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Performance Measurement: A Conceptual Framework for Supply Chain Practices

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Abstract

Measurement of Supply Chain (SC) performance with regards to key practices of SC paradigms is the area which is under research. Presently there are no guidance or set rules under which we can measure SC performance. The lack of clarity and comparability concerns in this area creates misunderstanding and makes it more difficult to formulate a clear strategy. The aim of this research is to identify antecedents of existing SC paradigm's practices, as well as antecedents for SC performance measurement to formulate a conceptual framework. Based on this research, new sustainable SC performance measurement conceptual framework is proposed for existing SC paradigms. The detailed analysis presented in this research paper offers a set of characteristics and structure that industry as well as academia could use it as a guidance framework to measure SC performance.

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Keywords: Supply Chain ; Paradigms; Performance measurement; Conceptual framework

1. Introduction

To enhance the competitiveness SCs are implementing new innovative paradigms of management. Among the existing SC paradigms particularly few are required to be mentioned here, since its better performance of SC and importance: agile, lean, green and resilient (LARG). Green drive has been converted from a simple cause to protect our environment into a well-developed, scrutinized economy. Environmental obligation has progressed from a fashion to a business imperative; it does help corporations

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to accomplish their business goals. The objective of SC is to provide the exact product, in the exact amount, in the exact state, at exact time to exact place and that too at the exact cost. Since the consumer necessities are incessantly changing, so SCs must also be adjustable to advanced modifications, so that requirements of changing markets could be accommodated. Business economic security is influenced by global SC as well as on a mutual acceptance of global risk. These common threats and susceptibilities in SC stress building sufficient resilience. Equally agility and lead time reduction are preferably required by each SC manger, to contest with the varying demands and necessities of the businesses. Currently four SC paradigms are normally practiced by the business managers, namely Lean, Agile, Resilient and Green. But in current scenario disruptive innovative technologies change market tendencies very rapidly. That allows very less time for business for responding as per the varying demands and desires of the customers. Besides next disruptive innovation in technology is about to be launched, which poses extra pressure on the business managers and making it difficult to select any one SC paradigm permanently. It is extremely needed to formulate a framework; which could incorporate all best practices of existing SC paradigms as well as measure SC performance.

2. Literature Review of Literature regarding SCM Paradigms

A SC could be labeled as that chain which connects several components, starting from end consumer to far most contractors, over the process of manufacturing and various amenities so that the course of information, resources and cash could effectively be accomplished for meeting the commercial necessities (Stevens, 1989; Azevdo, et al., 2011). The SCM could be considered as a tactical aspect, so that managerial efficacy and profitability could be achieved as well as for the greater fulfillment of organizational objectives e.g., better customer service, enhanced competitiveness, (Gunasekaran and Tirtiroglu, 2001). (Gunasekaran, Patel and McGaughey, 2004) explained that in the perspective of SC, the measurement of performance is strategic and also essential because most firms realize that SC prerequisite that its performance should be measured as well as techniques of SC should have been precise and measured. In contemporary business, it is assumed that SCs compete each-other instead of corporations (Christopher & Towill, 2000), whereas the failure or success of SC is mostly determined by the open market. However, to guarantee the improved SC, development of a system for measuring the performance which suitably reveals the factual presentation is essentially vital. The literature review indicates that mostly researches remained concentrated on the study of singular paradigm of SC (Anand and Kodali, 2010; Hong, Kwon and Roh, 2009); or maximum in the combination of only two of these, e.g., green verses lean (Kainuma and Tawara, 2006), agile verses resilience (Christopher and Rutherford, 2004), green verses resilient (Rosič, Bauer, and Jammerneegg, 2009), or agile verses lean (Naylor, Naim, and Berry, 1999). Nevertheless the simultaneous incorporation of agile, lean, green and resilient paradigms of SC; might support SCs to be extra sustainable, rationalized and efficient.

