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FLEXIBILITY AND EFFECTIVENESS IN REVERSE LOGISTICS OF PRODUCT RETURNS IN THE FORM OF PARTS AND SUB-ASSEMBLIES

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ABSTRACT

Reverse logistics has become a major component of extended producer's responsibility. The dynamic nature of reverse logistics and the uncertainties within it demands more investigations on its variables. This paper elaborates the findings of a survey using factor analysis in investigations of factors influencing return handling of products in the form of parts and subassemblies. The Statistical Package for Social Sciences version 17 was used to analyze the effect of independent variables on key dependent variables. A survey was carried out over the firms experiencing product returns in terms of parts and sub-assemblies in the vicinity of Mumbai, India. It revealed product design, retrieval centers, information technology, return policies; organizational role and forecasting have significant effect on the flexibility and effectiveness of reverse logistics of parts and sub-assemblies. Implementing reverse logistics with adequate consideration to these factors could bring enterprises a competitive advantage and many business opportunities. This research contributes to theory of reverse logistics with an anticipation of providing guidelines to the enterprises taking up the reverse logistics program.

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INTRODUCTION

Supply chain management is undoubtedly a primary concern for any enterprise of today for being competitive. The forward logistics in the supply chain had been studied so well and various models for an efficient handling of the same have been worked out by different researcher, practitioners and academicians. The need of reverse logistics has been realized as a result of environmental safety and the regulations pertaining to it in different nations. The companies involved in manufacturing are incorporating reverse logistics in their supply chain management activities also many business enterprises look at reverse logistics as gaining business advantage on product returns (Das and Chaudhury, 2012). Many studies have given different insights on this topic. Moore (2006) in his investigations mentions, "It is estimated that reverse logistics costs account for almost one percent of the total United States gross domestic product and is rapidly becoming an integral component of retailers and manufacturers profitability and competitive position".

"The Center for Logistics Management at the University of Nevada conservatively estimates that 6 percent of all goods may be returned, but concedes that the true number may be closer to 8 percent" (Roger & Tibben-Lembke, 1999). The literature on reverse logistics is often seen in form of descriptive nature exploring the area of reverse logistics and its implementation. However, the literature on the service improvement and effectiveness of reverse logistics is surprisingly less. We set our objectives with respect to these research gaps as to identify the factors influencing the flexibility and effectiveness of reverse logistics. For the present study, the product returns taken into consideration are the returns in the form of part and subassemblies.

LITERATURE REVIEW

Reverse logistics was seen as an important concern by the various enterprises in 90's. (Pohlen & Farris, 1992) defined reverse logistics as, "The movement of goods from customer towards a producer in a channel of distribution". Roger & Tibben-Lembke,(1999), Dowlatsahi, (2000), Dowlatsahi, (2005), Brito and Dekker, (2003) also defined reverse logistics in their own words however the definitions reflect similar concept. The concept is moving of the product back into the

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supply chain for the purpose of capturing value or otherwise disposal. Reverse logistics activities begins after the sale of the product. These activities are multiple in nature which include customer support, product warranties, maintenance and repair, product upgrades, sales of complementary products and the product disposal (Aminia *et al.*, 2005). Legislations of different nations are making it mandatory for the proper disposal of the product in order to protect the environment and reduce the issues of land fill. European legislation is believed to be more advanced in the regulations on recycling and disposal of by-product (Lambert *et al.*, 2011). The concern of environment motivated reverse flows and thus reverse logistics become the subject of research (Fleischmann *et al.*, 1997).

Adenso-Diaz *et al.* (2012) carried an analysis of the main factors affecting bullwhip effect in reverse supply chains and identified demand variance, forecasting technique, demand variability, the delays between the chain's links and shared information being available are the accelerators for bull-whip effect in reverse supply chain. The two main components of any successful reverse logistics system are information management and disposal system (Lambert *et al.*, 2011). Thierry *et al.* (1995) gives five categories of product recovery as remanufacturing, repairing, refurbishing, cannibalization and recycling. Mukhopadhyay & Setuputro, (2005) proposed a planning approach of reverse logistics based on modular product design. The importance of reverse logistics is extremely difficult to evaluate due to its existence within the logistics infrastructure of the company (Stock, 2001). A good reverse logistics program should have flexibility and effectiveness. These variables were taken as performance indicators for reverse logistics.

