

Integrated Supply Chain in Solar Energy Sector

Author's Details:

⁽¹⁾**Syed Abdul Ahad**

Scholar, Greenwich University, Karachi, Pakistan. Email: ahadabdul.1997@gmail.com

⁽²⁾**Dr. Masood Hassan**

PhD, IoBM, Karachi, Pakistan and Visiting Faculty Greenwich, Karachi, Pakistan, Email: masoodhassan1@hotmail.com (**Corresponding Author**)

⁽³⁾**Mohammad Usman**

Scholar, Greenwich University, Karachi, Pakistan. Email: m.sardar.usman456@gmail.com

⁽⁴⁾**Abdul Rahim**

Scholar, Greenwich University, Karachi, Pakistan. Email: abdulrahim_12@hotmail.com

⁽⁵⁾**Malik Muhammad Bilal**

Scholar, Greenwich University, Karachi, Pakistan. Email: bilalmalikk150@gmail.com

Abstract:

The aim of this study is to find the entities of supply chain that establish integration in supply chain activities of solar energy sector. It is précised to examine logistics, procurement and purchasing, sourcing and manufacturing phases of supply chain in explaining integrated supply chain. The paradigm of this research is past-positivism as it initiates a newer relationship between underlying variables. The sample size for the data collection was chosen by random sampling technique and a number of 203 respondents participated for primary data. The respondents were selected from top 12 solar energy companies in Karachi, where manufacturers, their suppliers and logistics partners were surveyed with minimal exposure of the researcher in a non-contrived environment. This research provides evidences for positive and negative significant impacts of sourcing and manufacturing in creating supply chain integration respectively, while the impacts of logistics, procurement and purchasing impacts were positive but insignificant. This research is beneficial for students who are pursuing their majors in supply chain and it also provides some measures for those who are involved in solar energy sector to improve their manufacturing deficiencies in order to positively influence integration in supply chain. Further, the data of this research is analyzed through SMART-PLS and SPSS. The data is found reliable and all the constructs are found discriminant under all statistical tools. Moreover, linear and multiple regressions were also analyzed to conclude the path coefficients and degree of influence between variables.
Keywords: Logistics, Procurement, Purchasing, Sourcing, Integration, Supply Chain.

Introduction

The compilation of different enterprises at one platform in order to bring competitiveness in supply chain integration procedures with other group of suppliers and firms is the core criteria of carrying out a successful business strategy in this digital era of technology (Awad & Nassar, 2010). Many researchers have studied different strategies of integrating supply chain which include inward and outward facing strategy as well as periphery and supplier or customer focused supply chain policies. A study from (Frohlich & Westbrook, 2001) was stated by (AlSagheer & Ahli, 2011) highlighting the critical function of integrated supply chain which leads to a better and competitive organizational performance in the marketplace. For improvising business strategy to be sustainable in terms of competitive advantage, supply chain integration process has proved to bring successful business performance by modeling supplier-manufacturer relationship and it also helped all the surveyed manufacturers in the unification of different tiers of suppliers (Trkman & Groznik, 2006), these tiers will be further discussed in literature review of this paper. A favorable supply chain is one that manages a better coordination of the manufacturer from suppliers to the end users and this originates the concept of integrated supply chain (Chan & Qi, 2003), that is incomplete without studying supply chain management which refers to establish proactive and booming relationship between all the entities of a firm's supply chain (Cox, 2004) by renouncing the buyer's strategy of having control over only the direct components suppliers from tier 1 (Turban, McLean, & Wetherbe, 2004). Since, importance of integrated supply chain has been evolved as a very

crucial element for business processes, thus today most of the manufacturers are well aware of its implications as the primary aspects for conducting a profitable business. Some of the basic advantages of supply chain integration have been identified by past researchers for instance optimization of organizational output by creating reliability in communication with suppliers (Zhang, Li, Golizadeh, Zhao, Lyu, & Jin, 2020; Ivanov, Pavlov, & Sokolov, 2016), reduction of product wastage through reverse supply chain perspective (Mahajan & Vakharia, 2016; Ocicka & Raźniewska, 2018; Björklund & Fors, 2018; Geda, Ghosh, Karamemis, & Vakharia, 2020; Kucukvar, Egilmez, & Tatari, 2014), a better result in customer experience (Mihardjo, Sasmoko, Alamsyah, & Elidjen, 2020; Esper, et al., 2020; Hoberg & Alicke, 2016; Liu, Liang, Wei, Xie, & Wang, 2021; Sdoukopoulos, Perra, Boile, Efthymiou, Dekoulou, & Orphanidou, 2020), a better flow of information among all entities of a supply chain as integrated supply chain is maintained over a software thus it eliminates bottlenecks and brings efficiency in minimized error in the information (Yousefia & Alibabaei, 2015; Gajšek & Sternad, 2020) and moreover when extra operations are removed and unification is implied for all suppliers and distributors of a firm, it results in decreasing cost of production and sales which simultaneously brings efficiency in increasing profitability of a firm by choosing right suppliers and analyzing correct future market and demand trends through removing disruption of the entire supply chain.

Background of the Study

The entire business circumstances have evolved since the beginning of this modern era of commerce and technology where everything and every procedure is compiled into most strategic business models to conform with the fast moving and evolutionary business trends under the interdependence of countries with each other or globalization patterns, thus it is crucial for all the firms and product manufacturing to selling entities to secure a high end strong relationship with all the suppliers and business partners for the timely maintenance of product requirements along with the advancements of technology and strategic modes of business trots (Christiansee & Kumar, 2000). A better backward and forward integration in supply chain enhances a better understanding of developing management process in supply chain with advanced logistics and distribution tactics in order to get a competitive advantage in supplier services (Christopher, 2015; Bowersox, Closs, & Stank, 2000) while reducing the cost of production (Kumar, Fantasy, Kumar, & Boyle, 2006). The concept of value chain is considered as the ideology behind becoming competitive in supplier side to sustain in the continuously evolving business strategies, where value chain comprises the concept of adding value to every single process involved in the chain of providing final customer with best experience and value added service (Porter, 1985). Similarly, supply chain management follows the notion of enhancing most suitable suppliers to establish strong supplier-manufacture-retailer relationship in order to deliver the product while being competitive at the back end of the product (Wahyuni, 2010). In this context, the need of identifying major supply management entities to bring integrated supply chain in process where logistics, sourcing, manufacturing, purchasing and procurement will be studied further to highlight their impact in the integration of supply chain of a firm.

Logistics

The term logistics refers to the planning for the movement of material from the very beginning point of the product to its final consumer (Ristovska & Petkovski, 2017) while managing the overall information flow involved in the process regarding product current position in the most efficient way through discarding extra processes in terms of cost reduction feature of supply chain management (Mellat-Parast & Spillan, 2014). The concept of logistics management strengthened after 1980 when firms started outsourcing other firms to provide transportation and warehousing facilities, where logistics began the major aspect of supply chain by compiling the clusters of firms which further improvises the supply chain performance and backward integration capabilities to the manufactures in carrying out a value added final product to the consumer (Sinkovics & Anthony, 2004). Further, logistics have been studied into three components by (Kim, Lee, & Hwang, 2020) under the “Resource Dependence theory” represented by (Pfeffer & Salancik, 1981). Every firm needs some sort of resources from other firms in which it lacks, this dependency on other firms brings about the proportion of trust level on the suppliers integrity. In logistics, manufacturer has to build trustful communication with the

transportation and warehousing services to match their supply and value chain management (Kwon & Suh, 2004; Zhao, Flynn, & Yeung, 2008; Fynes, de Búrca, & Mangan, 2008). When the logistics trust is ensured from both ends, a level of satisfaction in terms of security and confidence is set leading to future commitment for the maintenance of value added services (Zacharia, Sanders, & Nix, 2011; Sahay, 2003; Yuan, Feng, Lai, & Collins, 2018). Basically, logistics' primary function is to ensure that delivery of each material will value added feature which conforms to integration of supply chain for providing improvised feedback from end consumers of finished product. Though integration of logistics in supply chain management had been a complex challenge primarily due to compilation of many firms working together (Villena, Revilla, & Choi, 2011; Richey, Roath, Whipple, & Fawcett, 2010; Mahour, 2014) but now globalization tactics have made it easier for worldwide firms to manage their interdependency and build stronger relationship to bring quick and reliable transportation of raw materials or components of desired production to the manufacturer (Kim, Lee, & Hwang, 2020).