There are four existing SC paradigms, namely agile, lean, green and resilient, given the nomenclature as LARG, which are reasonably interesting SC paradigms, but lately it got fair intention to integrate of these LARG paradigms (Azfar, 2012). This paper is focused on formulation of a conceptual framework, after finding antecedents of LARG practices as well as deducting antecedents for SC economic, operational, and environmental performance. This research paper adds value to the literature by presenting a new conceptual framework, to improve the agility, leanness, greenness and resilience of manufacturing SCs. This paper is structured as the following: After introducing the research, review of published work is presented for the LARG paradigms in the SC viewpoint and some practices of these paradigms are also explained. Following to these practices of SC Paradigms; insight on performance

measurement of SC is presented. Consequently, a conceptual-framework is offered for advising antecedents of LARG- practices of SC and few antecedents for measurement of SC-performance.

3. Existing SCM Paradigm's Practices

In Japan at Toyota Motor Corporation, Taiichi Ohno (1998) developed the Lean approach of management, which is the main foundation for "Toyota Production System (TPS)". Its central pillars are: "just-in-time (JIT) production" and "automation". The lean approach main focus remained on the reduction of waste to increase actual value being added, to fulfill needs of the customers and retaining profits. The lean paradigm is based on reduction of cost and flexibility, which focus on improvement of processes, through reducing or eliminating all the wastes (operations which don't add value). It encompasses all the procedures throughout the life cycle of the product starting from design of product to selling of product, from order of the customer till the delivery of product. (Reichhart and Holweg, 2007) stretched the philosophy of lean-manufacturing up-till the level of downstream-distribution; they defined lean-distribution "as process of reducing waste in the downstream SC, whereas ensuring the availability of right product to end customer at the right time as well as location". (Vonderembse et al., 2006) explained "lean SC as the one that engages continuous development efforts which focus on removing waste or non-value adding steps along the SC". "The internal efficiency of manufacturing and reduction in setup time are the enablers for the manufacturing flexibility, cost reduction, profitability and economic production of small quantities" (Vonderembse et al., 2006). In table 1 antecedent of lean-practices of SC are presented.

The solicitation of these procedures entirely in the networks have consequences in reducing of the lean paradigm is supposed to perform best when volumes are high, varieties are low and predictable demands and supplies are certain, so that the serviceable stocks could be created. Quite the reverse, in volatile SCs and high variety, when requirements of customer are mostly unpredictable, great agility levels are essential (Naylor et al., 1999; Cox and Chicks, 2005; Agarwal et al., 2007). In certain circumstances leanness might be a component of agility, but it might not be a satisfactory situation for business to encounter the accurate customers' requirements most promptly. According to (Christopher & Towill, 2000; Agarwal et al., 2007), "SC objective is to delivering the right product, in the right quantity, in the right condition, to the right place, at the right time, for the right cost. Since customer requirements are continuously changing, supply chains must be adaptable to future changes to respond appropriately to market requirements and changes".

In lean SCs the main focus is on elimination of waste, but in agile SCs the main focus is on the ability of responding rapidly and having comprehension of the market changes. Major change in lean-SC is that it's linked with the equal arrangement, while agile-SC preserves capability to survive even during the unpredictable demands (Christopher & Towill, 2000). The agile-SC expected to attain capacity for responding quickly and budget efficiently according to the random variations in the market as well as enlarged stages of instability in the situation, according to bulk and range (Christopher, 2000; Agarwal et al., 2007). (Baramichai et al., 2007) defined agile-SC as the incorporation of businesses associates to facilitate fresh proficiencies for reacting rapidly for the varying and persistently split marketplaces. (Agarwal et al., 2007) presented that SC-agility be influenced by the ensuing: cost reduction, customers' satisfaction, improved quality, speedy-delivery, introduction of fresh products, improvements in service-level and reduction in lead-time. In table 1 antecedent of agile practices of SC are presented.