THEORY DEVELOPMENT

Development of Constructs

Any product design is appreciable if it is avoiding undesired aspects in the particular product (Chitale & Gupta, 2008). Most of the reverse logistics activities mainly focus on remanufacturing & recycling (Dowlatsahi, 2000). Thus, it is clear that product design influence remanufacturing flexibility. Use of information technology refers to supplement the reverse logistics activities with its modern compatibility. Govindan *et al.* (2012) proposed information technology as an attributes to reverse logistics. Thus information technology will exhibit important role in flexibility and effectiveness of reverse logistics. Return policies can be seen as major drivers for sales and customer satisfaction. Liberal or restrictive return policies make a significant effect on product return handling (Richey *et al.*, 2005). Return policies play an important role in effective reverse logistics program and is thus considered as an important independent variable. The construct of organizational role refers to decision making on the arrival of product return. Decision makers must be aware of the relative importance of the various drivers and the techniques for implementing them. Reverse logistics is an activity within the organization that intends towards customer satisfaction (Meade and Sarkis, 2002). Strategic planning in supply chain management considers the issues such as organizational structure, top management support and the all other activities focusing to develop an effective supply chain (Gunasekaran *et al.*, 2004). Thus, organizational role governs the flexibility in

reverse logistics. Forecasting refers estimates on product returns and can be treated as preplanning for handling of returns. Toktay *et al.*, (2003) finds that future returns are the function of past sales. Thus, forecasting can make significant effect on improving effectiveness of reverse logistics program of any enterprise. Flexibility can be defined as “the capacity of manufacturing system to adapt successfully to changing environmental condition as well as changing product and process requirement” Swamidass,(2000). Returns may vary largely on the condition and the severity as well. The remanufacturing systems need to be adaptable as to this variation. Flexible remanufacturing systems can make it easy for the reverse logistics for the parts and subassemblies. Effectiveness refers to the level of performance exhibited by the program and hence is taken as an important performance indicators. The organization, which observes higher rate of returns, tends to develop a reverse logistics program more effectively (Johnson, 1998). The study on the challenge of reverse logistics in catalog retailing by Autry *et al.*,(2001) reached to the conclusion that smaller volume firms are performing well in terms of reverse logistics.

Conceptual Framework

The scope of this research is within the conceptual framework presented in the figure 1 with the returns as parts and subassemblies

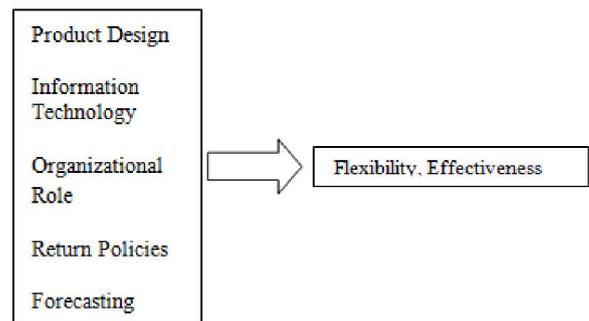


Figure 1. Conceptual Framework

RESEARCH METHODOLOGY

Hypotheses

- H1 Product design strategies for environment will make a significant effect on flexibility of reverse logistics system
- H2 Use of information technology as an enabler for return processing will makes a significant effect on the flexibility reverse logistics
- H3 Organizational role in decision making on the returns will make a significant effect of flexibility of reverse logistics
- H4 Use of information technology as an enabler for return processing will make a significant effect on the effectiveness of reverse logistics
- H5 Liberal return policies will have a significant effect on the effectiveness of the reverse logistics.
- H6 Forecasting the expected returns will have a significant effect on the effectiveness of reverse logistics.

Data Collection

We surveyed 383 small to large size firms through a survey questionnaire. As Hair *et al.* (2012) suggests a general rule for

researcher to obtain observations five times greater than the number of variables to be analyzed. Thus 383 were adequate to take up the analysis.

Measurement Scales

Measurement scales used in this analysis were all matured scales from previous research. Respondents were asked to mark their response on a 0- 5 Point scale [0= not at all, 1 = to very little extent, 2 = to some extent, 3 = to reasonable extent, 4 = to reasonably high extent, 5 = to very high extent].

Validity and Reliability

We made an initial test of KMO and Bartlett’s test of sphericity to check sampling adequacy for factor analysis. The test resulted in the values greater than 0.5 indicating the sample being adequate for factor analysis Kaizer, (1974). Bartlett’s test was favorable representing the existence of correlation amongst the variables selected. The factors loading values were always greater than 0.40 indicating significant convergent validity Narkhede *et al.*, (2012). Matrix had no cross loading which ensured significant discriminant validity. Constructs had significant nomological validity, as the scales used were all matured scales Hair *et al.*, (2012). Reliability of the data was ensured using reliability coefficient. Cronbach alpha assesses the consistency of the entire scales, the suggested Cronbach alpha is a minimum of 0.60 Hair *et al.*, (2012), Hulland, (1999). The reliability test resulted in Cronbach alpha above 0.60 indicating significant reliability of measures. Table 1 shows correlation matrix Table 2 gives complete statistics of constructs.