Procurement

Procurement refers to getting the inventory from selected vendors and its final allocation in the manufacturing department at the very right time, keeping the right demand and supply, right quality and right supplier. It is defined as the buying and allocation of raw materials in correct quality and quantity (Suvittawatt, 2017). For procurement purposes, the firm has to do market assessment to select desired vendor that helps in cost reduction with better quality features (Fynes, de Búrca, & Mangan, 2008). Procurement is a procedure which includes the stages as seller assessments, making contracts and payments agreement, negotiation with seller or supplier, regular connectivity with the supplier and making final analysis and sourcing of the preferred seller (Villanueva-Ponce, Garcia-Alcaraz, & Cortes-Robles, 2015). Considering the fact that competition is getting complex among suppliers, firms are focused on cutting the transaction cost as much as possible by compressing the suppliers with effective procurement skills (Mikalef, Pateli, & Batenburg, 2013). According to a research, companies spend 70% of their revenues in management of supply chain activities thus it has been a hot topic for researchers to identify the spots where supply chain can be improvised by developing suppliers participation in providing raw materials (Batenburg & Versendaal, 2008; Presutti Jr, 2003). Moreover, it is crucial to discuss the gap between procurement and purchasing while these terms are used interchangeably, but are distinguished by (Miemczyk, Johnsen, & Macquet, 2012) that procurement is particularly specified to evaluate the purchasing of raw materials to develop the quality in future through better suppliers and derive cost reduction effects and value addition, while purchasing only comprises buying and selling of materials.

Purchasing

Purchasing is the subset of procurement, where procurement involves a whole procedure from identifying the correct seller to giving final analysis of its services, purchasing only refers to buying products both in either backward or forward integration. In 1985, purchasing is explained as the buying of products from suppliers to fulfill the firm's need to maintain a product's value in supply chain management (Elliott-Shircore & Steele, 1985). Further, purchasing is described as the manufacture's involvement in the acquisition of raw materials that it lacks because no firm can be full independent in every department from its manufacturing stage to delivering final product to consumer stage (Dobler, 1990; Jay, 2012; Chang, Tsai, & Hsu, 2013). Formerly, purchasing was all about making purchase orders and invoice processes but since last two decades of evolving informational technology, purchasing is expanding with terms of making strategies for cost effective suppliers and ensuring quality raw materials at this stage of supply chain.

Sourcing

When a firm seeks another supplier to help in profit optimization through purchasing a specific facility from it, refers to sourcing in supply chain (Dr.Ramakrishnan, 2020). It develops an understanding of gathering information about the business partner with proper research work, explaining required quality demands to the partner and then hiring a firm which follows the firm's actual criteria. During strategic sourcing, firm calculates seven different types of service providers studied by (Biazzin, 2020), first option that all firms have is the *basic*

service provider which enables very low cost differentiations as compared to the market when a lot of suppliers are in existence, while *approved source provider* is the actual supplier for the raw materials and both of these sourcing categories are substitute friendly, but *preferred source provider* is the supplier that provides desirable outcome for value added business model (Vitasek, 2016). Further, there are *performance based source providers* who are willing to make improvisations as well as fulfilling the current expectations, while *vested source providers* are those who work with the partners for the two-sided success which exist where high level of innovation and transformation is expected in consumer demand. Lastly, we have *shared services* and *equity partnership service providers* which include sourcing per unit charges and when companies don't have enough investment to commit external outsourcing respectively (Vitasek, 2016). This elaborates that strategic outsourcing is all about searching for the best service provider and hiring best supply partner to fulfill desired competencies in the supply chain management. With evolving challenges in global supply chain, where procurement is aimed at adding value to raw materials with effective cost strategies, there sourcing of efficient suppliers strikes as the genuine value adding factor in modern era of supply chain. Moreover, today it is implied as value-based sourcing where manufacturer evaluates the extra benefits from suppliers other than the actual components or purchased materials, it makes sure that suppliers give better contribution in developing a more efficient product to fulfill customer desires while establishing a team work strategy with them, resulting as a unique supplier-manufacturer bond with optimized output as a by-product of this relation (Glas, Kleemann, & Michael, 2012).

Manufacturing

This is the most important stage where a firm establishes value added product for its customers. It is defined as the point of transformation of raw materials into polished and finalized product to be served to its customers (Al-tarawneh & Al-Shourah, 2018). This is the stage where manufacturer works with subtractive and additive manufacturing in order to shape the final product. The subtractive manufacturing involve heavy machinery implications, cutting and drilling the product while additive manufacturing is also known as 3D printing which includes product packaging and designing for product recognition among costumers. The manufacturing is done by three procedures; either it can be integrated manufacturing, disintegrated manufacturing or service production. The integrated manufacturing comprises the compilation of different raw materials to transform them in a newer finished product like car manufacturing, the disintegrated manufacturing comprise manufacturing of products from one product for instance companies produce many different oils from crude oil while service production includes no transformation of simpler materials into another product but it includes providing service to consumers like internet service , education or logistics (Sharma & Rai, 2019).

Supply Chain Management

As above mentioned, supply chain management has been evolved as the most crucial element for any firm in the whole world. It is most commonly explained as the collection of firms working together and each firm forwards the product to next stage with some additional services for value added experience of the customers which results in gaining competitive advantage either in cost reduction or better retail experience and enhanced product supply in the market (Stadtler, 2008). Supply chain refers to the huge connectivity of each and every single effort involved in the product manufacturing from its stage of raw material to finished goods in the hands of final user of the product, this chain includes backward and forward integration having entities as wholesaler of each raw material, inbound and outbound logistic providers, warehousing services, manufacturers, packaging sorts, distributors, retailers and finally the end consumer (Mentzer, DeWitt, Keebler, Min, Nix, & Smith, 2001).

Problem Statement

Since, supply chain management has been found significantly important for all the organizations so it is important to understand the entities that organizations should consider carefully for the integration of supply chain. In all the previous research works, the research has found that many researchers have contributed to find

impact of logistics in integrated supply chain (Bowersox, Closs, Cooper, & Bowersox, 2013; Kamal & Irani, 2014; Anca, 2019; Globerson & Wolbrum, 2014; Abdul Hamid, 2017; Danese & Romano, 2011; Maia & Cerra, 2009), some have studied the importance of manufacturing in supply chain (Stylidis, Wickman, & Söderberg, 2015; Pavlínek & Janák, 2007; Omega, Noel, Masbad, & Ocampo, 2016; Narasimhan & Das, 2001; Radej, Drnovšek, & Begeš, 2017; Hirsh, Kakkar, Singh, & Wilk, 2015), purchasing (Monczka, Handfield, Giunipero, & Patterson, 2008; Schiele, 2007; Kembro, Näslund, & Olhager, 2017; Elram, Leenders, & Nollet, 1994; Burns & Lee, 2008; Schneller, 2009; Chicksand, Watson, Walker, Radnor, & Johnston, 2012; Hendrick, 1997; Huber, Sweeney, & Smyth, 2004), procurement (Suvittawatt, 2017; Villanueva-Ponce, Garcia-Alcaraz, & Cortes-Robles, 2015; Rugman & Hodgetts, 2000; Chang, Tsai, & Hsu, E-procurement and supply chain performance, 2013; Dong, Xu, & Zhu, 2009; Wiengarten, Fynes, Humphreys, Chavezand, & McKittrick, 2010; Fernando, 2016; Fynes, de Búrca, & Mangan, 2008; Essig & Arnold, 2001; Puschmann & Alt, 2005) and sourcing (Liker, 2004; Yawar & Seuring, 2018; Helmold & Terry, 2016; Gurtu & Johny, 2021; Schulze, Bals, & Warwick, 2022; Costantino & Pellegrino, 2010) have also been found in the literature contribution to have an influence on integrated supply chain. Thus, the research has found the gap to study all these five variables to affect the integrated supply chain in a combined state to develop a better understanding of supply chain with the proper implication of these dependent variables of this research.

