Modelling and evaluation of investment strategies in human resources for logistics improvement

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Abstract: Logistics cost is an important factor that affects the competitiveness of nations as well as firms. High logistics costs and low levels of service are a barrier to trade and foreign direct investment and thus to economic growth. Shortening of production cycles, amplification of competition globally, sharing and outsourcing of production processes, shorter delivery times and plethora of choices for customers have made logistics a potential source of competitive advantage. The success of logistics depends on the quality, qualification, skills and commitment of the employees and to excel in future, firms need to attract, retain and develop individuals with the right skills and, capabilities. The paper evaluates various investment strategies for investment in human resources by an Indian-based logistics firm using system dynamics modelling to study the effect of improvement in human resources on the logistics performance index.

Keywords: system dynamics; simulation; human resources; logistics performance index; LPI; modeling; investment; causal loop diagram; reliability; flexibility; safety; delivery time; logistics cost.


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the specific areas of organisational behaviour, human resource management and strategic management. During her academic career she has to her credit the publication of few research papers and presentation of research papers at international conferences. She has also attended many seminars, workshops and conferences.

1 Introduction

Logistics cost is a significant feature that influences the competitiveness of the organisation as well as the country. It is one of the key elements in the product cost, motivating manufacturers and service providers for nominal and efficient logistics solutions. The annual logistics cost in India is valued at Rs. 6,750 billion (US$135 billion) and its growing 8% to 10% annually (NSDC, 2011). The emerging market survey 2011 conducted by Transport Intelligence, highlights India’s attractiveness as a strong growth area for logistics in future and emerging as a major logistics hub (Deloitte, 2012). According to the national skill development organisation of India, transportation and logistics sector employed 7.3 million people in 2011, but the number is expected to increase to 25 million in 2022, raising a requirement of 17 million workers in the next ten years (PwC, 2012).

Since the logistics function is shifting to a strategic role from operational and third party logistics service providers becoming strategic partners, logistics management in today’s environment has become more complex. Logistics providers today are expected to provide complete end-to-end logistical support throughout the supply chain cycle of a business, cutting down costs and lead time and offering integrated one stop logistics solution for businesses to maintaining their bottom line. The logistics cost in India is around 13% to 14% of GDP, which is much higher than Europe (10%), the USA (9%) and Japan (11%) (Deloitte, 2012). With such high logistics cost, the competitiveness of Indian organisations is getting severely hampered.

The main reasons for the high costs are lack of skilled manpower along with poor infrastructure and complex government regulations. The Indian logistics industry suffers from acute labour shortages due to the following core issues identified by KPMG (2007):

1. Poor image/lack of attractiveness for new recruits arising from poor working conditions and relatively low attractive pay and progression incentives – in turn arising from the fragmented and unorganised nature of the industry.
2. Rapid evolution in the logistics management processes and operations with technological change and changing customer requirements.
3. Absence of an institutionalised skill development environment.
4. Emergence of attractive career alternatives leading to attrition (especially in sectors where logistics skills come in handy like organised retail).

According to a report by KPMG (2007), from a survey done on 80 logistics company it was found that the manpower costs forms 8% to 10% of overall costs in the sector (in case of road logistics it is 4%). This roughly translates to about Rs. 500 billion spent on logistics manpower annually. Of this, only 13% to 14% is spent on non-salary expenses such as manpower development items like welfare, training, etc., which is much less than in global logistics countries which spend more than 20% (KPMG, 2007).

People are an expensive, critical resource in any organisation, and can represent a powerful source of sustained advantage which profoundly affects other resources, such as customers, brand reputation, intellectual property, and cash (Warren and Kourdi, 2003). The Indian logistics sector is suffering from talent shortage in terms of both quality and quantity leading to improper handling of products, rash driving, high level of losses, damages, deterioration of stocks, separate person for each activity rather than multi-tasking, lower standard of living, etc. At management and mid-tier levels, the logistical sector in India suffers from organisational skills, lack of leadership, disjointed skills and positions and lack of process driven systems (LCL, 2011). With the reasons stated above lack of infrastructural facilities, low pay scale, lack of clearly defined career path, no suitable designations, lack of accountability and proper training and poor or non-existent manpower policies make this sector the most unattractive sector for employment among job seekers including female workforce leading to improper and less recruitment and high attrition rates. This has widened the gap between skill set required and skill set available in the industry. To have a world class logistics system, the prerequisite is the team which can run such system. Hence, it is required to improve the human resources (HRs) available, which is influenced by the investment in HRs by the government and the private sector. At international level, companies that are effective in their supply chain practices put a lot of emphasis on developing their HR by adopting HRM practices such as training and retraining their employees and providing them with the adaptability that will help them fulfil their role in the supply chain (Anastasiou, 2012).

HR is a critical factor in achieving logistics excellence (Gowen and Tallon, 2003). Possessing HRs does not necessarily lead to firm’s success rather poor human resource management (HRM) can negatively impact the employee’s perception towards job satisfaction and their organisational commitment which in turn influences the firm’s ability to achieve its performance goals (Ding et al., 2015). HRM practices like training, reward management, performance management, job design, staffing are considered important for making an integrated supply chain
which in turn leads to improved supply chain performance in terms of cost, quality, delivery and flexibility (Shub and Stonebraker, 2009).

Government and organisations are focusing on investment and development of infrastructure and technology adoption to improve logistics performance. But simultaneously the need of the hour is to focus on the development of people who manage the logistics operations. Owing to availability of cheap labour, HR is not considered as an important asset in the Indian business environment. With 95% unorganised logistics market, it is very difficult to convince the company to invest in improvement in HRs. To improve the HR in the logistics sector in the Indian context, investment is required in areas like imparting training, providing wages at par with other sectors of the economy keeping the job requirement in view, improving working conditions and enhancing employee welfare. The emphasis and priority of these areas can differ from organisation to organisation depending upon the existing level of these factors, the investment required in each area and improvement potential.

