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# Investigating Relationship between Product Features and Supply Chain Integration

Saied Rasul Hosseini Baharanchi

***Abstract*—**This paper addresses integration issues in supply chain, and tries to investigate how different aspects of integration are linked with some product features. Integration in this study is interpreted as "internal", "upstream" (supply), and "downstream" (demand). Two features of product innovative and quality are considered. To examine the relationships between supply chain integrations – as mentioned above, and product features, this research follows the survey method in automotive industry.The results imply that supply chain upstream integration has a higher impact on product quality, comparing to internal and supply chain downstream integrations. It is also found that the influence of supply chain downstream integration on product innovation is greater than other variables. In brief, this study mainly tackles the importance of specific level of supply chain integrations and its effects on two product features.

***Keywords*—**Supply chain upstream integration, supply chain downstream integration, internal integration, product features

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## I. Introduction

THESE days, competitive global marketplace has high influence on business activities whether they are local or international on their own. Apparently, supply chains as the key part of global business are needed to be considered in particular. In supply chain management, it is necessary for industries to develop and organise networks of activities involved in procurement, production and delivery of products globally. Considering characteristics of the abovementioned global market, a prerequisite for successful supply chain management (SCM) is the integration of flows of material and information [1]. Effective and efficient supply chain management requires integrated business processes that go beyond purchasing and logistics activities.Supply chain integration is crucial for SCM, however there are doubts about the applicability of supply chain integration practices in particular. Frohlich and Westbrook [2] point out that the supply chain integration practices vary depending on the type of firm strategy. They also state that different aspects of supply chain integration might be important under different circumstances. Hence, there is still a need for more research to investigate the relationships between each supply chain integration practice and different types of firm competitive capability.In this paper, the concept of supply chain integration is identified into different dimensions: internal, upstream or supply side, and downstream or demand side integration; and investigate the role of specific supply chain integration practices in predicting product quality and innovation performance

S. R. Hosseini Baharanchi is with the Industrial Engineering Department, Faculty member of Engineering, Imam Hossein University, Tehran, Iran (corresponding author to provide), phone: +982177104902; fax: +982177104903; (e-mail: rhoseini@ihu.ac.ir).

## II. Literature Review

Review of the literature in this section is organised in three subsection based on the different types of integration across the supply chain.

### *A. Supply Chain Integration*

There is realization that the basic concept of supply chain management is to integrate production and information flow across the supply chain processes [1]. In the supply chain context, integration is defined as the extent to which all activities within an organization, and the activities of its suppliers, customers, and other supply chain members, are integrated together [3]. An integrated supply chain is linked organizationally and coordinated with information flow, from raw materials to on-time delivery of finished products to customers. The entire supply chain is linked by information about anticipated and actual demand.

Frohlich and Westbrook [2] identify two interrelated forms of integration that manufacturers regularly employ. The first type of integration involves integrating the forward physical flow of delivery between suppliers, manufacturers, and customers. The second type of integration involves the backward integration of information technologies and the flow of data from customers to suppliers. Steven [4] classifies supply chain integration into three levels from functional integration, to internal integration, and to external integration. However, this study focuses only on internal and external integration because the functional integration is claimed as a basic requirement that all firms should implement and achieve.

### *B. Internal Integration*

To support customer requirements at the lowest total system cost, internal integration represents the integration of all internal functions from material management to production, sale, and distribution. At this stage, the firm focuses on the internal flow of goods into the organization and also on the way out to the customer. Moreover, the internal integration is characterized by full systems visibility from distribution to

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purchasing, and required integration across functions under the control of the firm to achieve customer satisfaction. In practice, it means that special attention must be given to the interface between functional areas such as procurement, production, logistics, marketing, sale, and distribution [4].

### C. Upstream and downstream integration

Upstream and downstream integration, involve the full supply chain integration which extends the scope of integration outside the company to embrace suppliers and customers [4]. More specifically, this stage of integration represents more than a change of focus from product-oriented to customer-oriented in relation to mutual support and cooperation. A review of the external supply chain integration literature reveals two major areas of emphasis. They are: (1) customer integration, and (2) supply integration.