There is indication that the trends of many corporations to search for solutions having lowest cost, for the reason that the stress is over the borders, might results in lean nonetheless extra susceptible SCs

(Peck, 2005; Azvedo et al., 2008). Nowadays marketplaces are considered by high levels of turbulences and volatilities. Resultantly, SCs are susceptible for interruption but consequently; numbers of risks for businesses continuities had amplified many-folds (Azevedo et al., 2008). Although historically the chief SC aim while designing remained reduction of cost or optimized service, but presently resilient SC has got maximum attention (Tang, 2006). The resilient-SC may not be minimum price choice nevertheless these have additional capability for surviving in indeterminate businesses environments. Resilient SC represents capability for SCs which deals the unpredicted instabilities. It's considered system's ability to coming-back to previous position or even novel position; supplementary anticipated once suffering the trouble as well as evading the incidence of catastrophes. SC resilience investigation and administration aim is avoiding fluctuation in unwanted situations, e.g, situations in which catastrophe might happen again. According to (Haimes, 2006) the purpose of the resilient strategies has dual folds; "i) recover to the favorite values of the conditions of that system which had been upset, within suitable time period and that too at suitable cost; ii) reduce the usefulness of the disruption by altering the levels of the efficiency of a potential risk". Capability of recovering from disruptive happening links improvements in sensitivity competences by being flexible and redundant (Rice and Caniato, 2003). (Tang, 2006) suggested the usage of strong SC policies enables the organization for arranging allied unforeseen event tactics proficiently as well as effectually while facing an interruption, making the SC organization becoming more resilient. In table 1 antecedent of resilient practices of SC are presented.

Table 1 Antecedent of LARG - SCM Practices

Paradigm	Supply Chain Practices
Lean	Just in time
	Relationship with the suppliers
	Cycle/setup time reduction
Agile	Speed in responsiveness
	Change in batch size
Resilient	Developing visibility
	Lead time reduction
	Demand based management
Green	Reduce variety of material
	Reduce environmental impacts

The sustainability of environment and green supply chain management (GSCM) ascended for administrative beliefs in achieving commercial profits as well as enhanced market-shares purposes the decrease in environmental-threats, effects even though increasing environmental effectiveness, administrations for its allies (Rao, 2005; Zhu et al., 2008). Alterations of governmental guidelines, e.g., electrical wastage as well as in European-Union ordinance of Electronic Equipment (Barroso and Machado, 2005; Gottberg, 2006), ensured industries accountability in merchandises after consumption disposals'; compelling execution for sustainable-operations throughout SC. Similarly increased strain from society as well as from the consumers who are environmentally alert; compels industrialists for efficiently incorporate ecological apprehensions keen on its organizational managerial practices (Zhu et al., 2008). It's essential for incorporating company's practices regarding environmental-management in complete SC for accomplishment of sustainable-SC objective as well as preserving competitive-advantage (Linton et al., 2007; Zhu et al., 2008). Practices of GSCM have to encompass entire SC events, starting

the green-purchasing till incorporating lifecycle-management, from end to end customers, manufacturers terminating at reverse-logistics (Zhu et al., 2008). Logistics and distribution operation-networks would be vital features which would upset GSCM (Sarkis, 2003; Khan et al., 2011). In table 1 antecedent of GSCM practices are presented.

4. Measurement System for SC Performance

(Lambert and Pohlen, 2001), indicated that the deficiency of suitable metrics might be the major reason for the following breakdowns and failure in the SCs: (1) incapability to meet satisfaction of the customers; (2) sub-optimized performance of firms; (3) missed-opportunities for outclassing the competition (4) creating clashes inside SC. Measuring the performance would be decisive for improved SCs. That could be made possible to understand and integrate SCs allies; whereas during close-fitting special properties to strategy for probable prospects of SCs. (Christopher and Towill, 2000) discussed difference of market within agile and lean paradigm by means of marketplace leaders (vital prerequisite for persuasive) as well as market contenders (vital prerequisite for sustaining competitiveness). These researchers considered that once price is marketplace champion moreover service level excellence and lead-time are qualifiers for market; at that time lean paradigm to sustain SC performance is more powerful. Once the service-level could be the topmost prerequisites to become champions (available in right time at right place) as well as quality, cost lead-time are contenders for market, at that time being agile would be the crucial measurement. Resilient paradigm's main attention focused regaining preferred standards conditions for system (which is categorized for service-levels as well as the positive qualities) inside the adequate cost and time period. Therefore, for the resilient SCs, cost and the time are crucial indicators for performance measurement. Green paradigm is apprehensive about the reduction of adverse environmental impacts in the SC; nevertheless these reductions couldn't be completed to detriments of SC performance in cost, quality, time and service level.