Research Significance

The results of this research are supposed to be collected from solar energy sector in Karachi which highlights that how well solar energy sector is maintaining its suppliers and the perfection of its services delivered to consumers by giving value added experience. This research is focused on gaining integrated supply chain in terms of the implication of all five factors involved in supply chain activities.

Hypotheses

- H₁*: Logistics significantly affects Integrated Supply Chain
- H₂*: Procurement significantly affects Integrated Supply Chain
- H₃*: Purchasing significantly affects Integrated Supply Chain
- H₄*: Sourcing significantly affects Integrated Supply Chain
- H₅*: Manufacturing significantly affects Integrated Supply Chain

Research Questions:

- RQ₁: Does logistics have any role in maintaining integrated supply chain?
- RQ₂: Does procurement play its role in improving supply chain?
- RQ₃: Do purchasing capabilities have impact on integrated supply chain?
- RQ₄: Does sourcing helps in integration of supply chain?
- RQ₅: Does manufacturing stage of a product has any effect on integrated supply chain?

Research Objectives:

- RO₁: To find out the impact of logistics on integrated supply chain.
- RO₂: To find out the impact of procurement on integrated supply chain.
- RO₃: To find out the impact of purchasing on integrated supply chain.
- RO₄: To find out the impact of sourcing on integrated supply chain.
- RO₅: To find out the impact of sourcing on integrated supply chain.

Literature Review:

Logistics role in Integrated Supply Chain

Consideration on cost reduction is the most highlighted aim of any business for profit optimization that can be done through either by declining the product or service quality or by decrease the quantity of product per serving. In that case, the value providing feature to customers diminishes, which commences the idea of

bringing supply chain management in the back end procedures of a product preparation. The transportation is the vital cause of product price increment that can be solved if the logistics part is centralized and gathered into a narrowed system, when any inflow and outflow of raw materials, finished products or human capital are detached from unnecessary intermediaries, which results in an integrated supply chain. The researcher has studied past contributions to literature in finding the impact of logistics in creating integration in supply chain phase of a product. Logistics indicates the globalization of inventory and management of all resources required for the organization and no firm is completely independent in backward integration, through globalization it has been possible to compile all the firms together at a marketplace to earn profit following the resource dependence theory (Pfeffer & Salancik, 1981). The booming effect in supply chain management is the outcome of effective logistics movement (Bowersox, Closs, Cooper, & Bowersox, 2013; Kamal & Irani, 2014), as the import export and transportation of materials from one supplier to other widens the narrow levels of processes outside the seals of a firm. Logistics is the way out solution to the complexities of globalization for the compression of supply chain because all the operations are initially dependent on the inbound and outbound transportation of material flow (Abdul Hamid, 2017; Danese & Romano, 2011; Maia & Cerra, 2009). For the active survival in the complex competition, working together as a team with other firms is definitely a positive implementation in terms of logistic barriers (Gupta & Ramesh, 2015; Nilsson, 2006). It wouldn't be wrong to say that in today's world, competition does not lie between companies but supply chain (Simon, Di Serio, Pires, & Martins, 2014). Logistics has different functions to uplift supply chain which include supplier and customer relation management, demand and customer service management where logistics identifies the value addition to customer in product delivery and availability (Bowersox & Closs, 1996; Bowersox, Closs, Cooper, & Bowersox, 2013), informs the suppliers about the transportation charges and follows the actual key performance indicators defined by the company to ensure that the entire supply chain runs smoothly (Lambert, 2008). Further, (Anca, 2019) has explained logistics as the fundamental part of supply chain corresponding to era 6 during 1990s of inventing integrated supply chain management (Globerson & Wolbrum, 2014) which established the logistics relation between companies throughout the functions of organizations. Moreover, (Martin, 2011) concluded that logistics is the smaller operation in a broad aspect of supply chain, when the smaller parts are managed in both upstream and downstream functions of the company, cost reduction and desired value added experience to customers is achieved at the same time, thus logistics is found to influence integration of supply chain significantly. This builds the first hypothesis of this research to find out the impact of logistics on integrated supply chain in the solar energy sector of Pakistan.

H₁: Logistics significantly affects Integrated Supply Chain

Procurement and Integrated Supply Chain

For the achievement of integration in supply chain of a firm, the main goal is to acquire competitiveness in the market which is the benefit of cost reduction in the production phase of the project as compare to market competitors (Ghasimi, Ramli, & Saibani, 2014). By the time, complexities in supply chain procedures, market competition and customer demand variations have developed the aiming preferences of organizations to indulge supply chain in an improvised effective and efficient team gathered together at a platform to bring productivity and obtain economies of scale in the supplier side of a firm (Kannan, Ahmed, & Balaji, 2016). Procurement procedure in the supply of raw materials plays the core performance in optimizing company's overall profit and loss, it is supposed to be regulated with professional, trained and knowledgeable staff to bring cost effectiveness in supplier's selection and negotiation to fulfill the needs of an efficient and integrated supply chain (Suvittawatt, 2017). It has been found that since procurement is all about sourcing raw materials from the right suppliers at right in the right amount and plays a vital role in gaining the competitive advantage for a company so its prime goal is not to just lower the prices from supplier side but it also focuses on overall good cost management in a company by upgrading the process of production and quality which directly influences the integrated supply chain positively and results in increased organizational output (Suvittawatt, 2017; Villanueva-Ponce, Garcia-Alcaraz, & Cortes-Robles, 2015; Rugman & Hodgetts, 2000). Procurement is a practical and crucial factor which contributes to boost the performance of supply chain operation through controlling

informational flow, decision making related to suppliers or right raw materials and better relationships with supplying partners through supplier relation management processes (Dong, Xu, & Zhu, 2009; Chang, Tsai, & Hsu, 2013). In literature, the researcher has also found that procurement processes also increase the transparency and credibility of a supply chain (Puschmann & Alt, 2005) through creating value and redefining value addition opportunities available to the supply chain management team (Wiengarten, Fynes, Humphreys, Chavezand, & McKittrick, 2010). In 1998, (Telgen, 1998) had predicted procurement to bring revolution in competition among supply chains of organizations through purchasing skills and value addition in sourcing phase. With the increased focus of economies on value of gathering correct information and delivering potential decisions based on transparent analyses of suppliers and negotiations, electronic and classics procurement both are deriving the escalating effects of integration in supply chain (Essig & Arnold, 2001). And today, it is procurement that has brought international trade in practice through accessing a huge variety of suppliers in order to get potential output in organizational performance by cost reduction efficiency with its informational and connectivity functionalities (Fernando, 2016). Procurement as a crucial factor to supply chain integration may bring unique selling proposition while facing global market challenges through regulations in suppliers and accurate or précised decision making to get materialistic value for the organization (Fynes, de Búrca, & Mangan, 2008; Fernando, 2016) Since the beginning of 21st century , the concept of electronic procurement has replaced the old mediocre procurement concept due to lack of value creation in supply chain process, but now electronic data interflow about suppliers has been evolving the value creation power of procurement processes by making sure the effectiveness and efficiency of all the actions taken at this stage where excessive suppliers are highly approves and desired suppliers are selected resulting in cost effective final product in the hands of end-user thus procurement is found to be significantly important in creating an integrated supply chain for any organization. This builds the second hypothesis of this research to find out the impact of procurement on integrated supply chain in the solar energy sector of Pakistan.

