

AN EMPIRICAL ASSESSMENT OF ELECTRONICS AND COMPUTER SOFTWARE TRADE LOGISTICS PERFORMANCE IN INDIA

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Abstract

It is an empirical study which has been conducted to explore the area of concern in the logistics operation based on the responses collected from exporters of electronics and computer software and freight forwarders experienced during course of export and import consignment. The global LPI is being calculated on every 2 years by the world bank reflecting the logistics friendliness and competitiveness of the different countries, where India stands on 38th Position out of 139 countries in according to WB LPI 2023 report. This study has tried to explore the area in which government is supposed to take improvement measures based on the traders and freight forwarders perception towards logistics mechanism with special reference to electronics and computer software items export and import. The study is based on primary data collected through structured questionnaire developed along eight finalised indicators to measure logistics performance in electronics and computer software trade. To reach the inference, principal component analysis method, normalised weighting method and sensitivity analysis have been used which reflect that information system and prices paid during the logistics operation at different points are two major area with which traders and freight forwarders are satisfied, whereas other indicators need further improvement to have an overall efficient logistics mechanism for the export and import of electronic products and that of the computer allied articles as well.

Keywords: Electronics and Computer Software, Trade, Logistics, Performance Measurement, Principal Component Analysis (PCA).

Introduction

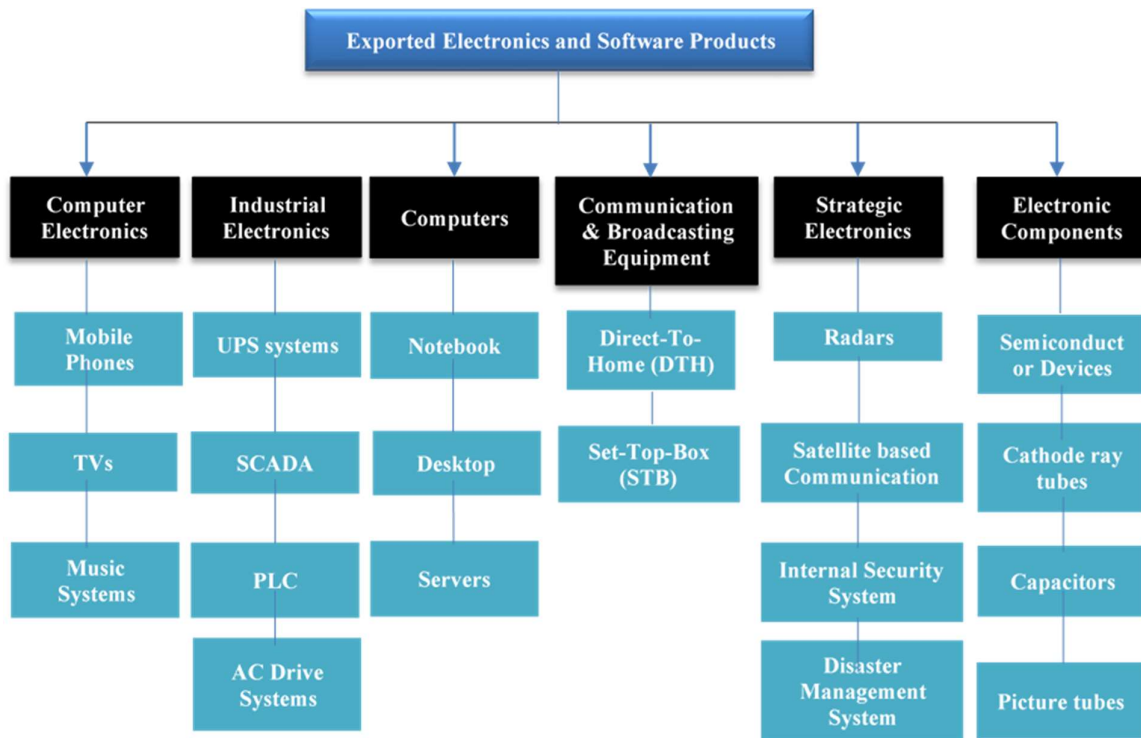
Electronics and IT Sector is providing to be the catalyst of growth in the modern era and giving boost to economies of the world. Over the decade, the Electronics and software industry has evolved to offer several innovative products for the convenience of the mankind. Electronics is playing a major role in their everyday routine activities. The Electronics hardware industry is identified as one of the fastest growing segments in terms of international trade.