To improve the SC more effectual and operative, it is required to assess the performance of SC. Measurement of SC performance should offer the business an outline of how their SCs are economical and sustainable (Gunasekaran, 2001). Several researchers discussed that which indicators for performance measurement of lean and agile SCs are key metrics (Nailor et al., 1999; Christopher & Towill, 2000; Mason-Jones et al., 2000; Argwal et al., 2006). For evaluation of the performance of SCs (Kainuma and Tawara, 2006) referred lot of metrics. Nevertheless these may be accumulated as quality, customer service, cost, and lead time. Many events' set as well as procedures were suggested for calculating performance of SC. (Anderson, Aronson and Storhagen, 1989) assumed that the measurement system of SC performance would include a poised collection of few measures of performance from the following: customer satisfaction, quality and productivity. (Beamon, 1999) suggested few measures interrelated to output resources and flexibility. Gunasekaran, Patel and Tirtiroglu, 2001) considered that SC performance should be evaluated from a tactical level, strategic level and operational level as well as from a commercial and non-commercial perspective. Bearing in mind this approach of thought, some measures offered by these researchers are: (1) accuracy in forecasting methods/demand predictability; (2) lead time of delivery; (3) flexibility in meeting particular customer requirements; (4) proper capacity utilization; (5) total time of cycle as well as amount of buyers/suppliers partnerships; (6) inquiry-time for customer; (7) amount of collaboration to improve quality; (8) total cost of transportation; (9) cost of carrying inventory; (10) cycle time for product-development; (11) cost of manufacturing; (12) investment rate of return; (13)) cost of carrying information; and (14) total time of cash-flow. Above mentioned measures try to quantify the SC performance in relations to suppliers, delivery, order planning, strategic planning and

production. Cash to cash metric is an additional important measure; in the meantime it ties inbound activities related to material with the suppliers, doing it through operations of manufacturing as well as outbound activities with the clients (Farris II and Hutchison, 2002).

(Cumbo, Kline and Bumgardner, 2006) suggested following measures for performance: (1) order till delivery lead-time; (2) changeover or setup times; (3) the skill to when it is actually needed; (4) timely shipments; and (5) reduction in inventory. (Schroer, 2004) used performance measures as following: (1) Time of delivery; (2) customer satisfaction; (3) quality; (4) productivity; and (5) costs. Moreover (Browning and Heath, 2009) and (Holweg, 2007) endorsed that cost is the best method to measure the impacts of lean paradigm on the manufacturing organizations performance. The correlations between practices of GSCM and performance have been examined from the environmental perspective (Handfield & Pannesi, 1992; Zhu et al., 2005) the economical perspective (Zhu et al., 2005) as well as the operational perspective (Zhu et al., 2005; Vachon, 2007). As regards to the measurement of performance, means which measure impacts for practices' of GSCM of economic-performance and environmental-performance. (Zhu et al., 2005) advised the following measures: (1) quality of product; (2) solid waste; (3) utilisation of capacity; (4) consumption of unsafe and toxic supplies; (5) air emissions; (6) cost of training; (7)) cost of operation; and (8) levels of inventory. (Vachon, 2007) advised the following methods for estimating impacts of SC-practices over operational-performance of SCs, specifically on flexibility, cost, delivery and quality. Concerning the SCM paradigms which are focused in this especial research, a set of antecedents to measure SC performance are appended in table 2

Table 2. Antecedents to measure SC performance

Performance Measure	Supply Chain Antecedent
Operational Performance	Inventory Levels
	Quality
	Time
	Customer Satisfaction
Economic Performance	Cost
	Environmental cost
	Cash-to-cash Cycle
Environmental Performance	Business waste

