The Impact of Product and Process Strategies on the Service Performance: The Mediating Role of Supply Chain Integrations

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Abstract- **The main purpose of the current study is to investigate he relationship between product and process strategies and the service performance namely delivery performance and the support performance. In addition to that the study has also examined the mediating role of supply chain integrations namely supplier integration and customer integration in the relationship between product and process strategies and the service performance. In this research, Product Modularity is the specific product and Process Modularity is the process strategy, which has been selected. The performance of service is influenced by these two strategies in a direct and indirect way. The focus of the study is on the evaluation of the level to which the supplier (upstream) as well as customer (downstream) integration mediates the impact of process strategies on performance of services. The study is among the pioneering studies on the issues. Therefore, current study has used SEM-PLS as statistical tool to answer the research questions raised in this study and research objectives envisaged in the current study. The findings of the current study have provided support to with the hypothesized results. This study will be helpful for policymakers and researchers in examining the link between product and process strategies and the service performance namely delivery performance and the support performance.**

Keywords: *Product, Process, Service performance, Supply chain integration*

1. Introduction

There is rapid increase in the product portfolio size and it is not bounded in limits when firms seek to target their products to more niche segments [1] When a product is withdrawn from the portfolio, 1.8 new products are added by the marketers. Difficulties are faced by firms in the achievement of excellent performance. The complexity of portfolio can be dealt with a number of approaches. One of these approaches is supply chain integration as it enables a firm to deal with its customers and respond them as per the conditions in the global market. The service performance surely improves with the increased relation among the trading partners through integration [2].

The performance should be influenced by the integration of supply chain, as suggested by literature [3]. However, there is inconsistency in the results of literature. Some of the researchers have found no impact of integration on performance [4]. Some other researchers have found mediated effects. Studies similar to the one conducted by Swink and Song [5] has made some researchers to draw the conclusion about positive influence of supply chain integration on the performance of firm [6].

It is suggested by the inconsistency in the literature results that some important variable is missing in finding the impact of integration on performance. The evaluation of supply chain integration' effects must be done based on the market and product strategy of the firm [7]. In this study, the impact of supply chain integration on performance is studied by taking in account the process strategies as extension of ref. [7] reasoning. The focus of the study is on the evaluation of the level to which the supplier (upstream) as well as customer (downstream) integration mediates the impact of process strategies on performance of service.[8, 9]. There is no study in literature finding the impact of modularity on performance of service [10]. It has been suggested there is a significant positive relation among these. Serviceability was added by IBM through hot swapping and use of vanilla boxes was done for improved performance in delivery [11]. Modular processes were used by JLA to dominate in the central valley of California in feed testing business to give its customers faster delivery and reliability as compared with its competitors. With the variation in products, the potential negative impacts can be mitigated by modularity such as availability on time, fill rate and

offering large amount of products from small amount of modules [1, 12].

The existing literature related to integration, strategies of process and product modularity as well as performance of service has been studied. The hypotheses have been formulated and research model has been developed. Canonical correlation has been used for testing to find the relation between the product/process strategies, integration, and performance of service. Baron and Kenny [13]have suggested effects decomposition for clearing the role of supply chain integration in modularity strategies of product and processes. Using theoretical framework, the results have been discussed. The implications of the study for managers have been stated along with identification of areas for study in future.

2. Hypothesis Development

2.1. Product strategy (product modularity) and service performance

The strategies of product modularity are linked with the service performance in literature. However, very few studies signify this relation empirically [10]. The positive relation between service performance and product modularity is presented based on logical facts in this section. Fill rates of inventories are improved by the subassemblies and pool components by the standardization related with architectures of modular product [14]. When multiple instances replace the distributed stock, this increases the work-in-process inventory. Different demand streams are allowed to be pooled by employing some common and standardized components. This results in improved accuracy of prediction and managing stock with the variation in demand. The result is improvement of fill rates of inventory across the firm [15].

Postponement strategies are supported with the architectures of modular product, as these can be parallel produced [16, 17]. Potential benefits can be achieved by this. Moving modules to several regions and assembling the products according to demand can result in differentiation with highly responsive time of delivery [16, 17].

Operations are influenced by modular architectures in addition with the implications of physical inventory. A range of products can be facilitated by modular architectures from a small number of inputs. Moreover, it supports responsiveness to demand based on seasons. A variety of implications exists for the infrastructure of manufacturing along with a stable and balanced workforce as well as volume of production and less variability [18].