H₂: Procurement significantly affects Integrated Supply Chain

Purchasing and Integrated Supply Chain

From the academics, the realms of purchasing and supply chain gained the attentions as a topic of vital research in the beginning of 1990s (Lamming & Hampson, 1996; Morgan & Monczka, 1995; Farmer, 1997; Kraljic, 1993). A wide contribution to literature has been studied by the researcher form last 3 decades on this relationship. The concept of adaptation in purchasing processes evolved in the integration of supply chain along with the rising strategies of vertical integration adopted by the companies (Chicksand, Watson, Walker, Radnor, & Johnston, 2012). The main reason behind this paramount relationship between these two variables is the companies' urge to become competent at the corporate level. In a research, (Huber, Sweeney, & Smyth, 2004) used definition of (Hendrick, 1997) to explain purchasing impact on integrated supply chain where they explained that purchasing is the official and unofficial methods of two or more companies to collaborate with each other by integrating their mutual needs of getting cost and quality advantages along with suitable suppliers through bulk selling and purchasing in the marketplace. The supply chain management is an interchangeable terminology used to explain the purchasing and manufacturing strategies of firms and how they deal with transportation of their raw materials inflow and outflow of finished goods to the hands of end user of their product of service, through management of purchasing activities companies may attain value addition benefits which derive an integration in supply chain of a firm (Chen, 2001). Further, (Elram, Leenders, & Nollet, 1994) contributed that purchasing as a separate entity formerly acquired greater importance in companies but if we talk about regulated and more effective supply chain, purchasing itself is not very beneficial if it does not opens up gateway in future for fully integrated supply chain as globalization has adapted changes in supplier selection criteria to gain cost effectiveness at the purchasing stage, thus its contributed by (Schneller, 2009; Burns & Lee, 2008) in the literature that building purchase alliances bring a lot to cost reduction in two terms, either through pool purchasing leverages or through price cap. A very important quotation has been given by (Schiele, 2019) that "firms exist by selling, but earn profits by purchasing" which highlights the effects of purchasing in supply chain and the companies who have skilled purchasing tactics have technically resulted in greater savings and

more stronger supplier relationship (Schiele, 2007). Moreover, for a better understanding of supply chain, included by (Monczka, Handfield, Giunipero, & Patterson, 2008) in the literature that a purchaser is supposed to gain information of suppliers' supplier for a better integration in supply chain. There are three tiers in suppliers, tier 1 comprises direct suppliers of a firm, tier 2 comprises suppliers of components to tier 1 suppliers while tier 3 comprises the primary suppliers of raw material who usually act as tier 1 for tier 2 suppliers. So, a purchaser can develop better understanding of the complete chain by gaining insights of tier 2 from tier 1 with potential communication skill, therefore the purchasers who have clear approach to understand primary suppliers operations have a greater advantage over competitors in the market because they can analyze the flexibilities of supply chain and advanced negotiation skills with potential suppliers (Kembro, Näslund, & Olhager, 2017). Thus, it can be identified from past literature that purchasing with skilled knowledge and strategies may be a provider of support to the achievement of organizational goals in terms of making the product or service cost efficient for the customers as well as for the organization's manufacturing stage, this builds the third hypotheses of this research to find the influence of purchasing in integrated supply chain of solar energy sector of Pakistan.

H₃: Purchasing significantly affects Integrated Supply Chain

Sourcing and Integrated Supply Chain

As sourcing is the smaller version of procurement and deals in making choices between most suitable suppliers for the delivery of raw materials and components required for the production of desired goods, so the top companies including Apple, Samsung, Dell and Toshiba have used strategic sourcing in their operations making a successful supply chain network who are finely focused on their mutual key performance indicators and strategic venture (Helmold & Terry, 2016). Since, the globalization is the core of today's supply chain, and companies outsource with many tier 1 and tier 2 or 3 supplier levels who are beyond the boundaries of the manufacturer country, thus the supply chain gets longer and needs risk management factor to avoid any disruption in shipment of raw materials and components in such a long route supplier-manufacturer gap (Gurtu & Johny, 2021). This is the area where integrated supply chain requires proper sourcing strategy at procurement level in order to bring a capable supplier in action where a low or minor risk level is expected (Helmold & Terry, 2016). The task to reduce risks behind global sourcing is the biggest challenge for corporations in sourcing the minimal risk causing supplier. Similarly, companies can reduce their non core competencies by sourcing them with competent suppliers who can together make their product a premium finished product resulting into a stabilized and integrated supply chain network (Schulze, Bals, & Warwick, 2022). In 2015, from Future Automotive Industry Structures survey conducted by Mercer Management Consultants, it was found that dependency on supplier in non core competencies of companies has increased up to 10%, and due to increased supplier networks and high risk effects the internal competency of a manufacturer declines up to 25% on an average (Helmold & Terry, 2016), thus the lean corporations who have minimal supplier processes involved in production can work with flexibility in sourcing strategies (Liker, 2004; Yawar & Seuring, 2018). Sourcing in terms of multiple and single suppliers have both positive and negative aspects in integration of supply chain. The pros and cons of both multiple and single sourcing have been explained by (Costantino & Pellegrino, 2010) in a study quoting that if a company has single supplier than the opportunistic behavior in the supplier and purchase cost is decreased, a better economies of scale is attained due to better and strong relations with the spotted supplier while it may also lead to higher dependency on the single supplier which creates a hazard for manufacturer to respond quickly to get the supply in any uncertain situation. In contrast, if a company has used multiple sourcing strategy, it enables the manufacture to have alternative sources if one supplier gets delivery issues, due to high competition among suppliers it creates a motivation to work better and results and better quality or cost benefits and also the manufacturer acquire flexibility to cope up with any uncertain condition through any supplier. But multiple sourcing may also result in lack of efforts from the supplier side if the manufacturer is being biased with them which may decline the quality of supply, moreover it can cause higher management of suppliers and an increased responsibility to keep all suppliers records efficiently. Precisely, it can be said that sourcing can bring a hand full of benefits to integrated supply chain if efficient and strategic

planning is ensured from the manufacturer side (Costantino & Pellegrino, 2010) . Thus, from the previous study of contribution in literature about identifying how valuable sourcing can be to improve the integration of supply chain which builds the fourth hypothesis of this research to find the affectivity of this relation in solar energy sector of Pakistan.

H₄: Sourcing significantly affects Integrated Supply Chain

Manufacturing and Integrated Supply Chain

For every firm, the key to success in 21st century is to cope up with the issues and management system of supply chain for optimized integration in the addition of value addition feature in the finished products. Due to continuous adaption in customers' demands worldwide, the product complexities have been increased due to which sourcing other companies is becoming essential to sustain the competition which is shifted from single companies war to supplier and groups of companies, thus for getting the competitive advantage, the supply chain should be integrated so that all the suppliers of a firm are gathered in a smaller and easily manageable circle. In the integration process, manufacturing is a part of internal integration while procurement, purchasing, sourcing and logistics are all together support the external integration of supply chain (Narasimhan & Das, 2001). At the manufacturing stage manufacturers have to respond according to customers defined functionalities requirement in the product which keep evolving with the changing trends of the market (Tang, 2005), if the external integration is fast enough to fulfill required demand of the manufacturer once the manufacturer has identified the internal procedures to respond accordingly (Hirsh, Kakkar, Singh, & Wilk, 2015), this conforms the value addition to customers satisfaction and results in formation of a well established integrated supply chain (Radej, Drnovšek, & Begeš, 2017). The manufactures have to make the quality assurance in the complete supply chain which involves management of supplier tiers (Stylidis, Wickman, & Söderberg, 2015; Pavlínek & Janák, 2007; Omega, Noel, Masbad, & Ocampo, 2016), usually manufactures integrate the supply chain processes through forcing tier one suppliers to invest in better quality components for value added finished product and due to simple integration with tier 1 suppliers (Radej, Drnovšek, & Begeš, 2017) , the production cost is reduced for the final manufacturer with an increased quality standard while continuous production of items without poor quality for their mutual success of product acceptability in the customer market (Coetzee, r Merwe, & Dyk, 2016; Jasti & Kodali, 2015; Soliman, 2017) . Therefore, from these linkages in literature review the researcher of this paper has established the fifth hypothesis of this research to find the impact of manufacturing competencies in formation of an integrated supply chain of solar energy sector in Pakistan.