Table 1. Correlation Matrix

| | PD | IT | RP | OR | F | FX | ERL |
|-----|--------|--------|--------|--------|--------|-------|-----|
| PD | 1 | | | | | | |
| IT | .181** | 1 | | | | | |
| RP | .021 | .539** | 1 | | | | |
| OR | -.131* | .266** | .462** | 1 | | | |
| F | -.033 | .382** | .412** | .395** | 1 | | |
| FX | .393** | .280** | .129* | .148** | .274** | 1 | |
| ERL | -.124* | .416** | .432** | .337** | .572** | .104* | 1 |

*. Correlation is significant at the 0.05 level (2-tailed).
 **. Correlation is significant at the 0.01 level (2-tailed)

Table 2. Statistics of construct

| Constructs | KMO values | Cronbach Alpha | Eigen Values | % Variance explained | No. of Factors Indicated |
|------------|------------|----------------|--------------|----------------------|--------------------------|
| PD | .819 | .943 | 5.866 | 15.933 | 04 |
| IT | | .845 | 3.764 | 29.787 | 05 |
| RP | | .823 | 2.180 | 42.626 | 04 |
| OR | | .823 | 1.561 | 52.954 | 03 |
| F | | .672 | 1.100 | 71.713 | 03 |
| FX | .740 | .817 | 3.752 | 20.251 | 04 |
| ERL | | .686 | 1.157 | 66.433 | 03 |

RESULTS AND DISCUSSION

To test the effect of product design, use of IT, return policies, organizational role and forecasting on the Flexibility and Effectiveness of reverse logistics following equations were made.

$$\text{Flexibility} = \alpha + \beta_1 * \text{PD} + \beta_2 * \text{IT} + \beta_3 * \text{OR}$$

$$\text{Effectiveness} = \alpha + \beta_1 * \text{RC} + \beta_2 * \text{IT} + \beta_3 * \text{RP} + \beta_4 * \text{F}$$

We tested (H1, H2, H3) effect of product design, information technology and organizational role on the flexibility of reverse logistics. The test resulted in the R² value of .220 representing a good model fit. This value is significant to define a high strength of association of the variables. H1 is supported with β value of .382 and P value .000. H2 is supported with β value of .170 and P value of .000. H3 is supported with β value of .152 and P value of .002. Normality of the error terms were tested by examining Histogram and Normal Probability plot. Histogram being the simplest diagnostic tool for normality checks (Hair *et al.*, 2012). The visual check of histogram indicates an approximately normal distribution. If the distribution is normal, the residual line closely follows the diagonal (Hair *et al.*, 2012). The examination of normal probability plot indicates the normal distribution. Multicollinearity test was carried to examine the existence of any multicollinearity affecting the analysis. The tolerance values and Variance inflation factors were checked. There was no multicollinearity within the variables observed. Accepted level of tolerance upto 0.10 corresponding to VIF of 10 (Hair *et al.*, 2012) was considered.