The interaction of the firm with its customers before the purchase is an important element in the improving performance. The interaction with the customers can give maximum value with the architectures of modular product by make customer able to alter the product as per the needs. The customers get the ability of altering the product, which is referred as responsiveness by the company. Making it able at a large scale is called mass customization, this results in a number of positive results [19, 20].

The alignment is created between the structure of produced products and structure of the company [21, 22]. In this way, the theoretical concepts of socio-technical, contingency theory and law of Conway is implemented [23, 24]. Moreover, the result is in line with AST. A firm is forced toward the use of horizontal integration based on the modules in a product modular [25]. It has been suggested by the theoretical concepts that outsourcing of production of modules will be done. In horizontally integrated firms have a direct influence created on performance of service as compared with the firms, which are integrated vertically. In this way, new technologies can be incorporated easily in the modules along with the changes in volume. Economies of scale can be achieved by improving quality and price structure. All these benefits result in increased responsiveness of the firm towards its customers by fulfilling their timely requirements of delivery.

The delivery system of the product is supported by the architectures of modular product to respond to the requirements of customers. A flow of activities is achieved by effective utilization of inputs, which results in performance improvement [26]. It has been suggested by literature that the changes in delivery speed requirement and customer support is influenced through product modularity. The following hypothesis is developed based on the direct effects discussed above.

H1: Product strategy is in significant relationship with the delivery performance.

H2: Product strategy is in significant relationship with the support performance.

2.2. Process strategy (process modularity) and service performance

Responsiveness is improved through process modularity by reduction in time cycle [16]. Time cycle is an element of performance delivery [27]. According to Shafer and Charnes [28], simulation reduces the time cycle for processes of modular. Time cycle is reduced when products are manufactured parallel and assembling is done based on the requirements of customers [17]. Agility is produced through designing of modular process. The ability of firm to alter its operations based on the demand of customers is referred as agility. The ability to respond to the unexpected demand changes is involved in agility. Agility is linked with the responsiveness of customers,

reduction in time cycle and speedy delivery in literature. The results are in line with the delivery performance measures used in this research.

A range of volume of product and product mix is facilitated through process modularity through equipment, which is reconfigurable. Agility is achieved when a firm is able to reconstruct the system as per the requirements rather than just forecasting the requirements. The needs of customers can be responded by using different processes of modular manufacturing. Higher flexibility is achieved through processes of modularity by restricting the changes in volume to specific segments of process. According to Droge, et al. [29], use of equipment, which is reconfigurable, determines the success of modular manufacturing systems. However, the system performance is based on the selection of equipment and locating the tasks to different workstations. A discrete function is possessed by each process such as milling, turning and drilling. The changes in demand can be dealt by activating or deactivating the process module. The activities before the sales can be supported through modular processes. The qualification of vendor can be done rapidly through modular processes as a specific portion of production processes of supplier are focused by the buyer. Time cycle is reduced through modular processes along with quick customer support and testing of product sample. Customer support can become faster with effective process of purchase decision. The following is the second hypothesis with direct effects.

H3: Process strategy is in significant relationship with the delivery performance.

H4: Process strategy is in significant relationship with the support performance.

2.3. The mediating impact of External Integration on the relation of modularity and Service performance

It is suggested by AST that socialization is influenced by the structure that impact the outcomes. The hypothesis developed is based on theories, which state that supply chain integration is influenced by process and product strategies. These influence the performance of service. Performance is influenced by the process and product modularity strategies in a direct manner as hypothesized in H1 and H2 [30]. The impact of modularity can be indirect through integration of supply chain or it can have direct influence as well. Barriers can be break down through modularity in the form of improvement in communication as an indirect affect [16].

Standardization interface support communication that leads to increased coordination within and across the boundaries of a firm. The increase of integration is associated with increase in performance along with the coordination and communication [3]. It is suggested by literature that supply chain integration indirectly influences service performance to improve through modularity.