H₅: Manufacturing significantly affects Integrated Supply Chain

The literature review of this study has shown compatible relation between logistics, procurement, purchasing, sourcing, manufacturing and integrated supply chain, the researcher wants to implement all these contribution in the solar energy sector Pakistan to find the consistency of past research results with the help quantitative research approach based on a close-end structured questionnaire which will be further discussed in methodologies later.

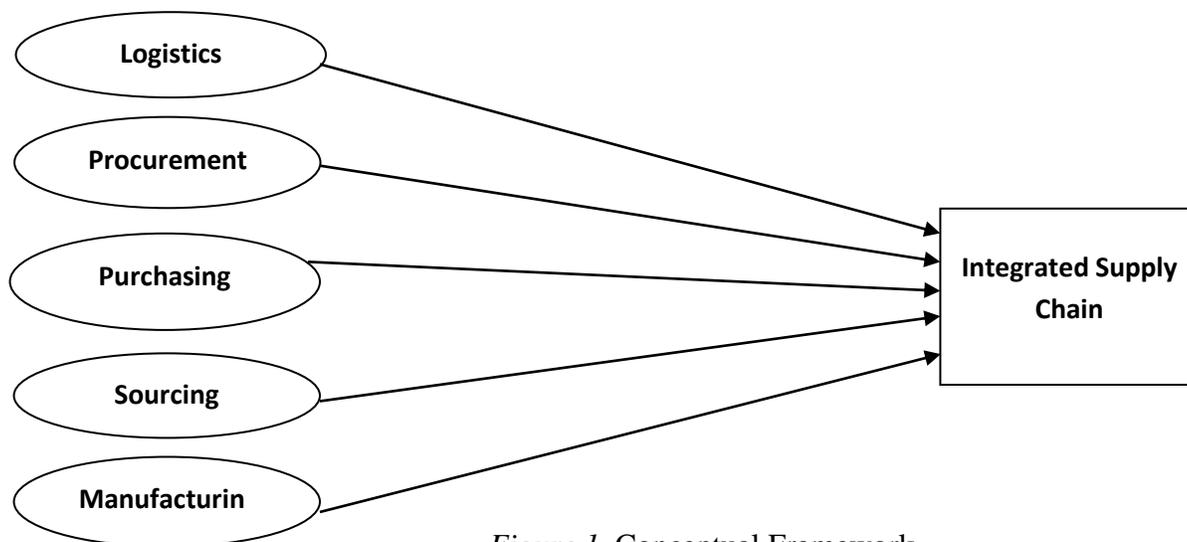


Figure 1. Conceptual Framework

Methodology

Research Design: To find the relationships of mentioned variables in literature review, the researcher has done a systemic investigation about the occurring phenomenon with the help of statistical and mathematical calculation of the collected data. The research design of this paper is correlation and it is a one-time quantitative study, the concept of the study belongs to Past-positivism research paradigm as it establishes a newer relationship among the underlying variables.

Variables: The researcher has developed a clearer understanding and better knowledge about the components of this research from the past contributions about the topic in literature review. Thus to fill the gap described in problem statement, the researcher has found five independent variables and one dependent variable for this research comprising logistics (IV₁), procurement (IV₂), purchasing (IV₃), sourcing (IV₄) and manufacturing (IV₅) while integrated supply chain is pointed out as DV.

Population and Sample size: This research is about finding the correlation among variables from solar energy sector of Pakistan. The data for the statistical calculation of this research is collected from solar energy producing top 12 companies established in Karachi where a total of 210 respondents participated randomly who are involved in supply chain department of these companies.

Data Collection and Statistical Technique: The data is collected through the distribution of 210 questionnaires among which best suited 203 questionnaires have been chosen for the data with a very minimal exposure of the researcher. The questionnaire comprises the liker scale with the values as 5 (strongly agree), 4 (agree), 3 (neutral), 2 (disagree) and 1 (strongly disagree). The data is then passed through reliability and validity tests of SMART-PLS SEM to first confirm the reliability and validity of collected data and then significance of the relations will be studied through t and p tests from bootstrapping. Further, for the analysis of demographics and descriptive statistics, the data has been studied by SPSS statistical software.

Results and Analysis:

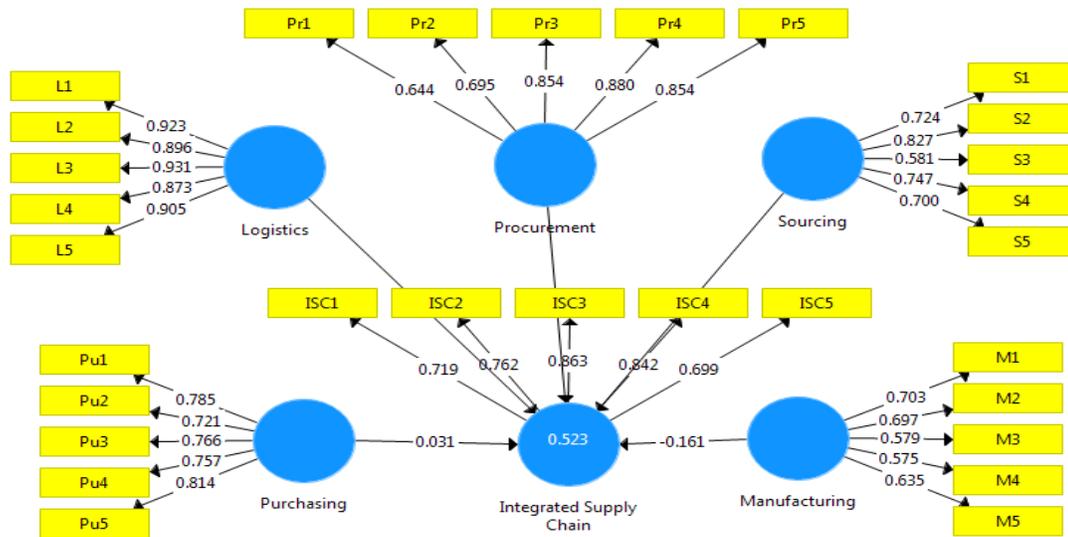


Figure 2: Research Model

Construct Reliability and Validity

Table 1

Chronbach’s Alpha , Rho _A & Composite Reliability

	Chronbach’s Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Integrated Supply Chain	0.842	0.873	0.885	0.608
Logistics	0.946	0.978	0.958	0.821
Manufacturing	0.701	0.654	0.775	0.51
Procurement	0.849	0.869	0.892	0.626
Purchasing	0.84	0.917	0.879	0.592

Through this testing, the researcher has confirmed the reliability and validity of the data that ensures the consistency and accuracy of each construct of the data respectively. (A. Santos, 1999; Tavakol & Dennick, 2011 ; Altman & Head, 1997; Taber, 2016) referred that the data is found to be acceptable and highly reliable if the values of Chronbach’s Alpha are higher than or equal to 0.7, (Tarkkonen & Vehkalahti, 2005) suggested the values of Rho-A higher than or equal to 0.7 are highly acceptable for the reliability confirmation of the data, where (Borsboom, 2004; Raykov, 1997) presented the values of composite reliability to be higher than or equal to 0.7 for the reliability of each construct in the data. Here in table 1, according to all these parameters , the data is found to be internally consistent that is collected from the questionnaires.

Discriminant Validity

Discriminant validity shows that all the constructs of the data are different from each other and are not overlapping with one another (Hair, Hult, Ringle, & Sarstedt, 2014) .It comprises of three methods to confirm the discriminant validation that includes Cross-loading, Fornell-Larcker Criterion and Heterotrait-monotrait (HTMT) correlation ratio. Below, the tables 2, 3 and 4 are shown to pass the constructs of the data through this validation test to prove that all of them are different from each other.