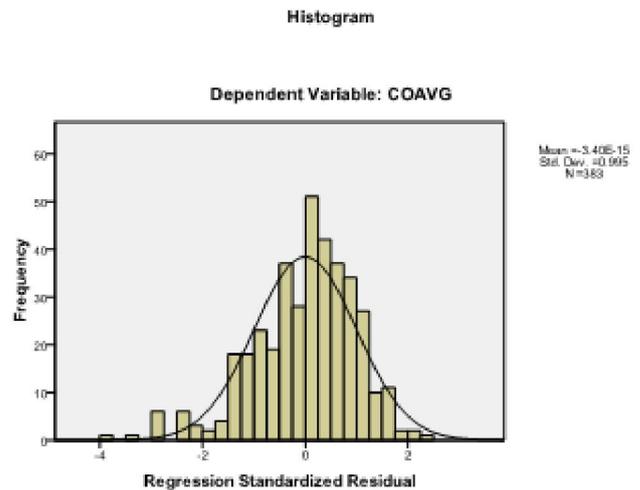


Figure 1. Histogram for normality check

Normal P-P Plot of Regression Standardized Residual

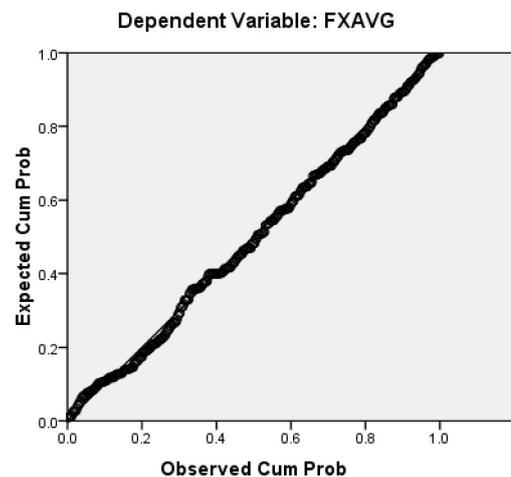


Figure 2. Normal Probability Plot for normality check

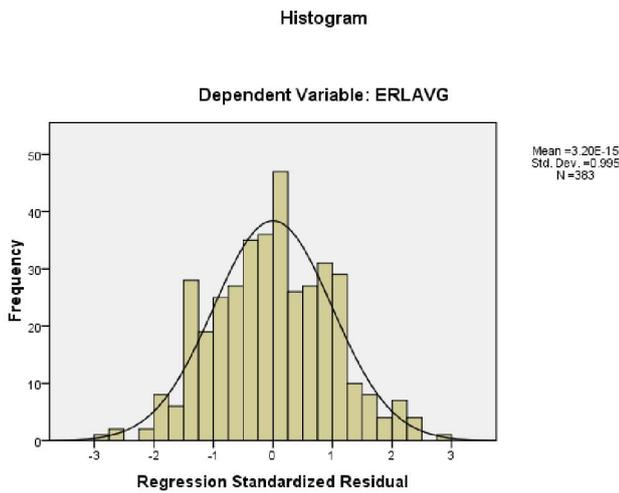


Figure 4. Histogram for normality check

Normal P-P Plot of Regression Standardized Residual

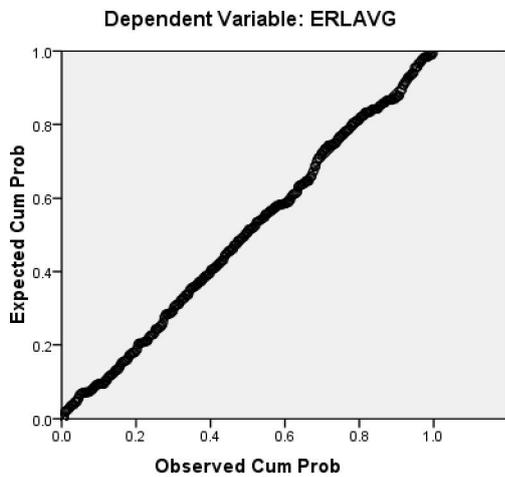


Figure 5. Normal Probability Plot for normality check

Table 3. Hypothesis Test Results

| Hypothesis | Results |
|---|-------------------------------|
| H1 Product design strategies for environment will make a significant effect on flexibility of reverse logistics system | 0.220, 0.382, 0.000 Supported |
| H2 Use of information technology as an enabler for return processing will makes a significant effect on the flexibility reverse logistics | 0.220, 0.170, 0.000 Supported |
| H3 Organizational role in decision making on the returns will make a significant effect of flexibility of reverse logistics | 0.220, 0.152, 0.002 Supported |
| H4 Use of information technology as an enabler for return processing will make a significant effect on the effectiveness of reverse logistics | 0.392, 0.170, 0.001 Supported |
| H5 Liberal returns policies will have a significant effect on the effectiveness of the reverse logistics. | 0.392, 0.164, 0.001 Supported |
| H6 Forecasting the expected returns will have a significant effect on the effectiveness of reverse logistics. | 0.392, 0.443, 0.000 Supported |

We tested H4, H5 and H6 for effect of information technology, return policies and forecasting on the

effectiveness of reverse logistics. The test resulted in the R² value of .392 representing a very good model fit. H4 is supported with β value of .170 and P value of .001. H5 is supported with a β value of .164 and the P value of .001. H6 is supported with β value of .443 and P value of .000.

The resulting equations after analysis.

Flexibility = 0.382 PD + 0.170 IT + 0.152 OR
Effectiveness = 0.170 IT + 0.164 RP + 0.443 F

CONCLUSIONS

This study has the limitation of product return in the form of parts and subassemblies and the only performance measure considered for the study are the flexibility and effectiveness of reverse logistics. In this study, we have empirically studied the role of product design, use of information technology, return policies, importance of organizational decision making and forecasting. The analysis of data was from small to large-scale. The present research offers a scope of study on a very similar ground where the returns could be categorized in terms of the degree to which the cause of return may be estimated.

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