Simulation and optimisation are salient tools in the supply chain management (SCM) field as a means for increasing performance (Rios Prado et al., 2014). It can be an excellent test-bed to evaluate the effects of a particular policy under a wide set of operational conditions taking into account variability and stochasticity that are unavoidable features of complex systems (Nicoletti et al., 2014). Therefore, through system dynamics modelling, this study is an attempt to identify the impact of improvement in HRs on logistics performance.

The rest of the paper is structured as follows. Section 2 presents the review of literature. Section 3 discusses the methodology, development of causal loop diagram and system dynamics model. Section 4 discusses the identified problem and full description of the case under study. Section 5 discusses the model validation. Finally, results and discussion, conclusion, managerial implication and future work are discussed in Section 6, Section 7, Section 8 and Section 9, respectively.

2 Literature review

2.1 Role of HRs in logistics

A lot of studies have been conducted to examine the role of HRs in logistics management and organisational performance. Table 1 shows the benefits of various HRM practices in logistics.

Asthana (2012) has identified the changing trends in Indian logistics services and the growing requirement for skilled and trained HR, intensifying the skill gap situation arising as a result of movement of Indian logistics sector from mere in house staff to complex 3PL SCM system. Jhawar et al. (2014) conducted a study which proved that skilled workforce has a very positive effect on the logistics performance index (LPI).

2.2 Improvement in training, wages, working condition and welfare

Table 2 depicts the various authors who have highlighted the importance of improvement in training, welfare, wages and working conditions. Very few authors have studied the importance of investment in all the four activities considered in the paper. It can be observed that importance of welfare can be seen only in studies conducted in the last five years. But improvement in working conditions is still not the area of interest for many researchers and it is a topic of concern as it is one of the crucial factors for the unattractive image of the logistics sector in the Indian market.

<table>
<thead>
<tr>
<th>S. no.</th>
<th>HRM practices</th>
<th>Authors/s</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Recruiting, selection and compensation</td>
<td>Gibson and Cook (2001), Ding et al. (2015), Barnes and Liao (2012)</td>
<td>Benchmarking hiring practices for recruiting and selecting high quality management talent; higher positioning, distribution support and agility competencies; successful strategic partnerships</td>
</tr>
<tr>
<td>2</td>
<td>Performance and reward management</td>
<td>Kam et al. (2010), Pandey et al. (2012)</td>
<td>Integrated logistics services (ILS), flexible supply chain (FSC); high levels of supply chain (SC) integration</td>
</tr>
<tr>
<td>3</td>
<td>Training and development</td>
<td>Ding et al. (2015), Gorane and Kant (2013), Menon (2012)</td>
<td>Influences both employee and organisational performance; SCM success; higher positioning, distribution support and agility competencies; SC performance satisfaction with regard to cost and suppliers and successful supply chain integration</td>
</tr>
<tr>
<td>4</td>
<td>Health and safety of employee</td>
<td>Okeudo (2012)</td>
<td>Positive impact on firm performance and on logistics capabilities like flexible supply chain (FSC) solution, communication technology (ICT) and integrated logistics services (ILS)</td>
</tr>
<tr>
<td>5</td>
<td>Work motivation, employee commitment, empowerment</td>
<td>Gorane and Kant (2013), Anastasiou (2012)</td>
<td>greater competitive advantage; supply chain success</td>
</tr>
<tr>
<td>6</td>
<td>Organisation culture, teamwork and trust among employees</td>
<td>Acar (2012), Gorane and Kant (2013), Menon (2012)</td>
<td>Employee’s commitment to the organisation; important supply chain enablers; technological integration and coordination</td>
</tr>
</tbody>
</table>
The advantages of investment as highlighted by Huselid (1995) are lower employee turnover, greater productivity and corporate financial performance. Delaney and Huselid (1996) and Prowse and Prowse (2010) assert that it has a positive effect on organisational performance, whereas Kalliath and Kalliath (2012) state that it has a positive effect on employability of employees. HR strategies have a very positive effect on supply chain integration and performance was concluded by Shub and Stonebraker (2009).

### Table 2

<table>
<thead>
<tr>
<th>Authors</th>
<th>Training</th>
<th>Welfare</th>
<th>Wages</th>
<th>Working conditions</th>
</tr>
</thead>
<tbody>
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<td>Kam et al. (2010),</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Anastasiou (2012),</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PwC (2012)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Okeudo (2012),</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pandey et al. (2012)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Huselid (1995),</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wiley (1997)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delaney and Huselid (1996), Hohenstein et al. (2014)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Ellinger et al. (2008), Shub and Stonebraker (2009)</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Prowse and Prowse (2010)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kalliath and Kalliath (2012)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Hohenstein et al. (2014) conducted a literature review on issues of HRM in SCM and concluded that the authors are concentrating more on skills, training, impact on performance and less on wages, recruitment procedures and global mind-set which are very important to tackle talent shortage in some. Wiley (1997) suggests that the most important factor for employee motivation is wages. From these studies, it can be understood that HRM issues play a very important role on logistics and organisational performance and investment in it will reap positive outcomes.