Table 2
Factor Loading:

	Integrated Supply Chain	Logistics	Manufacturing	Procurement	Purchasing	Sourcing
ISC1	0.719	0.179	0.131	0.225	0.194	0.373
ISC2	0.762	0.202	0.157	0.282	0.17	0.417
ISC3	0.863	0.161	0.33	0.305	0.151	0.647
ISC4	0.842	0.213	0.325	0.301	0.215	0.704
ISC5	0.699	0.188	0.224	0.184	0.159	0.5
L1	0.182	0.923	0.267	0.517	0.625	0.352
L2	0.169	0.896	0.178	0.467	0.579	0.319
L3	0.221	0.931	0.355	0.555	0.637	0.354
L4	0.183	0.873	0.24	0.423	0.611	0.285
L5	0.285	0.905	0.276	0.644	0.644	0.414
M1	0.249	0.23	0.703	0.155	0.178	0.459
M2	0.184	0.105	0.697	0.111	0.121	0.418
M3	0.111	0.119	0.579	0.046	0.127	0.291
M4	0.128	0.178	0.575	0.184	0.18	0.359
M5	0.264	0.258	0.635	0.287	0.243	0.364
Pr1	0.281	0.896	0.265	0.644	0.632	0.405
Pr2	0.141	0.384	0.343	0.695	0.292	0.246
Pr3	0.261	0.279	0.154	0.854	0.162	0.273
Pr4	0.324	0.326	0.168	0.88	0.257	0.331
Pr5	0.261	0.428	0.207	0.854	0.335	0.351
Pu1	0.134	0.638	0.257	0.332	0.785	0.296
Pu2	0.081	0.497	0.078	0.229	0.721	0.179
Pu3	0.129	0.481	0.266	0.319	0.766	0.206
Pu4	0.163	0.469	0.175	0.2	0.757	0.209
Pu5	0.26	0.562	0.235	0.457	0.814	0.331
S1	0.582	0.258	0.399	0.285	0.207	0.724
S2	0.657	0.329	0.432	0.371	0.303	0.827
S3	0.34	0.176	0.283	0.101	0.164	0.581
S4	0.476	0.318	0.522	0.363	0.286	0.747
S5	0.39	0.303	0.55	0.322	0.234	0.7

The constructs of the data are said to be discriminant from one another if factor loading value of each construct being above than 0.7 is higher than the factor loading values of other constructs (Hair, Hult, Ringle, & Sarstedt, 2014; 2011). So, the data of this research has passed through the test of discriminant validation as it fulfills the requirement of discriminant validity.

Table 3
Fornell & Larcker Criterion

	Integrated Supply Chain	Logistics	Manufacturing	Procurement	Purchasing	Sourcing
Integrated Supply Chain	0.78					
Logistics	0.239	0.906				
Manufacturing	0.319	0.296	0.68			
Procurement	0.337	0.59	0.268	0.791		
Purchasing	0.226	0.687	0.276	0.428	0.769	
Sourcing	0.706	0.389	0.6	0.415	0.336	0.72

After cross loading, further discriminant validity is assessed through Fornell & Larcker criterion. As (Hair, Sarstedt, Hopkins, & Kuppelwieser, 2014) suggested that the method compares the square root of the average variance extracted (AVE) with the correlation of latent construct. The variance of every indicator is explained by its own construct better than the variance of other latent constructs. Due to which the square root of each construct's AVE should have a greater value than the correlations with other latent constructs. According to this test, again the researcher has found the constructs discriminated from one another, all the latent constructs in Table 3 are explaining the variance of their own construct better rather than the variance of other latent constructs.

Table 4
Heterotrait-monotrait (HTMT) Ratio of Correlation

	Integrated Supply Chain	Logistics	Manufacturing	Procurement	Purchasing	Sourcing
Integrated Supply Chain						
Logistics	0.259					
Manufacturing	0.365	0.344				
Procurement	0.372	0.638	0.367			
Purchasing	0.235	0.762	0.34	0.466		
Sourcing	0.809	0.443	0.836	0.486	0.388	

The other measure for discriminant validity is Heterotrait-monotrait (HTMT) ratio of correlation. (Henseler, Ringle, & Sinkovics, 2009) suggested that this method performs better than the cross loading and Fornell-Larcker criterion as it achieves specificity and sensitivity rates i.e. 97% to 99% which are comparatively higher than cross loading and Fornell-Larcker i.e. 0.00% and 20.82% respectively. HTMT values close to 1 indicates a lack of discriminant validity. Therefore its threshold value is suggested as 0.85 (Henseler, Ringle, & Sinkovics, 2009). All the values above 0.85 will show the lacking of discriminant validity. The more the values are closer to 0, the more the discriminant validity is present. Similarly, in Table 4, all the values of each construct are below 0.85 which shows all the constructs are acceptably discriminated from each other.

Table 5

Demographics	F	%	Demographics	F	%
<i>Gender ></i>			<i>Job Role ></i>		
Male	139	68.5%	Transport Provider	22	10.2%
Female	64	31.5%	Supplier	114	53%
			Manufacturer	63	29.3%
			Distributor	8	3.7%
			Service Provider	8	3.7%
<i>Age ></i>			<i>Qualification ></i>		
21 to 25 years	5	2.5%	Under Matric	7	3.4%
26 to 30 years	27	13.3%	Matric	15	7.4%
31 to 35 years	59	29.1%	Intermediate	31	15.3%
36 to 40 years	76	37.4%	Bachelors	74	36.5%
41 and Above	36	17.7%			
<i>Experience ></i>					
Less than 3 year	15	7.4%			
4-7 years	85	41.9%			
8-11 years	86	32.5%			
12-15 years	26	12.8%			
More than 15 years	11	5.4%			

*N=203

Demographic Information

Demographic Information

In table 5, the researcher has discussed the demographic profiles of the participants. The demographics of this research have been studied through descriptive analysis from SPSS. For demographics, 5 items were chosen to identify the strength of respondents' opinions. A total of 210 questionnaires were distributed and 203 questionnaires were selected best suitable for the sample data among them male and female ratio was 68.5/31.5% with 139 and 64 participants respectively. Considering age factor, most of the respondents were aged above 26 years and only 5 out of 203 were between 21-25 years age and most of them had experience of supply chain more than 4 years, this indicates that questionnaires were responded by well experienced mature employees who had good knowledge regarding the relative topic of this study. Similarly, 74 and 76 respondents were bachelors and post graduates respectively, 31 respondents were intermediate qualified and only 22 respondents were below intermediate. Moreover, the most important aspect of demographics to conduct this research was to analyze the job roles of respondents. The data collected through questionnaire comprises opinions of 22 transport providers, 114 suppliers, 63 manufacturers, 8 distributors and 8 service providers who were chosen with random sampling technique to participate in this study.

Discussions and Results

This research is designed to find the correlations among underlying that are logistics, procurement, purchasing, sourcing and manufacturing implied together to establish integration in supply chain. The purpose of this research is to find that how well integrated is the supply chain of solar energy sector in Pakistan thus a number of sample size $N=210$ respondents were selected through extreme endeavors of the research in reaching out to respondents. All the main fields of solar energy sector where supply chain is integrated were identified and thus the questionnaires were opinionated by transport providers, suppliers, distributors of photovoltaic panels in Pakistan and manufacturers from top 12 solar energy production companies mainly from Karachi were interviewed to gain a better knowledge of supply chain systems of relative sector, further the companies who are final distributors of photovoltaic panels and thermal storage batteries were surveyed to separately distinguish in each phase of this integrated supply chain. Due to simpler correlation between variables, this research has found its multiple regression, path coefficients, reliability and validity tests through Smart-PLS, while for demographic analysis and descriptive statistics, the data was passed through SPSS to study more statistical observations of collected data, further for individual impacts of independent variables on integrated supply chain, linear regression was also studied through SPSS for specific conclusions on related variables. In the questionnaire, 5 items were selected to explain logistics that the researcher has considered from the study of (Kim, Lee, & Hwang, 2020) are: L_1 : We set meetings with our logistics to solve regular issues, L_2 : Our logistics provider work as a team with us, L_3 : We work with logistics provider through mutual understanding, L_4 : Our logistics provider helps us in cost reduction and L_5 : We trust on the promises of our logistics provider. The 5 items for analyzing procurement were suggested by (Omosa, 2005) which include Pr_1 : Our procurement technique help in our profitability, Pr_2 : Procurement helps in developing competitive advantage, Pr_3 : We have well maintained relationship with approved suppliers, Pr_4 : Our procurement technique is effective in terms of negotiation with suppliers and Pr_5 : We respond timely to our consumer demands. For Purchasing, 5 items were suggested by (Giunipero, Denslow, & Eltantawy, 2005) which include Pu_1 : We calculate the risk before purchasing, Pu_2 : We possess good interpersonal communication with suppliers, Pu_3 : We plan our purchases regularly, Pu_4 : We work with persuasive and influential skills and Pu_5 : We get our raw materials on time. For sourcing 5 items were suggested by (Frederico, Kumar, & Garza-Reyes, 2021) that are S_1 : We do complete market research before hiring a service, S_2 : We believe in developing our standard with our source provider, S_3 : We usually consider outsourcing in our operations, S_4 : We measure quality sourcing for our services and S_5 : We usually negotiate in our contracts while sourcing. Further, 5 items to explain manufacturing were considered from the study of (Manogharan, Wysk, & Harrysson, 2012) that are M_1 : We work effectively to meet consumer satisfaction with company's resources, M_2 : We manufacture according to diverse needs of consumers, M_3 : We work on quality improvement, M_4 : We make strategies to reduce manufacturing cost and M_5 : We manufacture products efficiently without field failures. Similarly, 5 items to explain integrated supply chain were proposed