5. Proposed Conceptual Framework

This particular portion of paper, proposes conceptual-framework for discovering interactions amongst (practices of LARG-SC) verses performance of SCs. It's assumed in this particular conceptual-framework that set of antecedent practices for (LARG) practices that add improvements for SC-performance. The conceptual framework is proposed in figure-1. This conceptual-framework attempted by suggesting few LARG-practices of SC which would help business related to distribution SCs become more lean, agile, resilient and green, simultaneously, moreover to discover the interrelations among these practices and SC's performance. The proposed conceptual framework is shown at figure1. This conceptual framework is different with previous ones, as it has different antecedents and structure of framework. This paper is part of ongoing research, so this proposed conceptual framework will be empirically validated, to prove this framework into accepted and validated model.

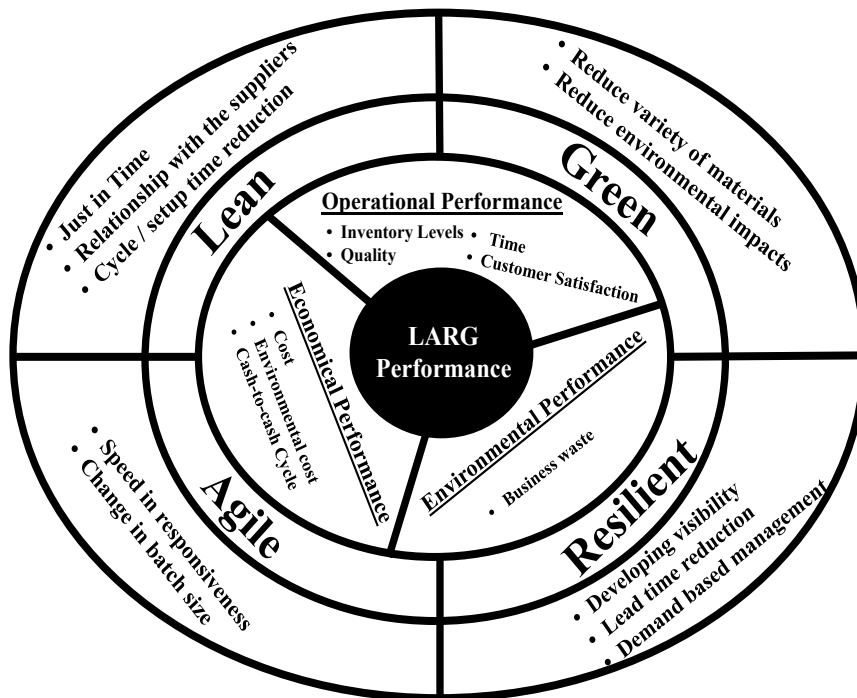


Fig 1. Conceptual framework for a LARG supply chain

6. Conclusion

This conceptual-framework proposed few key antecedent practices for measuring impacts of SC-performance with regards to LARG-SC-practices from operation, economic and environment viewpoint. This proposed conceptual framework is based on theory and could easily be implemented on distribution SC environment. By following proposed framework, it's now imaginable to understand that how antecedents LARG-practices can measure and influence SC performance. For deep understanding this proposed framework adds value in existing body of knowledge regarding green, lean, resilient and agile paradigms of SCs. From managerial perspective, managers now could utilize proposed framework for check-list; for categorizing potential LARG-practices for the accomplishment of organizational strategic-objectives. It does also propose framework which gives managers an insight that how they can make SCs leaner, enhance agility, enhance resilience, as well as enhance greenness; for the accomplishment of businesses' environmental, economical as well as operational, performance goals. Notwithstanding the significant contribution of the research paper, few pitfalls of this research paper have also to be kept in mind. Conceptual-framework has been proposed by utilizing only empirical and anecdotal evidences in the existing literature, whereas no research is carried out to validate this proposed conceptual framework.

As this part of ongoing research, in which further empirical research will be carried out to evaluate the impacts of identified LARG-practices with regards to SC-performance.

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