### 2.3 Logistics performance index

LPI is the weighted average of the logistics cost, delivery time, reliability of services, flexibility of services, and safety of the logistics system. Outstanding performance is associated with high financial performance through low costs, high revenues and efficient and effective asset utilisation (Anderson et al., 2007). LPI is an indicator of how well the country is placed in terms of its logistics efficiency and service quality (FICCI, 2011). Trade research shows that improving logistics performance is the area where developing countries have a great potential to reduce trade costs (Arvis et al., 2014) and there is a strong relationship between country’s LPI and its level of logistics costs (Rantasila and Ojala, 2012). Countries at the same level of per capita income with the best logistics performance experience additional growth of 1% in GDP and 2% in trade (Arvis et al., 2010). In addition, 10% improvement in LPI will lead to 36% increase in trade and 69% increase in imports (Korinek and Sourdin, 2011). The role of the five components of LPI on logistics performance is as follows:

#### 2.3.1 Reduction in cost

Logistics cost is directly proportional to distance and handling incurred while transporting goods (FICCI, 2011) and inversely proportional to share of 3PL in the country (Kaur, 2011). There is immense potential in cost saving for India if it can bring down its logistics cost from the current level of 13% to 14% of GDP, to that of the USA – 8.7% of GDP, leading to savings of around $20 billion, resulting in a potential 4.3% cut in prices of Indian goods globally, making them more competitive (Mitra, 2006). Somyuwa (2010) evaluated the importance of transportation cost in overall logistics cost management, focusing on the inherent costs incurred in transportation cost, and how cost reduction can be established, simultaneously maintaining the correct levels of customer service. Rahman (2004) discussed the role of internet in logistics cost reduction and its effects on profitability of firms.

#### 2.3.2 Reduction in time

McGinnis and Kohn (1993) highlighted that emphasis on time competitiveness will improve logistics efficiency and coordination and it is a major component of logistics strategy. Wilding and Newton (1996) suggested that logistics is a time-related positioning of resources and many benefits can be obtained through it. Nordas et al. (2006) proved that time is an important competitive factor and also a barrier to trade, which affects the volume of trade and more importantly ability of the firms to enter the export markets. A 10% increase in time reduced bilateral trade volumes by between 5% to 8% (De Sousa and Findlay, 2007). Therefore, reduction of time is one of the most important necessities for a developing country like India.

#### 2.3.3 Improvement in reliability of services

Reliability is considered to be an integral component among the nine elements of logistics identified by the Society of Logistics Engineers (SOLE) (Brimer, 1995). Reliability is the ability to perform the promised service consistently, dependably, and accurately (Simons, 2004). Reliability has often been cited as the most important dimension in assessing the quality of service and is therefore a fundamental requirement for businesses to compete in the marketplace (Cook et al., 2002). Reliability will boost trade, businesses, trustworthiness among 3PL providers and will give maximum customer satisfaction. A reliable system will reduce costs through reducing wastages and damages.
2.3.4 Improvement in flexibility of services

Flexibility “reflects the ability of a system to change or react with little penalty in time, effort, cost or performance” (Naim et al., 2006). Flexibility is affected by the physical and IT infrastructure of a country. Through well-connected roads backed by tracking and tracing devices, product movement can be customised according to the customer needs leading to customer satisfaction. Zhang et al. (2005) define logistics flexibility as the ability of a firm to respond quickly and efficiently to changing customer needs in inbound and outbound delivery, support and services.

2.3.5 Improvement in safety

Safety refers to the safety of stock, HRs, physical infrastructure and the overall logistics system (Cantor, 2008). Koster et al. (2011) conducted a study in 78 Dutch warehouses concluded that safety specific transformational leadership (SSTL) is a key driver of safety performance and it directly influences safety performance and indirectly influences the intermediating effects of hazard reducing system (HRS). They also concluded that the research on this topic is limited and future research should include safety of employees in its scope. Pia (2010) concluded that flow of information, cooperation between the various parties of the chain, and the training of employees have proven to be important in improving the safety of a logistic chain and material damage and accidents cause a lot of additional work and costs.

2.4 System dynamics modelling

Systems dynamics (SD), currently expanded and known as business dynamics (Sterman, 2000), has its origins in the field of control engineering and management. It was developed in the ‘60s by legendary Forrester (1961). It is a computer aided approach for analysing and solving complex problems with a focus on policy analysis and design (Angerhofer and Angelides, 2000). The fundamental structural elements that are considered in system dynamics models are feedback loops, accumulation processes, delays, which result in nonlinear behaviour modes of systems (Größler, 2010). Trcek (2006) applied system dynamics to enable quantitative and qualitative modelling of information systems security management that takes into account technology and human factor. Diawati et al. (1994) applied system dynamics to study the impact of skill formation on the adaptation of new production systems by an organisation. Bajracharya et al. (2000) used SD to study the importance of effective organisational infrastructure for training in Nepalese construction sector. Babío (2011) applied SD to conclude that policies leading to reduction in investment in training cut down a consulting firm’s capacity for future growth and lengthening the lead times before changing the firm’s objectives improves organisation’s competitiveness. Calvo and García (2014) used SD to find out that external demand for consultancy services determines the number of consultants required within the sector and knowledge management policies of each organisation determine its internal capacity to create and maintain its intellectual capital.

3 Research methodology

To study the investment plans, the objectives, scope, performance measures, policies, etc. are discussed below.

3.1 Objectives

The objectives of the research are:

1. To develop a dynamic model using system dynamics modelling for the investments in HRs.
2. To evaluate the various investment plans for the decision maker to formulate the investment strategy which best meets the requirements of the business.
3. To identify the investment area/s, which will maximise logistics performance.
4. To quantify the relationship between performance measures like logistics cost, delivery time, reliability, flexibility and safety and logistics performance.
5. To study the effect of improvement in logistics performance, if any, on the profit of the firm.

3.2 Scope and areas of investment

HRM has a very vast domain and thus there is a need to focus on certain areas of investment for improvement. For this study, the following four areas are considered:

- training
- improvement in wages
- working conditions and
- welfare of the employees.