2.3.1. Mediating Role of Supplier integration

The upstream supplier integration can be influenced positively by product modularity in a number of ways. The level of trust is increased leading to the development of a cooperative association. This increased association is linked with the better forecasting through effects of pooling [15]. Supplier integration is improved through product modularity because of low barriers in communication [16]. This results in enhanced communication with less issues or barriers [31]. Intellectual Property rights (IP) is the example related to this. One of the growing concerns among the manufacturers is the protection of IP, which reduces the risk of competitive advantage loss. The confidential information is protected for avoiding such a loss. The suppliers and buyers are kept in close relation and collaboration is maintained through product modularity by dealing with the risks related to development stage of product [30]. Sharing of information should be done to the level at which the final product is not completely revealed in the given geometries and signals. In different circumstances, a positive influence is created by integration on performance through different research approaches. The firm comes across improved performance in manufacturing through adoption of integration techniques. A study found that costs are reduced through use of integration techniques in a small manufacturing firm [32].

Integration of information and establishing relation is linked with better performance of the firm and faster delivery as per the survey analysis [33]. Moreover, a positive effect is created by upstream integration on the product development performance [34]. A positive influence is shown by Carr and Pearson [35] of supplier partnership on the performance of firm performance at large scale. Performance is influenced by management of supplier relation that is a crucial element of cooperative association with reference to quality, time, and cost. Several firms have given the anecdotal evidence, which support the association between performance and supplier integration [36]. One of the examples is of Motorola, which has achieved reduced in cost by implementing supplier integration. The second example is of Marks and Spencer, which has attained innovation along with reduction of time cycle and cost through supplier integration. Therefore, it is suggested by literature that supplier integration is influenced by modularity that influence supplier integration. The

following hypothesis can be developed incorporating the indirect effects.

H5: Supplier integration is in significant relationship with the delivery performance
H6: Supplier integration is in significant relationship with the support performance
H7: Product strategy is in significant relationship with the Supplier integration.
H8: Process strategy is in significant relationship with the Supplier integration.

H9: Supplier integration mediates the relationship between product strategy and delivery performance.
H10: Supplier integration mediates the relationship between product strategy and support performance.
H11: Supplier integration mediates the relationship between process strategy and delivery performance.
H12: Supplier integration mediates the relationship between process strategy and support performance.

2.3.2. The mediating role of Customer Integration

Customer integration is positively influenced by architectures of product modular through reduction in lead time [17]. Postponement strategies are supported by standardization and loose coupling, which reduce the lead time and create product that is pull-based. Increased level of communication is required by pull-based product and reduction of time cycle, which involve improved association among the customers and firm. Communication and customer interaction increased with the architectures of product modular [37]. A firm is able to produce products through modularity, which are highly configurable [17]. Modularity enables a firm to manage customer relationships and identify their needs. The focus on customer is increased through architectures of modular product that reflects the intention behind the partnership [38].
The customer demand pooling is supported through process modularity as smaller product modules set is achieved. Flexibility of volume and improved mix is attained as well as reduction in time cycle involved in product manufacturing and delivery Production variability is muted by demand variability aggregation to the modules. The exchange of information and coordination need to be involved in integration, which must be continuous. Exchange of information is supported by modularity, which makes the coordination better and less difficult. A positive impact of customer integration on delivery performance is evident by literature. It was found by Koufteros, et al. [38] that glitches are reduced by customer integration and delivery on time is improved by inference.
It was found by ref. [30] that responsiveness is improved by customer integration towards the needs of customers. found that there is positive correlation between customer integration and performance in delivery, which result in reduction in time cycle. It is suggested by the logical aspects in literature that customer integration is influenced by modularity and service performance is influenced by customer integration. Considering these indirect effects leads to the development of following research hypotheses.
H13: Customer integration is in significant relationship with the delivery performance
H14: Customer integration is in significant relationship with the support performance
H15: Product strategy is in significant relationship with the customer integration.
H16: Process strategy is in significant relationship with the customer integration.
H17: Customer integration mediates the relationship between product strategy and delivery performance.
H18: Customer integration mediates the relationship between product strategy and support performance.
H19: Customer integration mediates the relationship between process strategy and delivery performance.
H20: Customer integration mediates the relationship between process strategy and support performance.