For the supply integration, integration back down to the suppliers represents a change in attitude, away from conflict to cooperation starting from product development, supply high quality products, process and specification change information, technology exchange, and design support. Some researchers have investigated the supply-side integration in different dimensions. Handfield [5] defines supply integration as obtaining frequent deliveries in small lots, using single or dual sources of supply, evaluating alternative sources on the basis of quality and delivery instead of price, and establishing long-term contracts with suppliers. In terms of logistics communication, this concept could be viewed supply integration as the effective alignment, information sharing, and supplier participation between suppliers and manufacturers.

In terms of customer integration, the firm will penetrate deep into the customer organization to understand the product, culture, market and organization so that it can response rapidly to the customer's needs and requirements. The important concept of demand integration is based on the improvement of demand planning and visibility in supply chains. Without information sharing from one end of the supply chain to the other, it can lead to tremendous inefficiencies in customer service.

## III. Research Questions

Recent studies have indicated that supply chain integration will directly lead to considerable improvement in firm's performance. Steven [4] believes that to achieve competitive advantage, supply chain integration is crucial. The study of [6] in consumer products manufacturer demonstrates a significant relationship between supply chain integration intensity and such measures as cost, process flexibility, product quality, and delivery. However, most of the previous researches have failed to separate supply chain integration into different stages. Therefore, this study will specifically aim to present hypotheses linking the stage of supply chain integration and product quality and innovation.

### A. Supply chain integration and product quality performance

According to the total quality management (TQM), the key issue regarding extending a total quality approach across the organizational interface is essentially related to integration [7]. Dyer [8] states that effective collaboration between functions and between customers and suppliers can increase product quality. To support this statement, [9] surveyed 500 purchasing professionals and found that their high level of service quality leading to customer satisfaction was related to the level of collaboration with internal suppliers and internal customers. Moreover, inter-functional integration within a firm can improve performance in terms of better customer service [10].

Extended to the external integration, previous studies have shown that supply integration would lead to improved product quality. Erickson and Kanagal [11] and Wong [12] report that integrating with suppliers in terms of supplier participation and information sharing can help companies achieve higher product quality performance. In addition, strategic supplier partnership through technology sharing has been reported to yield specific benefits in terms of product quality [13, 14]. Besides supply integration, demand integration is also significantly related to product quality in terms of customer satisfaction and product customization because firms which closely interact with selected customers will better understand the detailed wants and needs of their customers [15, 16]. Basnet et al. [17] also find significant correlation between information sharing with customers through understanding customers' needs and product quality.

*Therefore, the following hypothesis was established:*

***Hypotheses 1a-1c****:* The higher the supply chain integration (a) internal, (b) supply, and (c) customer integration, the higher product quality performance.

### B. Supply chain integration and product innovation performance

The ability to develop new products rapidly is an important source of competitive advantage in many industries [18, 19]. More specifically, as suggested by [20], automakers which can develop new products more quickly than competitors have an advantage because their current models are more advanced and include the latest in technology. Moreover, [21] finds the significant relationship between performance in product innovation and functional integration through a survey of 40 British and Dutch companies from various sectors. To support this finding, Kahn and Mentzer [10] and Song et al. [11] indicate that the level of cross-functional integration is significantly related to new product development performance. It is also expected that supply integration will lead to improved product innovation performance. Ragatz et al. [14] develop an integrating supplier framework suggesting that effective integration of suppliers into product innovation can yield such benefits through reduced product development time and improved access to an application of technology. Within this perspective, other studies (e.g. [23]) also state the effects of supplier involvement in the performance of production innovativeness process. Consequently, close linkages between

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design and manufacturing both internally and with suppliers are often important for the success of product innovation [20]. Further discussed on customer involvement, Stank et al [16] suggest that demand integration relies on an assessment of a firm's strengths and weaknesses relative to the service requirements of its customers. In this concept, Waller et al. [24] point out that making a decision based on the consuming organization through vendor-managed inventory can shorten product development time. A survey of 160 Indian firms reveals that the level of customer involvement is high in product development process [25]. Therefore, the following hypotheses are established:

***Hypotheses 2a-2c:*** The higher the integration of supply chain; (a) internal, (b) supply, and (c) customer integration, the higher product innovation performance.

Hypotheses group 1 and 2 are summarized in Fig. **1**.