Various liberal policy initiatives of the Government of India in the last decade have propelled the Indian Industry on to a path of prosperity and development. IT Industry continues to transition to build digital solutions for the world and evangelize this shift. IT industry showcased transformation journey in last few years and are adding business value to global customers. Indian IT-BPM companies have been expanding their geographic footprint for several years now. The Electronics Hardware and IT industry a is a comparatively new entrant in India's export horizon but runs ahead among other industries and has been consistently showing an upward growth trend. The implementation of the Schemes/ programmes under the

aegis of the National Policy on Electronics 2012 (NPE 2012) has successfully paved the way for a competitive Indian ESDM value chain under NPE 2019.

The IT has industry has shaped up as a major success story in Indian’s Economy. Exports of Computer Software have become large component of the total exports of the country. The contribution of the Government in the growth of this industry consist of telecom policies, which enabled a low-cost computer Networking in the country and investments in Human Capital as such through IITs. Today, India competency in IT Technology significantly in Computer Software and IT enabled Services is recognized globally.

The electronic hardware and computer software/ services industry, a comparatively new entrant in India’s export horizon, has emerged as a fore-runner among all industries and has been consistently trending on a high growth path in recent years. It is not only contributing significantly to the employment and income generation, but also increasing the productivity growth in other sectors and innovation across the country.



Source: Compiled from ASSOCHAM Report

Figure1: A Schematic Presentation of Majorly Traded Products under Electronics

An innovation in electronics and computer software sector develops within itself several regional centres of economic strength which is describe as the "propulsive industry" (Hirschman, 1998). Consider the case of the United States, where electronic hardware has helped spawn a host of downstream service industries, including computer system development facilities, telecommunications, as well as data processing, hosting and associated information services. Electronics and computer software sector are supplementary to all other industries, including retail and wholesale trade, transportation, finance, real estate, education, professional services, manufacturing etc. As these sectors rely on heavy use of computers and information

technology. The pervasive application of all the products of electronics sector makes the sector paramount. At present, the industry is broadly classified into six major categories.

Electronics and software in India is great driver of the economic development by virtue of its contribution in production and export. Export of Electronics and software goods & services from India during the year 2018-19 registered a growth of 9.6 percent over the year 2017-18. In value terms, export of electronics & IT services during the year 2018-19 is estimated to be (US\$ 138172 million) as compared to US\$ 126072 million estimated in the year 2017-18.

Importance of Logistics in Electronics Industry

The role of logistics in the electronics industry has been increasing over the years due to sudden rise in consumer demand as new innovations are befalling each day. Due to cut-throat competition and to leverage the arising opportunities, firms all over the world are working towards providing the best quality of products at the right time and lowest possible costs. Successful companies of tomorrow will be those that drive supply chain collaboration (SCC) between manufacturers, retailers and consumers more strategically, creating new revenue opportunities, efficiencies, and customer loyalty (Anbanandam, et al., 2011)

The Electronic industry comprises of forecasting the demand, sourcing raw material sectors, processing & production, distribution and inventory management and a proper logistics system to carry the entire process smoothly. However, manufacturers need to pay more attention towards making an efficient supply chain in order to serve ever-changing consumer needs. The entire procedure together creates unpredictability, which requires investigation into each phase to comprehend elements like technology chain, Operational Consultancy and customizing the solution as per consumer needs. Indian electronic industry face challenges because of not having enough Manufacturing units, shortage of raw materials and skilled manpower. Therefore, boost should be given to country's manufacturing units through various schemes and subsidies. Therefore, streamlining the entire process will bring out clarity that leads to improvements in quality, capacity expansion and greater flexibility in manufacturing and leading reduction in cost of production. Economical Transaction: Bringing down cost of logistics is one of the most significant objective of all the efforts made by the government or an entity towards improvement of logistics operation and performance. Timely and safe movement of electronics cargo: Timely delivery is one of the most significant expectation of today's customer and most important criterion to influence customer satisfaction. Specifically electronics and technology based products have experienced high in time delivery expectation as can be experienced in personal business of life. Also the safety and security is one of the major concern in transportation of electronics items such as tracking system, anti-theft instruments, additional lock, proper packaging etc. are significant to be considered while electronics and computer items are in shipment. Technical Up-gradation: There are a variety of technological trends and innovations which have an impact on the use of information technology in logistics. Upgradation of information technology to support logistics operations across all industry sectors are very significant for successful and efficient integration and flexibility; EDI; hardware; and communications technology. Single Window Solution: A shipper (Exporter)/Importer has to go through a number of documentation and certification formalities i.e., from government authorities, customs, inspection agency, laboratory, port, freight-forwarders etc. availing these documents at different occasions is not an easy cup of