3. Methodology

In this research, the relation among the variables identified has been studied. A quantitative research approach has been adopted using survey method for the collection of data. A large sample size has been used for survey analysis. The responses have been used for making inferences. The data has been collected using questionnaire survey. Through use of questionnaire, the association between the dependent, independent and mediating variable has been determined. The relation among the dependent, explanatory, and intervening variables is determined through questionnaire. The development of questionnaire was made considering the problem of research, its objectives, and research hypotheses. Moreover, the formulation of questions has been done considering the theoretical concepts studied in literature review. The Likert scale was used for scaling the responses of respondents.
Initially, the questionnaire was structured in English language but the target population of the study was based in Malaysia. The manufacturing industry of Malaysia was the population of study and the target respondents were the brand managers in manufacturing firms of Malaysia. The mother tongue of the country was Malay. Considering the

fact, the questionnaire was converted to Malay language. The process for translation was adopted as per the suggestion of Brislin [39]. The researcher claimed that the back translation process is an effective and reliable method for translation. In this process, the reliability and validity is checked by translating the translated version of questionnaire to the original language. Both the versions are compared to find the original concept relevance. Comparing the two versions, the changes are made if needed. For this process, two bilinguals were found and requested to translate the questionnaire. The two versions of questionnaire in English language were compared and little amendments were done (Rajiani & Pyplacz, 2018).

Data was analyzed using Smart PLS Version 2.0 M3. Ringle, et al. [40] have suggested the use of this software. The software is adopted in the marketing and management science studies largely. The software is capable of identifying the association and is suitable for modeling. It can handle several the non-linear latent independent variables simultaneously. Moreover, the software has the ability of identifying the errors of measurement, independents having correlation and error terms having interrelation. The technique is considered powerful because of its ability to estimate dependent relationships simultaneously. It can assess the errors of measurements and degree of association in a precise way. Moreover, CFA is considered better as compared with EFA. Confirmatory factor analysis has been used [2]. The researcher is able to involve several measures for representation of constructs and dealing with errors. Multiple variables are determined in this research in indirect path forms, predictor variable and path analysis. Interval scales and ratio has been included in the designing of questionnaire along with hypothetical and conceptual constructs measures. It was clear by the study to select SEM for research analysis. The technique enables to identify the causal association between the variables. The complexity in the research analysis and unobserved variables are highlighted as well. All Measurement items are conceptually grounded in the literature as discussed previously and are drawn from published research projects of ref. [29].

4. Results

Partial Least Squares technique is also known as second-generation structural equation modeling. The approach is supported by structural equation models, which involve the unobserved variables and different cause and effect associations [41]. Moreover, the approach is considered suitable for prediction and establishing statistical model [40]. There are several reasons behind the selection of this technique in research. The first reason is related to convenience. The PLS path modeling is easier as compared with the other models, which are complex. Moreover, it has several advantages over other techniques. The association between the dependent and independent variables is examined in this research. Moreover, the research determines the mediating impact on the associations. The second fact behind the selection of this technique is its use for the normal as well as non-normal data. The data is mostly non-normal is most of the social science studies. However, the PLS approach can be adopted to deal with this issue. The third reason for the selection of this study is its benefit in the estimation of association among the structural model constructs. It can assess the relation among indicators and the related measurement model constructs in a simultaneous way [42]. These factors make this approach very affective statistical technique. The PLS path modeling has been used based on the potential benefits of the technique. It also supports in determining the hypothesized relations, reliability, and validity of constructs.