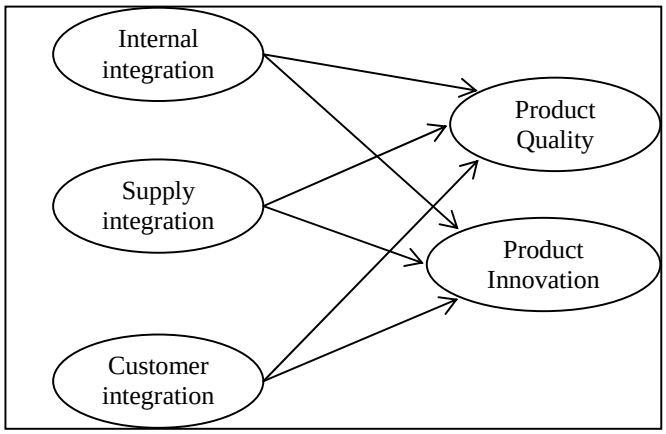



Fig. 1 Research Hypotheses

## IV. Methodology

The research method used to test the hypotheses is survey. This study used five-point scale for three constructs of independent variable (internal integration, supply integration, and customer integration) and two dependent variables (product quality and product innovation performance) to draft a questionnaire. This draft questionnaire then was pre-tested with academics and practitioners to check its content validity and modified accordingly. The modified questionnaire was pilot tested to examine its suitability for the target population before large-scale mailing.

Empirical data was obtained through a questionnaire survey to production or purchasing managers, who had knowledge of supply chain management practices. These respondents were asked to rate their firms relative to their understanding on supply chain integration and firm performance in his/her plant. The unit of analysis in this study was limited to plant level. Within this perspective, Flynn et al. [26] point out that most empirical research in operations management occurs at the corporation or individual level of analysis. Moreover, the independent variables of supply chain management practices usually reflect corporate level practices. Similarly, the dependent variable of firm competitive capability also reflects the corporate level results.

The survey specifically concentrates on automotive industry. This study selects this industry because of the following reasons. First, automotive industry is seen as an indicator to measure the wealth of the economy [27]. Second, the literature in automotive supply chain has been well documented in previous researches, and there is a clear structure of automotive supply chain [28]. Finally, automotive sector has been a leader in implementing supply chain management strategies in Iran industry. Some questionnaires have been submitted by post with a cover letter indicating the purpose of this study to qualified automotive suppliers. Some questionnaires have also been handed in directly, and some have been filled through structured interviews. Total number of distributed questionnaires was 403.

Initially, 91 completed responses received, and succeeding follow ups collected more 20 responded questionnaires. The total 111 responses were returned to the response rate of 27.5 % which is a good response rate.

The non-response bias was evaluated using the method suggested by Armstrong and Overton [29]. This method tested for significant different between early and late respondents, with a late respondents being considered as a non-respondent. By using this method, although it did not investigate non-response directly, a comparison was made between those subjects who responded in the first wave and the second wave [30]. A one-way analysis of variance (ANOVA) was used to make the comparisons in demographic variables, namely, number of employee, respondent's position, and number of years in business. Along with the demographic variables, randomly selected variables were also included in this analysis. The results indicate no significant different on any criteria, which the significant level, is far from 0.1. Based on the ANOVA test, non-response bias may not be the problem in this study; and the two waves were pooled for subsequent analysis.

## V. Date analysis

Table I presents the correlations between variables, which can serve as a predictor of predictive validity. In fact, predictive validity represents how scores on one scale relate to scores on others. In the current study, the results indicate that the three independent variables (internal, supply, and customer integration) are strongly correlated to firm performance (product quality and innovation), indicating that firms commonly implement all supply chain integration practices (internal integration, supply integration, and customer integration) in order to achieve high performance in product quality and innovation. Therefore, correlation analysis shows the association of five variables that constituted to the conceptual framework (Fig. **1**). However, it is important to note that the strengths of correlations are higher for product quality than product innovation. In addition, within product innovation performance, customer integration seems to have the strongest correlation compared to the rest of internal and supply integration.