tea. There is also lack of proper and timely coordination among all the involved stakeholders which kills valuable time of the organisation and leads to unnecessary delay ultimately resulting in increase in cost, expiry of the products and even loss of business. Therefore, it is believed based on the responses of the exporters and importers that a single window system for processing all the documents can phase out a number of complexities existing during course of the cargo shipment and drawback. Also, a logistics provider should be held responsible for all sort of communication and coordination, updating client about shipment status, and enabling them to focus on quality and abundant production with improved supply chain process. International trade logistics depending on various shipment terms need timely coordination: Clients (Exporters/Importers) expect full transparency of cargo movement, multiple/diverse carrier option, timely delivery, and visibility from pick-up point to final destination of the delivery, but the logistics chain is victimized under various interruptions (depending on various stakeholders)

Literature Review and Indicators Identification

Several reports and studies (Chang and Lai, 2017; Deloitte, 2018; Koh et al., 2018; OCED, 2018; Yang, 2016; Yang and Lim, 2017; Taschner, 2016; Deloitte, 2018; Huscroft et al., 2013; World Bank, 2023) have been reviewed to understand the in-depth about calculation of index reflecting logistics performance. Based on the indicators used for developing the logistics performance index, trade index and port performance index a list of indicators have been listed and then 8 indicators have been finalised which were felt most relevant in the context of Electronics and Computer Software export from India. The index developed by OECD, World Bank, UNCTAD, Deloitte such as Enabling Trade Index, STRI, World Bank LPI, Trade Facilitation Index, Ease of Doing Business Index etc. have been reviewed to identify the indicators.

Index Calculating Agency	Objectives/ Measurement	Methodology	Indicators
TFI (OECD, 2017)	Trade Facilitation Index was developed to help governments improve their border procedures, reduce trade costs, boost trade flow and reap benefits from International Trade	The eleven TFIs take values from 0 to 2, where 2 designates the best performance that can be achieved. The variables in the TFI dataset are coded with 0, 1, or 2. These seek to reflect not only the regulatory framework in the concerned countries, but delve, to the extent possible, into the state of implementation of various trade facilitation measures. The TFI database covers 163 countries, including economies at all income levels – 28 low income countries (LICs), 42 lower middle income countries (LMICs), 40 upper middle income countries (UMICs), 19 high-income economies outside the OECD area (HICs non-OECD) and 34 OECD countries – as well as all geographic regions (namely, Asia-	Information availability, Fees and Charges, Consultation, Advance rulings, Appeal procedures, Documentation Requirement, Automation of Border Procedure, Streamlining of Border Processes, Domestic Border Agency Cooperation, Cross-Border Agency Cooperation,

		Pacific, Europe and Central Asia, Latin America and the Caribbean, Middle East and North Africa and Sub-Saharan Africa)	Governance and Impartiality
Ease of Doing Business (WBG, 2020)	To investigate the regulations that enhance business activity and those that constrain it.	Research demonstrates a causal relationship between economic freedom and gross domestic product (GDP) growth, where freedom regarding wages and prices, property rights, and licensing requirements leads to economic development. The study covers 190 economies—including some of the smallest and poorest economies, for which other sources provide little or no data. The data are collected through several rounds of communication with expert respondents. More than 48,000 professionals in 190 economies have assisted in providing the data. Complex aggregation methods such as principal components analysis and unobserved components analysis were used to yield a ranking nearly identical to the simple average.	Starting a Business, Dealing with Construction Permits, Availability of Electricity, Registering Property, Getting Credit, Protection of Minority Investors, Payment of Taxes, Trading Across Borders, Enforcement of Contracts, Resolving Insolvency, Employing Workers, Contracting with the Government
Enabling Trade Index (ETI, 2016)	Studies capacity to facilitate the flow of goods over borders and to their destination	ETI covers 136 economies, which together account for 98 percent of world GDP and 98.3 percent of world merchandise trade. The ETI is composed of four main components namely Market access, Border administration, Infrastructure, and Operating environment further subdivided into 7 pillars, and each pillar is composed of a total of 57 indicators. All pillars are assigned a score of 1 and 7 corresponds to the worst and best possible outcome, respectively (Forum, 2016). The computation of the ETI is based on successive aggregations of the scores from the indicator level. An arithmetic mean is used to aggregate the scores within a parent component.	Domestic market access, Foreign market access, Efficiency and transparency of border administration, Availability and quality of transport infrastructure, Availability and quality of transport services, Availability and use