3.3 Model assumptions

The following assumptions are made for carrying out the simulations:

a. The activities are not interrelated to each other, i.e., improvement in working condition does not affect training or wages, etc.

b. The effect of improvement in activities is instantaneous and there is no time lag between investment and improvement.

c. After 12 quarters, if the profit increases by 3%, then the company will invest 1% of the investment amount every quarter.
3.4 Performance measures

Enhancing LPI has been taken as the objective of the decision makers in formulating the investment strategy. For this study, reduction in logistics cost, reduction in delivery time, improvement in reliability of services, improvement in flexibility of services and improvement in safety have been considered as components of LPI.

3.5 Investment plans

The investment plans need to be developed with respect to two aspects:

1. Proportion of investment in different HR improvement areas. These plans are given in Table 3.

2. Time phasing of the investment. Plans on this aspect are given in Table 4.

Table 3 Investment plans for different activities

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Training</th>
<th>Welfare</th>
<th>Wages</th>
<th>Working conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA1</td>
<td>Equal focus plan</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>PA2</td>
<td>Partial indirect focus plan</td>
<td>30</td>
<td>15</td>
<td>15</td>
<td>40</td>
</tr>
<tr>
<td>PA3</td>
<td>Semi focus plan</td>
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<td>30</td>
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</tr>
<tr>
<td>PA4</td>
<td>Indirect focus plan</td>
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<td>0</td>
<td>0</td>
<td>50</td>
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<tr>
<td>PA5</td>
<td>Partial direct focus plan</td>
<td>40</td>
<td>15</td>
<td>15</td>
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</tr>
<tr>
<td>PA6</td>
<td>Direct focus plan</td>
<td>0</td>
<td>50</td>
<td>50</td>
<td>0</td>
</tr>
</tbody>
</table>

In the equal focus plan (PA1), as shown in Table 1, 25% of total budgets are earmarked for training, 25% of welfare, 25% for improvement in wages and 25% to improve the working conditions is done in equal percentage in each activity to study the improvement in each activity for the period of time. Improvement areas like wages and welfare are considered as direct areas of improvement as they directly influence the manpower workers in the organisation. On the other hand, training and working conditions are taken as indirect areas since their impact is indirectly and may take some time to be visible. In partial indirect focus plan (PA2), 30% and 40% investment is done in indirect focus areas, i.e., training and working conditions respectively and 15% investment is done in welfare and wages each. In the semi focus plan (PA3), 30% investment is done in improving the wages which will directly benefit the employees and 40% and 30% investment is done in improving the working conditions and training respectively which will improve their morale and job satisfaction. In indirect focus plan (PA4), 50% investment is done in working conditions and 50% investment is done in training for the betterment of the employees and no investment is done in wages and welfare. In partial direct focus plan (PA5), 40% investment is done in training, 30% in working conditions and 15% in increasing wages and 15% in welfare which will focus on improving the skills of the worker which will help them in the long run in their career. Direct focus plan (PA6), will benefit the workers directly as it is completely focused on equal percentage, i.e., 50% investments is done in improving the wages and welfare with no investment in training and working conditions.

Table 4 Quarter wise allocation plan (QAP) as percentage of activity

<table>
<thead>
<tr>
<th>QAP</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>QAP1</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>5</td>
<td>5</td>
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<td>5</td>
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<td>5</td>
<td>100</td>
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<tr>
<td>QAP2</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
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<td>20</td>
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</tr>
<tr>
<td>QAP3</td>
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<td>0</td>
<td>25</td>
<td>0</td>
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<td>0</td>
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<tr>
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<td>15</td>
<td>15</td>
<td>15</td>
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</table>

To achieve the maximum benefits, the investment in an area is further broken quarter wise. Since the present plan is for three years, the investment is divided into 12 quarterly periods. Based on it, five plans are prepared and analysed as given in Table 4. In QAP1, 10% of the investment is done in first eight quarters and it was reduced to half in the last four quarters. Exactly opposite to this, in QAP2, 5% investment was done in first eight quarters and it was doubled in the last four quarters. In QAP3, 25% of the investment amount was invested every third quarter. More than 50% of the investment was done in QAP4, in the initial four quarters and 5% of the investment was done in every quarter afterwards. In QAP5, whole investment was done in the initial six quarters.

3.6 Research framework

As shown in Figure 1, the basis of this research is that through investment in the four areas of HRs, considerable improvement can be achieved in the performance measures which will improve the logistics performance leading to improvement in profit. Improved profit will lead to more investment.

3.7 Causal loop for investment done by LSPs on HRs

The causal loop diagram in system dynamics focuses on the structure and behaviour of the systems composed of interacting feedback loops (Kiani et al., 2009). The causal loop diagram is an important tool which helps the modeller to conceptualise the real-world system in terms of feedback loops (Sachan et al., 2005). In a causal loop diagram, the arrows indicate the direction of influence, and the plus or minus sign the type of influence. All other things being equal, if a change in one variable generates a change in the
same direction in the second variable, relative to its prior value, the relationship between the two variables is referred to as positive and the loop is known as reinforcing loop. If the change in the second variable takes place in the opposite direction, the relationship is negative (Forrester, 1985) and the loop is known as balancing loop.

**Figure 1** Research framework

![Image of Research framework diagram]

For example, in this case, the LSP will invest in training and improvement in HRs. Through training, the skilled labour workforce will improve and hence the cost will decrease. Decrease in cost will lead to improvement in LPI. Improvement in LPI will generate revenue for LSP which will invest more in HRs. Therefore, the loop between investments in HR, training, cost, LPI and profit is balancing. Skilled workforce will reduce the time for doing logistics activities, which will improve the LPI. So, the loop between investments in HR, training, delivery time, LPI and profit is also balancing. Skilled labour will improve the reliability, flexibility and safety of the system. So the loop between investments in HR, training, skilled labour, reliability or flexibility or safety, LPI and profit are reinforcing.