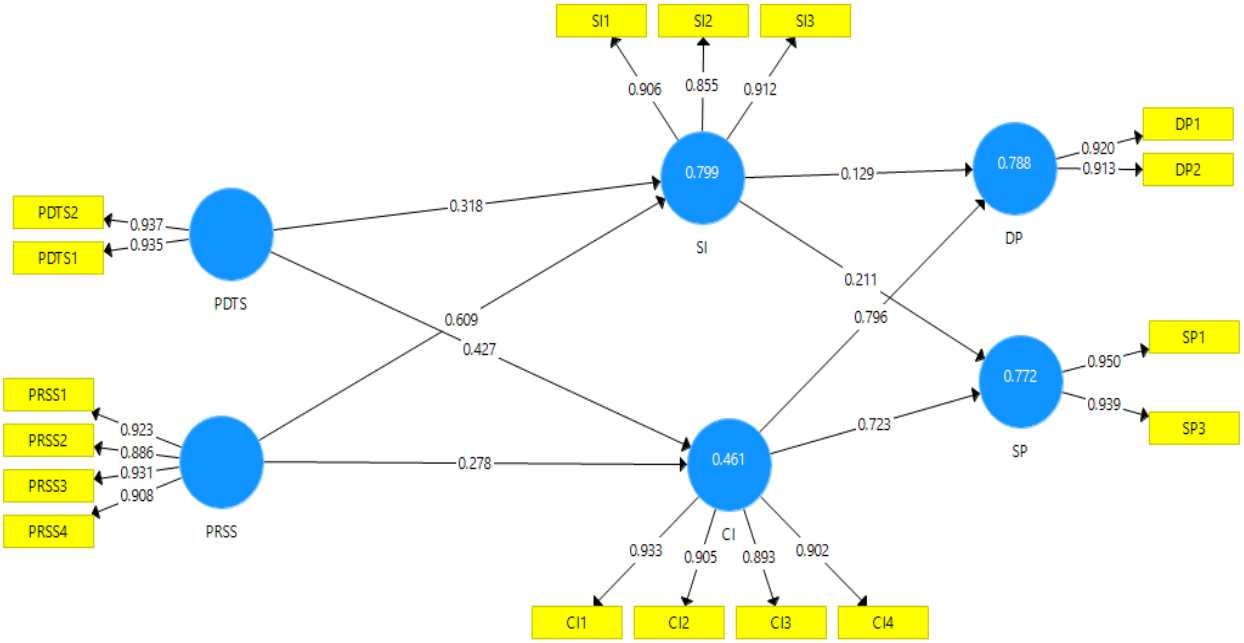

Figure 1. Measurement Model

The items with value in the range of 0.70 and 0.991 were retained.

Table 1. Outer Loadings

	CI	DP	PDTS	PRSS	SI	SP
CI1	**0.933**					
CI2	**0.905**					
CI3	**0.893**					
CI4	**0.902**					
DP1		**0.920**				
DP2		**0.913**				
PDTS2			**0.937**			
PRSS1				**0.923**		
PRSS2				**0.886**		
PRSS3				**0.931**		
PRSS4				**0.908**		
SI1					**0.906**	
SI2					**0.855**	
SI3					**0.912**	
SP1						**0.950**
SP3						**0.939**
PDTS1			**0.935**			

The suitable way of determining the reliability of internal consistency is the composite reliability in the PLS path model. Composite reliability is referred as Cronbach's α. The value of this should be greater than 0.7 according to Nunnally and Bernstein [43]. The composite reliability of every variable has been shown in the table. According to the table, the values of composite reliability for every variable lie in the range of 0.844 and 0.985. These values are greater than the standard value of 0.70. Ramayah, et al. [44] has explained the convergent validity to the level with which there exist similarity among different items measure.

Table 2. Reliability

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
CI	**0.929**	**0.929**	**0.950**	**0.825**
DP	**0.810**	**0.811**	**0.913**	**0.840**
PDTS	**0.859**	**0.859**	**0.934**	**0.876**
PRSS	**0.933**	**0.934**	**0.952**	**0.832**
SI	**0.870**	**0.872**	**0.921**	**0.795**
SP	**0.879**	**0.884**	**0.943**	**0.892**

This research study determines convergent validity by assessing the AVE (Average Variance Extract) as per the recommendation of Sweeney and Soutar [45]. Its value should be equal or greater than 0.5 to be sufficient for every variable. The items having lowest value are eliminated to improve the value of AVE. The level of difference among the constructs is referred as discriminant validity. Hair, et al. [46] recommended two measures for determining the discirminat validity. These measures include cross-loadings and criterion of [47]. The square root of the value of AVE is used in the measure of Fornell and Larcker [47] and it should be greater than the value of correlation among the variables. In this research, the value of AVE square root was greater than the value of correlation among the variables. The square root value of AVE has been shown in the table in boldface, while the value of correlation of latent variables is shown in lightface.

In empirical researches, a Fornell and Larcker [47] criterion is a widely used and an effective measure to assess the discriminant validity. Whereas, the discriminant validity shows whether the reflective variables are related to their constructs. Thus, Fornell and Larcker [47] criterion was used as a threshold. Therefore, the Reliability index must exhibit value equal or higher than 0.70. The outer and cross-loadings exhibited same values. The cross loadings in a study determines any correlation existing between the constructs. Thus, the values of discriminant validity are presented in Table 3.

