embedded continuous improvement mechanism that any country can follow and create its unique version of the benchmarking approach. Future researches can introduce more countries for step-4 and -5 analysis and, based on Taiwan's experiences, and compare and contrast the results.

We hope that this paper provides enough information and insights to let countries in the LPI database understand better the meaning and value of a national logistics performance benchmarking effort and hopefully inspire them and logistics scholars to initiate more national logistics performance benchmarking studies, particularly for those countries that are "logistics unfriendly".

REFERENCES

Arvis, J.F., Mustra, M.A., Panzer, J., Ojala, L. and Naula, T., *Connecting to Compete 2007-Trade Logistics in the Global Economy: The Logistics Performance Index and Its Indicators*, The World Bank, Washington, D.C., 2007.

Arvis, J.F., Mustra, M.A., Ojala, L., Saslavsky, D. and Shepherd, B., *Connecting to Compete 2010-Trade Logistics in the Global Economy: The Logistics Performance Index and Its Indicators*, The World Bank, Washington, D.C., 2010.

Arvis, J.F., Mustra, M.A., Ojala, L., Shepherd, B. and Saslavsky, D., *Connecting to Compete 2012-Trade Logistics in the Global Economy: The Logistics Performance Index and Its Indicators*, The World Bank, Washington, D.C., 2012.

Arvis, J.F., Saslavsky, D., Ojala, L., Shepherd, B., Busch, C. and Raj, A., *Connecting to Compete 2014: Trade Logistics in the Global Economy-The Logistics Performance Index and Its Indicators*, The World Bank, Washington, D.C., 2014.

Arvis, J.F., Saslavsky, D., Ojala, L., Shepherd, B., Busch, C., Raj, A. and Naula, T., *Connecting to Compete 2016-Trade Logistics in the Global Economy: The Logistics Performance Index and Its Indicators*, The World Bank, Washington, D.C., 2016.

Chattopadhyay, S. and Mo, J.P.T., The pentatomic face of organizations, In Sarlak, M.A. (ed.), *The New Faces of Organizations in the 21st Century*, Chapter 5, NAISIT Publishers, 2011, 188-233.

Ferrantino, M., Geiger, T. and Tsigas, M., The benefits of trade facilitation – a modelling exercise, In World Economic Forum (ed.), *Enabling Trade - Valuing Growth Opportunities Online Appendix*, Bain & Company, and World Bank, World Economic Forum, Geneva, 2013.

Goldkuhl, G. and Lind, M., "Coordination and transformation in business processes: towards an integrated view", *Business Process Management Journal*, 14(6), 2008, 761-777.

Hausman, W.L., Lee, H. and Subramanian, U., "The impact of logistics performance on trade", *Production and Operations Management*, 22(2), 2013, 236-252.

Hoekman, B., and Nicita, A., "Assessing the Doha round: market access, transactions costs, and aid for trade facilitation", *Journal of International Trade and Economic Development*, 19(1), 2010, 65-79.

IOT, *Develop Analytical Approach for the National Goods Flow and Logistics Competitiveness Analysis*, Institute of Transportation (ed.), Ministry of Transportation and Communication, Taipei, Republic of China (Taiwan), 2014.

Kova´cs, G. and Spens, K.M., "Humanitarian logistics in disaster relief operations", *International Journal of Physical Distribution & Logistics Management*, 37(2), 2007, 99-114.

Kova´cs, G. and Spens, K.M., "Identifying challenges in humanitarian logistics" *International Journal of Physical Distribution & Logistics Management*, 39(6), 2009, 506-528.

LaValle, S., Lesser, E., Shockley, R., Hopkins, M. S. and Kruschwitz, N. "Big Data, Analytics and the Path From Insights to Value", *MIT Sloan Management Review*, 52(2), 2011, 21-32.

Lee, R.G. and Dale, B.G., "Business process management: a review and evaluation", *Business Process Management Journal*, 4(3), 1998, 214-225.

Manyika, J., Bughin, J., Lund, S., Nottebohm, O., Poulter, D., Jauch, S. and Ramaswamy, S., *Global Flows in a Digital Age: How Trade, Finance, People, and Data Connect the World Economy*, McKinsey Global Institute, New York, 2014.

Mellat-Parast, M. and Spillan, J. E., "Logistics and supply chain process integration as a source of competitive advantage", *International Journal of Logistics Management*, 25(2), 2014, 289 – 314.

Moise, E., "Trade Facilitation Reforms in the Service of Development: Country Case Studies" *OECD Trade Working Paper No. 12*, 2005.

Nicholds, B. A. and Mo, J. P.T., "Estimating performance from capabilities in business process improvement", *Business Process Management Journal*, 22(6), 2016, 1099-1117.

Rantasila, K. and Ojala, L., "Measurement of National-level Logistics Costs and Performance" *OECD International Transport Forum Discussion Paper No. 2012-4*, OECD, Paris, 2012.

Rohleder, T.R. and Silver, E.A., "A tutorial on business process improvement", *Journal of Operations Management*, 15(2), 1997, 139-154.

Saslavsky, D. and Shepherd, B., "Facilitating International Production Networks: The role of Trade Logistics." *Journal of International Trade & Economic Development: An International and Comparative Review*, 23(7), 2013, 979–999.

Sever, K., "The power of process orientation", *Quality Progress*, 40(1), 2007, 46-52.

Su, S. I. and Ke, J., "National Logistics Performance Benchmarking for Trade Connectivity – an Innovative Approach Using World Bank Logistics Performance Index Database", *2015 International Conference on Global Integration of Economies and Connectivity Development* in collaboration with Asian Logistics Round Table (ALRT), Soochow

University, Taipei, Taiwan, August 31-September 1, 2015.

van Buren, N., Demmers, M., van der Heijden, R. and Witlox, F., "Towards a Circular Economy: The Role of Dutch Logistics Industries and Governments", *Sustainability*, 8(647), 2016, 1-17.

Whittaker, B., "What went wrong? Unsuccessful information technology projects", *Information Management and Computer Security*, 7(1), 1999, 23-29.

World Bank, *Doing Business 2015: Going Beyond Efficiency*, World Bank, Washington, DC, 2014.

World Economic Forum, Bain & Company, and World Bank, *Enabling Trade - Valuing Opportunities*, World Economic Forum, Geneva, 2013.

Zairi, M., "Business process management: a boundaryless approach to modern competitiveness", *Business Process Management Journal*, 3(1), 1997, 64-80.