The investment in improving the welfare, wages and working conditions will improve the workers' performance and will indirectly reduce the logistics cost and delivery time. Therefore, the loop between investments in HR, welfare/wages/working conditions, cost/time, LPI and profit is balancing. The reliability, flexibility and safety of the system will also get affected in a positive manner through a motivated workforce. So the loop between investments in HR, welfare/wages/working condition, reliability/flexibility/safety, LPI and profit is reinforcing.

**3.8 Stock and flow diagram**

The causal loop diagrams help to create the flow diagram, which is the ultimate diagramming aid that represents the feedback structure in terms of physical and information flows and stocks and is also known as stock and flow diagram. The important components used to develop the stock and flow diagram are shown in Table 5.

**Figure 2** Causal loop diagram of investment in HR to improve LPI

![Image of Causal loop diagram]
Table 5 Description of important system dynamics components

<table>
<thead>
<tr>
<th>S. no.</th>
<th>Variable name</th>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Level</td>
<td>[ ]</td>
<td>It accumulates changes and is influenced by flows</td>
</tr>
<tr>
<td>2</td>
<td>Auxiliary</td>
<td>[ ]</td>
<td>A variable type, which contains calculations based on other variables</td>
</tr>
<tr>
<td>3</td>
<td>Flow with rate</td>
<td>[ ]</td>
<td>It influences levels. The flow is controlled by the connected rate variable, normally an auxiliary variable</td>
</tr>
</tbody>
</table>

Source: Jhawar et al. (2014)

The stock and flow diagram shown in Figure 3, has been developed using STELLA 9.1.3 software. After developing the stock and flow diagram, the model has been simulated for 12 quarters, taking the value of delta time (DT) as 1. DT controls how frequently calculations are applied each unit of time and as they process will not change every unit of time, it is taken as 1 in this case. The calculations for all the performance measures and the values of all the important variables are discussed in section 4.

4 Case description

The company is an Indian-based medium sized logistics service provider having a turnover of Rs. 1,200 crores with a profit of Rs. 150 crores in 2012 to 2013. The manpower base of the company is 15,000, the majority of which is fleet staff. For improving the logistics performance, the company decided to invest Rs. 50 crores, 10% to 12% of the profit in the next three years.

Once the amount is earmarked and areas of improvement and performance measures are identified, the company needs to have an implementation plan which will provide the quarter wise investment in each of the improvement area for the next three years. To achieve this dynamic model as given in Figure 3 is developed and simulated using Stella 9.1.3. The following set of information was required for simulating the system:

a The present level and the target level of the performance measures in the case organisation.

b The improvement in the performance measures (improvement rate) with every one lakh investment.

c The improvement in LPI with 1% improvement in the performance measure.

d The weightage of each performance measure on the LPI.

To collect the above information, discussion was held with the executives of the company and the following information was collected for use in the study.

4.1 Existing and target values of performance measures

As discussed earlier, five performance measures considered for developing the LPI. 100% is considered as the target value for each of the performance measure as shown in Table 6. For cost, it is informed by the executives the logistics cost in their company is 63% more than the rest of the industry. Thus, logistics cost is taken as 163%. Similarly, the delivery time is 40% more than the industry and it is taken as 140%. 60% of the deliveries are consistent,
therefore, reliability of logistics services is 60%. Last minute changes cannot be incorporated in most of the deliveries and hence the flexibility of the system as measured by the executives is 55%. With the increase in accidents and damage to freight, safety is merely 52% in the case organisation.

<table>
<thead>
<tr>
<th>Performance measures</th>
<th>Existing (%)</th>
<th>Best in industry (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logistics cost (PM1)</td>
<td>163</td>
<td>100</td>
</tr>
<tr>
<td>Delivery time (PM2)</td>
<td>140</td>
<td>100</td>
</tr>
<tr>
<td>Reliability of logistics services (PM3)</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>Flexibility of logistics services (PM4)</td>
<td>55</td>
<td>100</td>
</tr>
<tr>
<td>Safety (PM5)</td>
<td>52</td>
<td>100</td>
</tr>
</tbody>
</table>

4.2 Improvement in performance measure for every one lakh investment

Improvement in the values of the performance measures is achieved by making investment in HR areas. Table 7 gives the percentage improvement in the performance measures for every one lakh investment in the improvement area. For example, the present value of logistics cost in the company is 163. With an investment of one lakh in training, the logistics cost will reduce by 0.009, i.e., it will become 162.99. Similarly, an investment of one lakh in welfare will reduce the logistics cost by 0.006. If investment of one lakh each is made in all the four areas, then the logistics cost will reduce by (0.009 + 0.006 + 0.007 + 0.006) = 0.03. With first one lakh investment in each area, logistics cost will reduce to 162.97 from the existing level of 163. This one lakh in each of the four areas will reduce the logistics time from 140 to 139.97, reliability will improve to 60.0095 from 60, flexibility will improve to 55.008 from 55 and safety will improve to 52.007 from 52.

The rate of improvement in performance measures is given by equation (1).

\[
\text{Rate of improvement in } PM(t) = PM(t - dt) + ((PV - TV)/TV) \times k
\]

where

- \( PM(t) \) is the value of performance measure in the next interval
- \( PM(t - dt) \) is the value of performance measure at the last interval
- \( PV \) present value
- \( TV \) target value
- \( k \) improvement per lakh investment.