Table 3. Discriminant Validity

	CI	DP	PDTS	PRSS	SI	SP
CI	0.908					
DP	0.882	0.917				
PDTS	0.663	0.581	0.936			
PRSS	0.640	0.591	0.846	0.912		
SI	0.668	0.661	0.833	0.878	0.891	
SP	0.865	0.833	0.615	0.666	0.695	0.945

The second step in the PLS analysis was to determine the model of measurement. The inner structural model was evaluated in the analysis. As per the suggestion of Henseler, et al. [48]the path coefficient significance was determined in this research along with the mediator effect, predictive relevance, and effect size. The standard process of bootstrapping was used for assessing path coefficient significance. Almost 5000 samples of bootstrap were used [48].

Table 4. Direct relationships

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
CI -> DP	0.796	0.789	0.054	14.716	**0.000**
CI -> SP	0.723	0.715	0.063	11.537	**0.000**
PDTS -> CI	0.427	0.425	0.091	4.710	**0.000**
PDTS -> DP	0.381	0.378	0.076	4.986	**0.000**
PDTS -> SI	0.318	0.316	0.086	3.692	**0.000**
PDTS -> SP	0.376	0.371	0.074	5.110	**0.000**
PRSS -> CI	0.278	0.283	0.088	3.169	**0.002**

PRSS -> DP	0.300	0.305	0.081	3.712	**0.000**
PRSS -> SI	0.609	0.610	0.089	6.849	**0.000**
PRSS -> SP	0.330	0.335	0.081	4.094	**0.000**
SI -> DP	0.129	0.136	0.056	2.323	**0.020**
SI -> SP	0.211	0.220	0.060	3.534	**0.000**