by (Wann-Yih, Chwan-Yi, Ya-Jung, & Hui-Ju, 2004) which include ISC₁: Our relationship with supply chain partners is very stable, ISC₂: Our supply chain is cost effective, ISC₃: Our supply chain partners are all like a family to us, ISC₄: We are strong enough to negotiate with our supply chain to revise their pricing and ISC₅: Our supply chain helps us in being competitive.

Table 6

Descriptive Analysis of Research Variables:

Constructs	N	Min	Max	Mean	Std. Deviation
Logistics	203	1.00	5.00	3.7606	0.99942
Procurement	203	1.00	5.00	3.6335	0.78505
Purchasing	203	1.00	5.00	3.7133	0.81080
Sourcing	203	1.00	5.00	3.8030	0.72289
Manufacturing	203	1.00	5.00	3.9094	0.69629
Integrated Supply Chain	203	1.00	5.00	3.8837	0.72158

In the table 6, the descriptive statistics have been studied where minimum, maximum, mean and standard deviation have been calculated through SPSS. All the labeling of values occurred in the data have mentioned in the methodologies where 5 was identified as strongly agree and 1 for strongly disagree. If we see the mean in table 6, there the mean of all the constructs lies slightly above 3, which indicates that all the respondents have mostly agreed to all of the items included in the questionnaire to study the impacts of logistics, procurement sourcing, purchasing and manufacturing on integrated supply chain. Since all the values of SD are below 1, this indicates that data has very low dispersion from mean values. The standard deviation helped in identifying the variances in the data through which coefficient of variation is calculated. From table 4.4.1, the logistics has a $CV = 0.2657$ i.e. 26.57% ($\sigma = 0.99942, \mu = 3.7606$), procurement has $CV = 0.216$ i.e. 21.6% ($\sigma = 0.78505, \mu = 3.6335$), purchasing has $CV = 0.218$ i.e. 21.8% ($\sigma = 0.81080, \mu = 3.7133$), sourcing has $CV = 0.190$ i.e. 19% ($\sigma = 0.72289, \mu = 3.8030$), manufacturing has $CV = 0.178$ i.e. 17.8% ($\sigma = 0.69629, \mu = 3.9094$) and integrated supply chain has $CV = 0.1857$ i.e. 18.57% ($\sigma = 0.72158, \mu = 3.8837$), so all the coefficients are close to 20% which shows that the data has very good level of dispersion which is highly acceptable for the research.

Significance Test

The β -coefficients of logistics and manufacturing with integrated supply chain are negative i.e. ($\beta = -0.099$ and $\beta = -0.161$ respectively) which confirm that there is no positive impact of logistic and manufacturing phases in creating an integrated supply chain in the solar energy sector of Pakistan . Similarly, considering the path coefficients of procurement, purchasing and sourcing in relation with integrated supply chain i.e. ($\beta = 0.098, \beta = 0.031$ and $\beta = 0.791$ respectively) indicate that these three variables are playing a positive impact in establishing integration in supply chain of solar energy sector.

Table 7

	Original Sample	Sample Mean	Standard Deviation	T Statistics	P Values
Logistics -> Integrated Supply Chain	-0.099	-0.113	0.089	1.123	0.262
Manufacturing -> Integrated Supply Chain	-0.161	-0.139	0.061	2.615	0.009
Procurement -> Integrated Supply Chain	0.098	0.099	0.062	1.586	0.113
Purchasing -> Integrated Supply Chain	0.031	0.05	0.06	0.525	0.6
Sourcing -> Integrated Supply Chain	0.791	0.78	0.058	13.54	0

Further, T-test & P-test is used to determine the level of significance between the independent and the dependent variable. If the T-value is above ± 1.96 and P value is less than 0.05 then the relation between the variables is said to be significant while if the T-value is below ± 1.96 and p-value is above 0.05 then the relation between the variables is said to be insignificant. From Table 7, the researcher has interpreted the significance level of relation between the independent variables and dependent variable. From the t- test and p-value, it is found that logistics and integrated supply chain have an insignificant negative relation with t values smaller than +1.96 and p value greater than 0.05 ($t=1.123$, $p > 0.05$) and ($t=4.043$, $p < 0.05$) respectively . In contrary, manufacturing found to have a significant negative impact on integrated supply chain with t values greater than +1.96 and p value smaller than 0.05 ($t=2.615$, $p < 0.05$). While, procurement and purchasing both have insignificant positive relation with integrated supply chain with t values smaller than +1.96 and p value greater than 0.05 ($t=1.586$, $p > 0.05$) and ($t=0.525$, $p > 0.05$) respectively. Moreover, the researcher has found that sourcing is the most beneficial element of supply chain that augments the integration in supply chain significantly in solar energy sector of Pakistan with t values smaller than +1.96 and p value greater than 0.05 ($t=13.54$, $p > 0.05$).

Coefficient of determination:

Table 8

Linear Regressions

Constructs	R	R Square
Logistics	0.232	0.054
Procurement	0.314	0.099
Purchasing	0.201	0.040
Sourcing	0.648	0.420
Manufacturing	0.269	0.072

R^2 denotes the coefficient of determination which shows how well the data fits a model. As explained in table 7, path coefficients have been studied through Smart-PLS readings, compiling the results with table 8, where we analyzed linear regression of each variable on integrated supply chain. The researcher has found that logistics explains integrated supply chain by 5.4%, procurement explains it by 9.9% , purchasing explains the dependent variable by 4%, sourcing explains it by 42% while manufacturing has an influence of 7.2% on integrated supply chain in solar energy sector of Pakistan. Thus, R^2 only for sourcing is moderate and significant on integration in supply chain , these results second with the analysis of significance test table 7, where all the other variables were found insignificantly impacting the dependent variable other than sourcing , and manufacturing phase was found to have negative relation with integrated supply chain. This might have happen because of manufacturer’s failure in reducing manufacturing costs of PV panels and thermal storage batteries; also they are lacking efficiency in managing field failures in plants.

Table 9

Multiple Regressions

	R Square	R Square Adjusted
Integrated Supply Chain	0.523	0.511

Further, since the researcher is studying integration in supply chain so merged impacts of these independent variables are the most vital aspect to conclude this study. After the integrated affects of logistics, procurement, purchasing activities, sourcing proficiencies and manufacturing efficiencies, the researcher has analyzed

regression through SMART-PLS path coefficients and all the independent variables together found to explain integrated supply chain in solar energy sector up to 52.3% with a moderate significant positive influence.

Hypothesis Testing

From all above discussions and analysis of results, the researcher deduced the hypothesis from significance of these relations between variables where logistics, procurement and purchasing failed to significantly impact integrated supply chain while manufacturing and sourcing imposed a significant influence in explaining integrated supply chain, thus the researcher rejects H_1 , H_2 , H_3 while H_4 and H_5 are accepted for this research in the surveyed sample size of solar energy sector.