4.3 Improvement in LPI

LPI is the weighted score of the five performance measures considered in this study. The weight of the each of the five inputs is arrived by using pair wise comparison technique (PCT). Inputs of PCT are taken in discussion with the executives of the company. Initially, when no investment is done, the LPI for the company is calculated using equation (2).

\[
LPI = \left[ \left( \frac{PV - TV}{TV} \right) \times w_1 \left( \frac{PV - TV}{TV} \right) \times w_2 \right. \\
\left. + \left( \frac{PV - TV}{TV} \right) \times w_3 + \left( \frac{PV - TV}{TV} \right) \times w_4 \right] \times 100
\]

where

- \( PV \) present value
- \( TV \) target value
- \( W_{1-5} \) weight of each performance measure.

Using equation (2), the LPI for the case organisation is calculated as follows:

\[
LPI = \left[ \left( \frac{163 - 100}{100} \right) \times 0.35 + \left( \frac{140 - 100}{100} \right) \times 0.25 + \left( \frac{100 - 60}{100} \right) \times 0.15 + \left( \frac{100 - 55}{100} \right) \times 0.15 \right] \times 100
\]

Using equation (2), the LPI for the case organisation is calculated as follows:

\[
LPI = 0.22 + 0.1 + 0.06 + 0.07 + 0.05
\]

\[
LPI = 0.50 \times 100
\]

\[
LPI = 50
\]

The present value and target value are used from Table 6 and the weight of each performance measure is taken from Table 8. Therefore, the existing value of LPI for the case organisation is 50 and the target value is 100, that is the best in industry.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Percentage change in performance measures by per lakh investment in activity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reduction in cost</td>
</tr>
<tr>
<td>Training</td>
<td>0.009</td>
</tr>
<tr>
<td>Welfare</td>
<td>0.006</td>
</tr>
<tr>
<td>Wages</td>
<td>0.007</td>
</tr>
<tr>
<td>Working conditions</td>
<td>0.006</td>
</tr>
</tbody>
</table>
With every percent improvement in the performance measure after investment, percentage improvement in LPI is given in Table 7. For example, if cost improves by 1%, then percentage improvement in LPI will be 0.0007. Therefore, the total improvement in LPI will be the product of percentage improvement in LPI through improvement in logistics cost and weight in LPI for logistics cost, i.e., total improvement will be 0.000245 for every percentage improvement in logistics cost. Similarly, improvement in LPI for every percentage improvement in delivery time will be 0.000125; improvement in LPI for every percentage improvement in reliability and flexibility will be 0.0000525 and for safety it will be 0.000025. Therefore, the total improvement in LPI, for percent improvement in performance measures is 0.0004475.

Table 8 Improvement and contribution in LPI by each performance measure

<table>
<thead>
<tr>
<th>Performance measures</th>
<th>Improvement in LPI (%)</th>
<th>Weight in LPI (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logistics cost</td>
<td>0.0007</td>
<td>0.35</td>
</tr>
<tr>
<td>Delivery time</td>
<td>0.0005</td>
<td>0.25</td>
</tr>
<tr>
<td>Reliability of logistics services</td>
<td>0.00035</td>
<td>0.15</td>
</tr>
<tr>
<td>Flexibility of logistics services</td>
<td>0.00035</td>
<td>0.15</td>
</tr>
<tr>
<td>Safety</td>
<td>0.00035</td>
<td>0.1</td>
</tr>
</tbody>
</table>

4.4 Improvement in profit

The existing profit percentage of the company is 10%. With every percentage improvement in LPI, profit will improve by 0.002.

5 Model validation

Validation of system dynamics model is necessary to establish sufficient confidence in the model (Sahay et al., 1996). Forrester (1961), Coyle (1979) and Wright (1971), suggests that the significance of the model depends on how well it serves its purpose and 13 subjective criteria have been suggested by them for model validation. Generally, there is a serious criticism for the popular validation techniques owing to their overemphasis on quantitative validation rather than the usefulness of the model and paying insufficient attention to underlying assumptions (Khanna et al., 2008). Data was collected for the organisation through a group of managers to assess the percentage change in the performance measures. The average score was then compared to the system dynamics model results for equal focus plan, as shown in Table 9.

Khanna et al. (2008) accepted the model at a percent deviation of 10%. Since maximum variation has been observed to be around 6%, the SD model fairly replicates the dynamic behaviour and thus validates the interrelationships.

### Table 9 Model validation results

<table>
<thead>
<tr>
<th>Performance measures</th>
<th>Percentage change based on calculations</th>
<th>Results based on SD model</th>
<th>Percent deviation from system dynamics prediction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logistics cost</td>
<td>162.52</td>
<td>161.24</td>
<td>−0.48</td>
</tr>
<tr>
<td>Delivery time</td>
<td>138.75</td>
<td>139</td>
<td>−0.089</td>
</tr>
<tr>
<td>Reliability of services</td>
<td>60.48</td>
<td>64.37</td>
<td>6</td>
</tr>
<tr>
<td>Flexibility of services</td>
<td>55.40</td>
<td>59.17</td>
<td>6.3</td>
</tr>
<tr>
<td>Safety</td>
<td>52.35</td>
<td>55.92</td>
<td>6.3</td>
</tr>
</tbody>
</table>

6 Results and discussion

The LPI results are shown in Figure 4. LPI reached the highest value in the indirect focus plan (PA4), with a value of 51.27. The second highest value of 51.23 was for semi focus plan (PA3), which is slightly less than PA4 followed by PA2, PA5, PA1 and PA6. Further simulations will be carried out with base as PA3 and PA4.

In phase 2, the quarter-wise allocation of funds as a percentage of total investment in the activity is shown in Table 4.

Figure 4 Results for LPI for alternative investment plans in activities (see online version for colours)

6.1 Quarter wise allocation with base as semi focus plan (PA3)

Simulations runs were carried out by taking base PA3 as selected above and quarter wise investment as the percentage of total investment in an activity (Table 4).