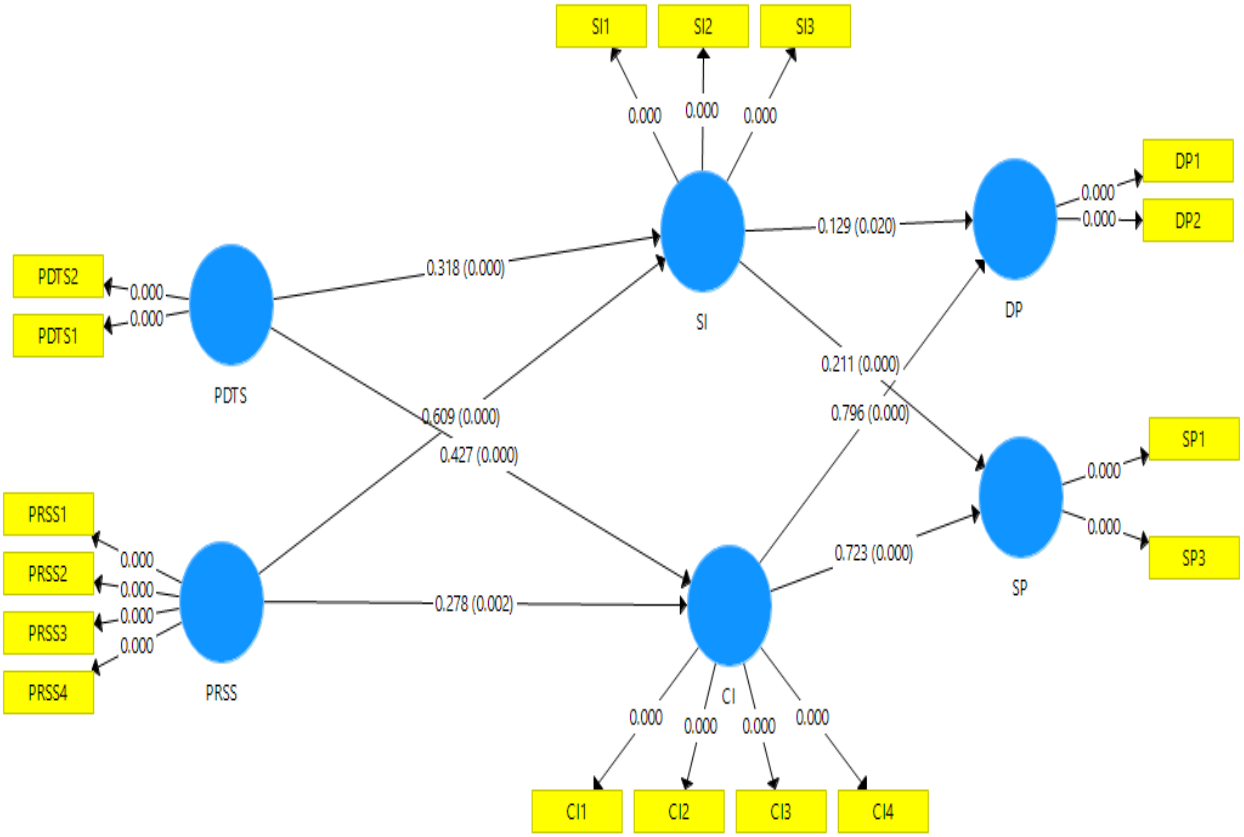

Figure 2. Structural Model

In this part, the direct and indirect hypotheses are determined having the mediators. T-value was used to determine the direct hypothesis. The minimum value to accept is considered to be at 1.96 level. The assessment of inner model has been shown in Fig. 2 and the direct effect is portrayed in Table 5. The direct hypotheses with the t-value greater than 1.96 are accepted.

Table 5. Indirect hypothesis (Mediation)

	Original Sample (O)	**Sample Mean (M)**	**Standard Deviation (STDEV)**	**T Statistics (|O/STDEV|)**	**P Values**
PDTS -> CI -> DP	0.340	0.334	0.070	4.875	**0.000**
PRSS -> CI -> DP	0.222	0.222	0.068	3.244	**0.001**
PDTS -> SI -> DP	0.041	0.044	0.023	1.806	**0.071**
PRSS -> SI -> DP	0.079	0.082	0.035	2.248	**0.025**
PDTS -> CI -> SP	0.309	0.302	0.063	4.882	**0.000**
PRSS -> CI -> SP	0.201	0.201	0.062	3.259	**0.001**
PDTS -> SI -> SP	0.067	0.069	0.025	2.635	**0.008**
PRSS -> SI -> SP	0.129	0.135	0.043	2.988	**0.003**

An important standard for determining the structural model is the value of R^2, which is the endogenous variable variance [49]. The total amount of variation in the dependent variable because of the explanatory variables is reflected by the value of R-square [46]. The value of R^2 values to be 0.250, 0.5 and 0.75 are considered weak, moderate and substantial respectively (Hair et al., 2011).

Table 6. R-Square

	R Square
CI	0.461
DP	0.788
SI	0.799
SP	0.772

5. Conclusion and Summary

The service performance is influenced by product modularity directly. It was found in the study that the three mediating factors were insignificant through integration constructs. The direct came out to be significant. The impact of process modularity is indirect because there were three potential mediation insignificant out of four. Therefore, the integration strategies are not required by product modularity as these are required by process modularity. The benefits of coordination are linked with interface for architectures of modular product. It leads to the question about the inability of intrinsic interfaces by modular processes.

It is logical to know about the interfaces types, which are standard and parallel with the products identified, when integration becomes an interface. Moreover, it should be known about the suitability of setting in which the standard types of interfaces are applied. The research also signifies the need to know that whether a particular type of integration can lead to better performance as compared with another type of integration in the similar circumstances. It is important to explore these aspects through research.

Downstream integration is crucial with reference to integration rather than the upstream integration. It is true for process modularity (antecedent) and performance of delivery (consequence). The future research can be conducted on exploring this case. It is important to reveal whether the focus of every note is on the supersede customer is required to focus on the suppliers as well or not. Alternatively, it can be said whether the customer integration makes the integration of supplier redundant or not.

The delivery performance is influenced greatly by the process and product modular strategies than the support performance. Delivery performance can be improved in five different ways; however, there are just two ways to make support performance better. There is greater range of options for the management to make delivery performance better. However, these are the not only ways to make improvements in service performance. In this research, delivery performance and support performance have been studied. The internal integration and other dimensions of organizations have not studied. These aspects can be included in future studies.

A limited AST test has been given by this research. Consistency has been revealed in some aspects where the relation of mediating variables is in line with AST test and the partial and direct effects, which are not consistent with the AST presentation in the research. An AST refinement has been suggested by this research considering the indirect effects. The research of Narasimhan and Kim [7] has been confirmed and expanded in this study by showing the effectiveness of AST in the research on supply chain. Moreover, future research can be conducted on the indirect effects such as the opportunity to associate supply chain and information systems by implementing AST.

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