Table 10
Hypothesis Results

H_1	Not Supported
H_2	Not Supported
H_3	Not Supported
H_4	Supported
H_5	Supported

Conclusion

In Pakistan, according to NEPRA 4% of its power generation capacity is derived from renewable sources which include solar energy mainly. Conducting research in this sector was crucial to develop a better understanding in establishing integration among all the entities of its supply chain. The researcher concludes that manufacturing and sourcing capabilities are the most prominent entities that are currently active in supply chain while logistics, procurement and purchasing activities are not measured significantly to enhance the customer satisfaction in this sector. The results of relation between manufacturing and integrated supply chain show consistency with the studies of (Stylidis, Wickman, & Söderberg, 2015; Pavlínek & Janák, 2007; Omega, Noel, Masbad, & Ocampo, 2016; Hirsh, Kakkar, Singh, & Wilk, 2015; Radej, Drnovšek, & Begeš, 2017; Soliman, 2017) while sourcing impacts in integrating supply chain showed consistency in results with the studies of (Yawar & Seuring, 2018; Helmold & Terry, 2016; Gurtu & Johny, 2021; Schulze, Bals, & Warwick, 2022) as discussed in literature review; Whereas, other three independent variables failed to determine consistent results with previous contributions in literature. Pakistan being a South Asian country is usually hot and dry, due to its climatic features it has a huge support in developing solar energy to generate electricity but still as per year 2022 readings it was analyzed that only 1.16% of its electricity is generated from solar energy while the rest is gained from fossil fuels and hydro power resources. This is the point at manufacturing that is failing to establish a positive impact in its supply chain where demand for energy and development in economy is not meeting the expectations of manufacturers and they have to depend on suppliers to source their operation to make sure quality improvements in production.

Limitations and Recommendations

The researcher has conducted this study in a very short span of time, therefore all the aspects of supply chain were not studied from a bigger sample size and only the metropolitan city of Pakistan was surveyed due to limited availability of time resource. Moreover, this study only shows results about the integration in supply chain of solar energy sector of Pakistan and does not imply its conclusions on any other sector, also no personal remarks in the study were made by researcher in the above analyses. Further, the researcher would like to recommend this sector to spread awareness about solar energy resources in households, as they are largely focused on providing solar energy to production and industrial sector which limits their demand and potential to manufacture with cost effective programs and improvised economies of scale at plants.

Future Dimension

For future research, the researcher would recommend to conduct study in finding the impacts of supply chain integration in the development of economic growth, also the future researchers may expand the sample size and conduct this study in some other sectors to derive more loop holes in supply chains of Pakistan.

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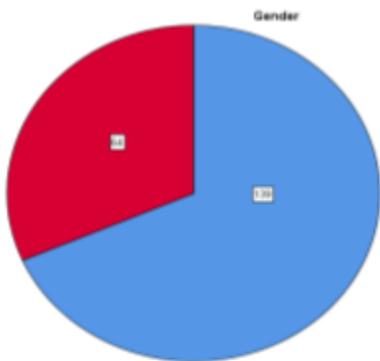
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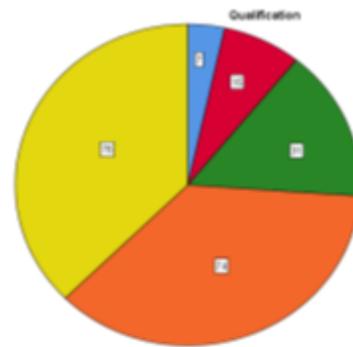
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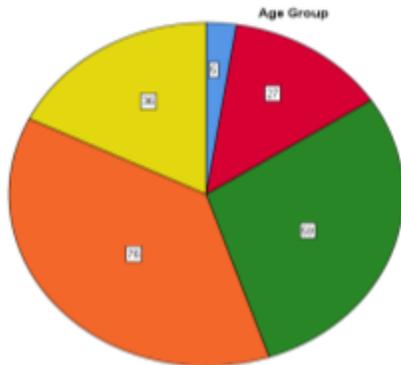
Appendix A-Pie Charts



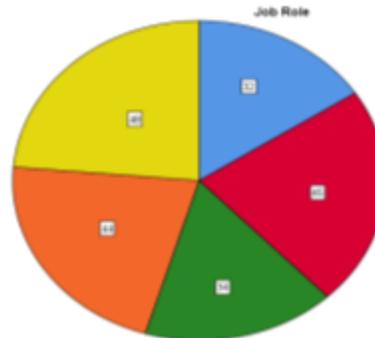
Male
Female



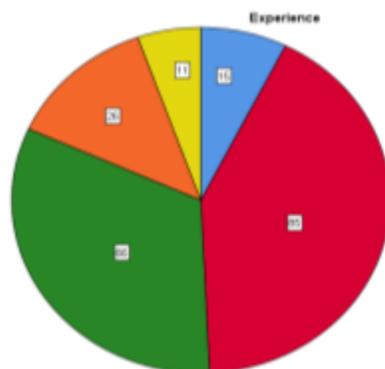
Under-Matric
Matric
Intermediate
Bachelor
Post-Graduate



21 to 25 years
26 to 30 years
31 to 35 years
36 to 40 years
41 and Above



Transport Provider
Supplier
Manufacturer
Distributor
Service Provider



Less than 3 years
4-7 years
8-11 years
12-15 years
Above 15 years

Appendix B-Survey Questionnaire

Respondent's Name _____

Gender:

- Male
- Female

Age Group:

- 15 to 20 years
- 21 to 25 years
- 26 to 30 years
- 31 to 40 years
- 41 and Above

Qualification:

- Under Matric
- Matric
- Intermediate
- Bachelors
- Post-Graduate

Job Role:

- Transport Providers
- Supplier
- Manufacturer
- Distributor
- Service Providers

Experience:

- Less than 3 years
- 4 -7 years
- 8-11 years
- 12-15 years
- Above 15 years

Integrated Supply Chain in Solar Energy Sector	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Logistics (Kim, Lee, & Hwang, 2020)					
1. We set meetings with our logistics to solve regular issues.					
2. Our logistics provider work as a team with us.					
3. We work with logistics provider through mutual understanding.					
4. Our logistics provider helps us in cost reduction.					
5. We trust on the promises of our logistics provider.					
Procurement (Omosa, 2005)					
1. Our procurement technique help in our profitability.					
2. Procurement helps in developing competitive advantage.					
3. We have well maintained relationship with approved suppliers.					
4. Our procurement technique is effective in terms of negotiation with suppliers.					
5. We respond timely to our consumer demands.					
Purchasing (Giunipero, Denslow, & Eltantawy, 2005)					
1. We calculate the risk before purchasing.					
2. We possess good interpersonal communication with suppliers.					
3. We plan our purchases regularly.					
4. We work with persuasive and influential skills.					
5. We get our raw materials on time.					
Sourcing (Frederico, Kumar, & Garza-Reyes, 2021)					
1. We do complete market research before hiring a service					
2. We believe in developing our standard with our source provider.					
3. We usually consider outsourcing in our operations.					
4. We measure quality sourcing for our services.					
5. We usually negotiate in our contracts while sourcing.					
Manufacturing (Manogharan, Wysk, & Harrysson, 2012)					
1. We work effectively to meet consumer satisfaction with company's resources.					
2. We manufacture according to diverse needs of consumers.					
3. We work on quality improvement.					
4. We make strategies to reduce manufacturing cost.					
5. We manufacture products effeciently without field failures.					

Integrated Supply Chain: (Wann-Yih, Chwan-Yi, Ya-Jung, & Hui-Ju, 2004)

1. Our relationship with supply chain partners is very stable.					
2. Our supply chain is cost effective.					
3. Our supply chain partners are all like a family to us.					
4. We are strong enough to negotiate with our supply chain to revise their pricing.					
5. Our supply chain helps us in being competitive.					