			of ICTs, Operating environment
STRI (OECD, 2019)	Provides information on regulations affecting trade in services in 22 sectors across 46 economies (36 OECD and the rest non-OECD)	The STRIs are composite indices taking values between zero and one, zero representing an open market and one a market completely closed to foreign services providers. The scoring system is based on binary scoring. To reconcile the complexity of services trade restrictions with binary scoring, non-binary measures are broken down to multiple thresholds; complementary measures are grouped and scored as zero only if all measures in the bundle are not restrictive. (Nordas, Grosso, Miroudot, & Gonzales, 2015)	Logistics cargo-handling, Logistics storage and warehouse, Logistics freight forwarding, Air transport, Logistics customs brokerage, Legal, Maritime transport, Road freight transport, Rail freight transport, Courier, Commercial banking, Insurance.
Linear Shipping Connectivity Index (UNCTAD, 2019)	Measuring the trade competitiveness in the area of transport and logistics by covering the level of integration into the existing liner shipping network by measuring liner shipping connectivity.	The LSCI is generated for all countries that are serviced by regular containerized liner shipping services. For each component, we divide the country's value by the maximum value for the component in Q1 2006 and then calculate the average of the six components for the country. The country average is then again divided by the maximum value for the average in Q1 2006 and multiplied with 100. The result is a maximum LSCI of 100 in Q1 2006. This means that the index for China in Q1 2006 is 100 and all other indices are in relation to this value. C	The number of ships, The total annual container-carrying capacity of those ships, The maximum vessel size, The number of services, The number of companies that deploy container ships on services from and to a country's ports
World Bank Logistics Performance Index (LPI 2023)	Logistics friendliness of the country through WB LPI	World Bank LPI is calculated on every two year by the world bank along set standards of indicators. The index has been developed considering 139 countries across the world which are characterised by coastal countries and landlocked countries as well. To calculate the Logistics Performance Index principal component analysis has been used.	Efficiency of the clearance process, Quality of trade and transport related infrastructure, Competence and quality of Logistics services, Tracking & tracing, Timeliness, Ease of arranging

			competitively priced shipments
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Table 2: Eight Relevant Indicators Identified based on Experts' View Which are relevant to Electronics and Computer Software Export

S. No.	Indicator	Definitions	Coverage
1.	Logistics Infrastructure Quality	Quality refers to adequate capacity and operating condition of roads, rails, seaports, airports, CFS/ICDs, logistics parks / freight terminals, warehouses, ICT, etc.	Under this indicator Road network, Rail network, Sea-Ports, Air cargo terminals, Inter-modal terminals (ICD/CFS, Logistics parks / freight terminals, etc.), Storage infrastructure (Warehouses, Cold storage, etc.), Information and communication system, and Facilities at inter-state borders
2.	Logistics Services Quality	It includes quality and ease of access to services offered by LSPs during handling, transporting, storage of cargo & containers, freight forwarding, customs broking and value adding logistics activities, online payment etc.	Ease of access to logistics services (handling, transporting, storage of cargo & containers, freight forwarding, customs broking and value adding logistics activities, etc.), Quality of logistics services offered by LSPs (Road transporters, Indian railways, port operators etc.), Efficiency of logistics services offered by LSPs, and Efficiency of custom services and inspection agencies etc.
3.	Information System	It refers to the capability of obtaining frequent, consistent & accurate information regarding movement and condition of consignments	Information availability, Real time tracking facilities, Real time condition of consignments, Reliability and accuracy, Availability of past data, Ease of accessing information, and Online portals etc.
4.	Timeliness of Delivery	Refers to high frequency of delivery within scheduled or expected delivery times	Timely delivery, Unscheduled stoppage, Documentation compliance check time etc.
5.	Efficiency of Regulatory Processes	Speed, simplicity, transparency and ease of documentation in regulatory processes. It includes formalities of agencies related to customs, tax, health, sanitary & phytosanitary, quarantine, drug controller, FSSAI, inter-state border crossing agencies and all other such agencies; online documentation services	Online documentation facilities, Speed (Time to complete all official procedures), simplicity in documentation process (detailed process), transparent rules and regulation (in written form), Custom clearance formalities, inter-state border crossing agencies, and Single window for customs procedures etc.
6.	Operating Environment Favorability	It includes low incidents of law and order issues including restriction in movement of cargo vehicles during day-time, frequent check points,	Treatment with other states suppliers and crew members, Discriminatory access to services, Restriction in movement of cargo vehicles during day-time, Frequent check points, Strikes, Impact of trade/transport unions