The results for quarter wise investment for PA3 are shown in Figure 5. LPI reached highest with a value of 51.58 in QAP4, where 10% to 15% investment is done more in initial quarters and 5% investment is done 6th quarter onwards. The second highest value of LPI is 51.41 through QAP1, in which 10% investment is done in initial quarters and 5% investment is done in last four quarters.
Table 10  Results of performance measures with quarter wise investment in PA3

<table>
<thead>
<tr>
<th>QAP</th>
<th>Logistics cost</th>
<th>Delivery time</th>
<th>Reliability of services</th>
<th>Flexibility of services</th>
<th>Safety</th>
<th>LPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>QAP1</td>
<td>161.17</td>
<td>138.96</td>
<td>64.98</td>
<td>59.42</td>
<td>56.18</td>
<td>51.41</td>
</tr>
<tr>
<td>QAP2</td>
<td>161.26</td>
<td>139.02</td>
<td>64.75</td>
<td>59.21</td>
<td>55.98</td>
<td>50.79</td>
</tr>
<tr>
<td>QAP3</td>
<td>161.19</td>
<td>138.98</td>
<td>64.93</td>
<td>59.37</td>
<td>56.13</td>
<td>51.23</td>
</tr>
<tr>
<td>QAP4</td>
<td>161.17</td>
<td>138.96</td>
<td>64.98</td>
<td>59.42</td>
<td>56.18</td>
<td>51.58</td>
</tr>
<tr>
<td>QAP5</td>
<td>161.14</td>
<td>138.95</td>
<td>65.07</td>
<td>59.50</td>
<td>56.25</td>
<td>50.67</td>
</tr>
</tbody>
</table>

After evaluating, the results for QAP1 to QAP5 with base as PA3, the result of performance measures is shown in Table 10. As seen from table, the lowest value for logistics cost and delivery time and highest value for reliability of services, value for flexibility of services, safety and LPI is highest for QAP5. But as the investment is done in only initial six quarters, LPI reached a maximum value of 50.67 only. Therefore, the best plan with base as PA3 is to follow QAP4 where LPI reaches the value of 51.58. Logistics cost decreased by 1.12%, delivery time decreased by 0.74%, reliability of services increased by 8.3%, flexibility of services improved by 8.03% and safety improved by 8.03%. LPI improved by 3.16% through 30% investment in training, 30% investment in wages and 40% investment in working conditions.

Figure 5  Results for LPI for quarter wise investment in PA3

Table 11  Results of performance measures with quarter wise investment in PA4

<table>
<thead>
<tr>
<th>QAP</th>
<th>Logistics cost</th>
<th>Delivery time</th>
<th>Reliability of services</th>
<th>Flexibility of services</th>
<th>Safety</th>
<th>LPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>QAP1</td>
<td>160.09</td>
<td>138.87</td>
<td>65.07</td>
<td>59.72</td>
<td>55.96</td>
<td>51.45</td>
</tr>
<tr>
<td>QAP2</td>
<td>161.19</td>
<td>138.93</td>
<td>64.83</td>
<td>59.49</td>
<td>55.77</td>
<td>50.86</td>
</tr>
<tr>
<td>QAP3</td>
<td>161.11</td>
<td>138.88</td>
<td>65.01</td>
<td>59.67</td>
<td>55.92</td>
<td>51.27</td>
</tr>
<tr>
<td>QAP4</td>
<td>161.09</td>
<td>138.87</td>
<td>65.07</td>
<td>59.72</td>
<td>55.96</td>
<td>51.63</td>
</tr>
<tr>
<td>QAP5</td>
<td>160.17</td>
<td>138.45</td>
<td>67.29</td>
<td>61.29</td>
<td>58.19</td>
<td>50.99</td>
</tr>
</tbody>
</table>

After evaluating, the results for QAP1 to QAP5 with base as PA4, the result of performance measures is shown in Table 11. As seen from table, the lowest value for logistics cost and delivery time and highest value for reliability of services, value for flexibility of services, safety and LPI is highest for QAP5. But the growth becomes stagnant and LPI reached a maximum value of 50.99 only. Therefore, the best plan with base as PA4 is to follow QAP4 where LPI reaches the value of 51.63. Logistics cost decreased by 1.17%, delivery time decreased by 0.8%, reliability of services increased by 8.45%, flexibility of services improved by 8.58% and safety improved by 7.61%. LPI improved by 3.26% through 50% investment in training and 50% investment in working conditions.

Figure 6  Results for LPI for quarter wise investment in PA4

6.2 Quarter wise investment in indirect focus plan (PA4)

Now, using the base as PA4, quarter wise distribution was done as shown in Table 4. The results for quarter wise investment in indirect focus plan (PA4) are shown in Figure 6. LPI reached highest with a value of 51.63 in QAP4. The second highest value of LPI is 51.45 through QAP1.

After evaluating, the results for QAP1 to QAP5 with base as PA4, the result of performance measures is shown in Table 11. As seen from table, the lowest value for logistics cost and delivery time and highest value for reliability of services, value for flexibility of services, safety and LPI is highest for QAP5. But the growth becomes stagnant and LPI reached a maximum value of 50.99 only. Therefore, the best plan with base as PA4 is to follow QAP4 where LPI reaches the value of 51.63. Logistics cost decreased by 1.17%, delivery time decreased by 0.8%, reliability of services increased by 8.45%, flexibility of services improved by 8.58% and safety improved by 7.61%. LPI improved by 3.26% through 50% investment in training and 50% investment in working conditions.