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TABLE I
CORRELATIONS AMONG CONSTRUCTS

| Elements | Internal Integration | Supply Integration | Customer Integration | Product Quality | Product nnovation |
|---|---|---|---|---|---|
| Internal ntegration | 1 | | | | |
| Supply ntegration | 0.505 | 1 | | | |
| Customer ntegration | 0.504 | 0.520 | 1 | | |
| Product Quality | 0.425 | 0.452 | 0.410 | 1 | |
| Product nnovation | 0.269 | 0.355 | 0.400 | 0.476 | 1 |

Table I shows the two multiple regressions of the three supply chain integration activities regressed on the two firm performance measures. Overall, both relationship models resulted in the R-square of 0.25 and 0.21, indicating acceptable explanatory power of the variance of the dependent variable. In addition, these R-square values were accompanied by an F-statistic for the regression which was highly significant, indicating a relatively strong relationship. In regards to the regression analysis with product quality, the result indicates that the strongest predictor was supply integration, followed by customer and internal integration based on beta values. In regards to product innovation, analysis for each individual predictor also indicates that customer integration shows the strongest significant predictor, followed by supply integration. However, internal integration is the only variable that is not significantly related to product innovation.

The overall result suggests that supply chain integration practices, which are proven to be effectively influenced in product quality, do not necessary to indicate a similar effect toward product innovation. For example, internal integration is highly significant associated with only product quality, but not with product innovation. In addition, it is interesting to find that the impact of predictor variables (beta values) is different depending on specific firm performance. For instance, customer integration shows a relatively stronger relationship in product innovation than do in product quality.

TABLE II
REGRESSION ANALYSES OF SUPPLY CHAIN INTEGRATION PRACTICES ON FIRM PERFORMANCES

| | Product Quality | | Product Innovation | |
|---|---|---|---|---|
| | Std. Beta | Sig. | Std. Beta | Sig. |
| Internal integration | 0.18 | 0.05 | 0.04 | 0.67 |
| Supply integration | 0.24** | 0.01 | 0.20* | 0.04 |
| Customer integration | 0.20* | 0.03 | 0.28** | 0.00 |
| * p < 0.05 | | | | |
| ** p < 0.01 | R2=0.25 | | R2=0.21 | |
| | F Statistics = 15.99** | | F Statistics = 11.15** | |

## VI. DISCUSSION AND CONCLUSION

The results illustrated in Table II provide some supports for the model of this study. The positive effect of supply and customer integration on both product quality and innovation is supported. Therefore, this result provides a confirmation on the previous studies that firms operating in highly collaborative practices with suppliers and customers are likely to have an excellence performance in product quality and innovation due to the improvement of information visibility in supply chain. However, more specifically, the results in multiple regressions show the different impacts of each integrative practice in explaining specific performance (product quality and product innovation). To be consistent with this observation, some researches such as [2] also suggest that different business goals might require different aspects of supply chain integration practices. Findings of the current study support this view. Firms targeting in high product quality performance require a greater need for supply integration than customer integration. On the other hand, firms that focus on product innovation need more focus on customer integration than supply integration. This result could be explained in two ways.

Firstly, most suppliers in automotive industry will expect to participate in supplier relationship management (SRM) provided by automakers in order to control and ensure high quality of their incoming parts. Therefore, as a part of SRM, supply integration should be expected to play a significant role in purchasing and production systems, leading to high product quality performance. Secondly, for firms focusing on product innovation, the role of customers could emphasize and follow from firm's moving to highly involve them in the new product development process. Being more integrated with customers also enables firms to more quickly respond to their product changing needs in the product innovation process.

Internal integration, on the other hand, indicates not only the weakest relationship with product quality but also insignificant predictor to product innovation. This seems surprising given that this particular integration practice plays the weakest factor. However, some researchers postulate that internal integration has an indirect effect and not necessary a direct influence [31]. Internal integration seems to be a prerequisite for the influence of supply chain integration practice on high product quality and innovation performance. Managers must ensure that the entire functional teams within firm are integrated in order to achieve supply and customer integration.

In terms of research contributions, this study highlights the importance of specific level of supply chain integration in considering strategies for boosting firm competitive capability. However, these results should not be interpreted to mean that other weaker predictor variable in specific performance would be ignored. In fact, these variables may be interacted or moderated so that the magnitude of its effect is changed. Future research should consider explaining such interaction and moderation in different supply chain integration practices. In regards to implications for managers, firms need to choose the specific supply chain integration strategy on developing

product quality and product innovation. The results provide managerial insights about specific integration practices that are effective in specific product quality and innovation performance. Managers can, therefore, ask about operational objectives in their firms so that they can focus on the right supply chain integration strategy. In addition, the findings provide additional support, building on the previous literature mostly conducted in Western countries, for the value of supply chain integration. Results of this study offer confirmation from the different context as an empirical study of supply chain integration in automotive industry.

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