		strikes, impact of trade/transport unions etc.	
7.	Cost Competitive Logistics	Shipment cost include those for transportation, handling, storage, value added services, and transparency in other informal charges	Transportation cost, handling cost, Storage cost, Value added services (labeling and packaging, etc.) at competitive price, Labor charges, and Transparency in other services charges etc.
8.	Safety and Security of Consignment	It refers to timely delivery without damage/ deterioration /pilferage of cargo due to logistics inefficiencies and incapability, accidents or theft	Safety during movement, Safety during Handling and storage, Safety during distribution and delivery, Frequency of loss/theft/damage, Frequent stoppage, and Insurance facilities etc.

The literature survey indicates that there are different indicators which have been used by the different global agencies to identify the area of concern and overall logistics performance in different perspective which have been shown in Table 1. Table 2 incorporates the identified indicators which are appropriate and relevant to the electronics and computer allied products' export.

Methodology

An exploratory study to measure logistics performance of electronics and software sector export which has been conducted along the identified indicators based on literature survey and experts' opinion. With the help of identified indicators detailed questionnaire was developed to record the perception of exporters and freight forwarders. The initial input for the development of methodology has been drawn from the Handbook on Constructing Composite Indicators (Nardo et al., 2005; Organisation for Economic Co-operation and Development, 2008) scientific research articles (Churchill, 1979; Parasuraman et al., 1988; Cronin and Taylor, 1994; Hinkin et al., 1997; Jain and Gupta, 2004; Garg et al. 2014; Khan and Rahman, 2016; Taheri et al., 2018; Carpenter, 2018; Wieland et al., 2018; Morgado, 2018), and various reports related to index development (OECD-STRI, 2015; World Bank-LPI, 2016, 2018; World Bank- Ease of Doing Business, 2018; Deloitte-LEADS, 2018, 2019).

Assessment of logistics performance of electronics and hardware sector in performing export includes many dimensions, indicators, and their sub-indicators. Accordingly, the questionnaire was prepared, validated, launched, and surveys were conducted among electronics and computer software products from different part of the country. Total 75 questionnaires were administered among exporters, logistics service providers and freight forwarders, 68 responses were collected out of which 55 have been found with all the requisite information necessary for analysis and reaching the inference.

The questionnaire was designed along 8 indicators with several sub-indicators under each of them. This helped to record micro level perception of the respondents about perception towards quality of logistics services, infrastructure, operational efficiency, regulatory processes etc. All perception-based constructs are designed on a standard 5-point Likert scale. The survey was administered to a sample of respondents selected with an assumption of 90 % confidence interval and a margin of error of 0.10. To check the internal consistency and validity of the data set for the purpose of this research Cronbach Coefficient Alpha method has been used and

found alpha value 0.846 which confirmed the data set were valid to conduct the statistical tests. Further, principal Component Analysis (PCA), Perception-based Score (Normalised) Method have been applied to derive relative weights to indicators for calculating Weight indicating the performance of the logistics mechanism in electronics and computer software export sector.

Analysis and Interpretation

Several weighting schemes have been explored to assign relative weights to the select 8 indicators for this study specifically. These are Balanced Weighted Average Approach, weights derived through Principal Component Analysis or Factor Analysis. The PCA results for the selected samples are as follows:

Table 3: Principal Component Analysis (PCA) Result

Components	Eigenvalue	Proportion	Cumulative	% of Variance Explained	Cumulative
Logistics Infrastructure Quality	5.299	0.589	0.589	58.883	58.883
Logistics Services Quality	1.051	0.127	0.716	11.678	70.560
Information System	0.699	0.078	0.793	8.761	79.322
Timeliness of Delivery	0.528	0.068	0.861	5.865	85.187
Efficiency of Regulatory Processes	0.423	0.047	0.908	4.696	89.883
Operating Environment Favorability	0.319	0.035	0.943	3.947	93.830
Cost Competitive Logistics	0.301	0.033	0.976	3.543	97.373
Safety and Security of Consignment	0.213	0.024	1.000	2.627	100.000

Table 4: Weights Derived Through PCA

Components	PCA weights	Cumulative
Logistics Infrastructure Quality	0.124	0.124
Logistics Services Quality	0.136	0.260
Information System	0.149	0.409
Timeliness of Delivery	0.118	0.527
Efficiency of Regulatory Processes	0.116	0.643
Operating Environment Favorability	0.099	0.742
Cost Competitive Logistics	0.133	0.875
Safety and Security of Consignment	0.125	1.000

The second scheme is weights derived through statistical methods, frequently derive from Principal Component Analysis (PCA). This is a statistical methodology that assigns the highest weight to the variables that contribute the most to the variation in the data set. The weights derived through PCA has been presented in table 4.

The third weighting scheme is expert judgement in which experts are asked to assign importance score to each indicator. Perception based score, has been considered to derive weights for measuring the perception about logistics performance along each indicator. The importance weights of the logistics indicators derived through above-mentioned method is as follows:

Table 5: Perception Based Normalisation Score

Components	Normalised Score	Cumulative
Logistics Infrastructure Quality	0.116	0.116
Logistics Services Quality	0.130	0.246
Information System	0.138	0.384
Timeliness of Delivery	0.117	0.501
Efficiency of Regulatory Processes	0.126	0.627
Operating Environment Favorability	0.121	0.748
Cost Competitive Logistics	0.131	0.880
Safety and Security of Consignment	0.120	1.000

The weights derived for various indicators, in previous step, were utilised during aggregation to derive the performance score of logistics mechanism for the export and import of electronics and computer software. These derived weights were multiplied to the scores of sub-indicators and same has results as indicating the performance level of all the eight indicators.

Sensitivity Analysis: Calculation of perception score for logistics performance measurement in the trade of electronics and computer software comprise several statistical techniques throughout its steps. to check the robustness of the performance scores derived using the various statistical and weight allocation techniques. On the weight allocation method, other than PCA, one additional method was investigated – Perception-based (Normalised score) Method. The diversity in the weights resulting from applying different methods is notable. Whereas according to perception-based survey, respondents preferred Efficiency of Regulatory Processes over other indicators followed by Quality of Logistics Services. Surprisingly, Efficient Transportation and Logistics Infrastructure received less preference over other indicators for facilitating trade in the marine sector. It can also be seen from the fourth Table, in this section, that the exporters are realising the importance of information system in their operations. Similarly, since various experts have recommended the application of confirmatory factor analysis (CFA), over PCA. The weights derived through the CFA analysis has been taken into consideration for the purpose. Lastly, the study has also calculated the select indicators' performance score using PCA weight and geometric means of the respective indicators. Following table 6, enlists the overall logistics performance value taking into account the performance score of all the indicators computed using three approaches and table 7 depicts the pair-wise correlation between these methods:

Table 6: Sensitivity Analysis

Normalized Weight	PCA	CFA
3.819	3.894	3.866

Table 7: Pair-wise Correlation of Indicators Performance Level through Different Methods

	Normalized Weight	Principal Component Analysis	Confirmatory Factory Analysis
Normalized Weight	1	0.864	0.987
Principal Component Analysis	0.864	1	0.895

Confirmatory Factor Analysis	0.987	0.895	1
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As can be seen in the table 8, logistics performance calculated by each approach are highly correlated, hence sensitivity analysis favours the performance measurement approach as it enables the comparison across the other logistics performance approaches.

Conclusion

Electronics and computer allied export logistics needs a comprehensive and efficient mechanism in the age of today's fast growing and dynamic technological advancement. It is one of the most significant trade subject for export and import, therefore its logistics mechanism need to be smarter to keep the cost of logistics down. Thus it becomes important to understand the area of concern in electronics and computer allied goods trade logistics. Taking into consideration the same, the study has been conducted along the eight identified indicators using appropriate statistical instruments and has been found that exporters and freight forwarders are satisfied with Information system and cost incurred on the different affairs during course of shipment and logistics. Pair-wise correlation indicated that there is strong association among the results of different approaches adopted to reach the inference. Satisfaction with infrastructure, operating environment, security and timeliness in the logistics process have been found least that indicates that proper steps are expected to be taken by the government and concerned authorities to make the sector excel the performance which would certainly enhance the performance level of the logistics. Perception about the quality of the services provided by different stakeholders involved in logistics, and regulatory processes efficiency are satisfactory to average level which need to be further improved.

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