Figure 6  Results for LPI for quarter wise investment in PA4

Impact of time lag between improvement and investment was considered instantaneous. But in actual conditions, the improvement cannot be instantaneous. So, if we consider that the time lag between investment and improvement is six months and as the best quarter wise allocation plan is QAP4 in both PA3 and PA4, the results of performance measures will be as shown in Table 12.
Table 12  Results of performance measures with time lag

<table>
<thead>
<tr>
<th>Investment plan</th>
<th>Logistics cost</th>
<th>Delivery time</th>
<th>Reliability of services</th>
<th>Flexibility of services</th>
<th>Safety</th>
<th>LPI</th>
<th>Improvement in profit (PI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA3</td>
<td>161.34</td>
<td>139.07</td>
<td>64.51</td>
<td>58.99</td>
<td>55.77</td>
<td>51.16</td>
<td>0.47%</td>
</tr>
<tr>
<td>PA4</td>
<td>161.28</td>
<td>138.98</td>
<td>64.59</td>
<td>59.27</td>
<td>55.58</td>
<td>51.20</td>
<td>0.49%</td>
</tr>
</tbody>
</table>

Table 13  Yearwise improvement in performance measures

<table>
<thead>
<tr>
<th>Years</th>
<th>Logistics cost</th>
<th>Delivery time</th>
<th>Reliability of services</th>
<th>Flexibility of services</th>
<th>Safety</th>
<th>LPI</th>
<th>PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>161.28</td>
<td>139.98</td>
<td>64.59</td>
<td>59.27</td>
<td>55.58</td>
<td>51.20</td>
<td>0.49</td>
</tr>
<tr>
<td>4</td>
<td>161.06</td>
<td>138.85</td>
<td>65.15</td>
<td>59.80</td>
<td>56.03</td>
<td>52.09</td>
<td>1.25</td>
</tr>
<tr>
<td>5</td>
<td>161.06</td>
<td>138.85</td>
<td>65.15</td>
<td>59.80</td>
<td>56.03</td>
<td>53.04</td>
<td>2.46</td>
</tr>
<tr>
<td>6</td>
<td>161.05</td>
<td>138.85</td>
<td>65.16</td>
<td>59.81</td>
<td>56.04</td>
<td>54</td>
<td>4.13</td>
</tr>
<tr>
<td>7</td>
<td>160.98</td>
<td>138.8</td>
<td>65.34</td>
<td>59.98</td>
<td>56.18</td>
<td>54.99</td>
<td>6.27</td>
</tr>
<tr>
<td>8</td>
<td>160.91</td>
<td>138.76</td>
<td>65.52</td>
<td>60.15</td>
<td>56.33</td>
<td>56.04</td>
<td>8.89</td>
</tr>
<tr>
<td>9</td>
<td>160.84</td>
<td>138.72</td>
<td>65.71</td>
<td>60.33</td>
<td>56.48</td>
<td>57.15</td>
<td>12.04</td>
</tr>
<tr>
<td>10</td>
<td>160.76</td>
<td>138.67</td>
<td>65.90</td>
<td>60.51</td>
<td>56.63</td>
<td>58.32</td>
<td>15.72</td>
</tr>
<tr>
<td>11</td>
<td>160.68</td>
<td>138.62</td>
<td>66.10</td>
<td>60.70</td>
<td>56.80</td>
<td>59.56</td>
<td>19.99</td>
</tr>
<tr>
<td>12</td>
<td>160.59</td>
<td>138.52</td>
<td>66.31</td>
<td>60.89</td>
<td>59.96</td>
<td>60.86</td>
<td>24.86</td>
</tr>
</tbody>
</table>

Therefore, LPI will reach a maximum value of 51.20 with a time lag of six months. In both the plans, there was no investment in welfare. So if the company intends to invest in improving the wages, it can invest in PA3 or else it can adopt PA4 by investing only in training and working conditions using QAP4. Likewise, after achieving significant improvement in training and working conditions, motivation of the workforce can be further increase through investment in wages and welfare.

To understand the exact amount of investment and time required by the company to achieve significant results, PA4 – QAP4 was further simulated by increasing the investment amount by 10%, when profit improvement will be more that 3% as it was decided by the company initially.

Therefore, LPI will reach its maximum value of 60.86 in a period of 12 years with an investment of Rs. 64 crores and 25% improvement in profit amounting to approximately Rs. 37.5 crores. Along with that, the cost will decrease by 1.47%, logistics time will decrease by 1.05%, reliability, flexibility and safety will improve by 10.51%, 10.70% and 15.3%, respectively, which according to the company will generate huge profits.

7 Conclusions

In this paper, the improvement in logistics performance is studied by making investments in HRs, which is generally a neglected area in the corporate world in general and logistics in particular. System dynamics is used as a tool to demonstrate the impact of investment in HRs on the LPI. The developed model will allow companies to simulate the investment environment and to understand the impact of investment on performance measures like cost, time, reliability, flexibility and safety and also the time frame and the investment area in which the investment will reap maximum benefits.

Out of the five plans proposed, two plans which reaped maximum benefits were indirect focus plan (PA4) and semi focus plan (PA3). In the indirect focus plan, 50% investment is done in training and 50% investment in improving the working conditions. In period of three years and a time lag of six months, the logistics cost reduced by 1.05%, delivery time reduced by 0.722%, reliability of services improved by 7.65%, flexibility improved by 7.76% and safety improved by 6.68% leading to an 2.4% improvement in LPI. The plan was further simulated for a period of 12 years, which lead to improvement in profit by 25%.

In the semi focus plan, 30% investment was done in training, 0% investment was done in welfare, 30% investment in wage improvement and 40% investment in improving the working conditions. With a time lag of six months, the logistics cost reduced by 1.01%, delivery time reduced by 0.66%, reliability of services improved by 7.51%, flexibility improved by 7.25% and safety improved by 6.88% leading to an 2.3% improvement in LPI. There is not a vast difference in the improvement of both the plans. If the company is interested in improving only training and working conditions then it can opt for PA4 and if interested in improving the wages too, then it can opt for PA3.

It can be observed that the value of LPI and other performance measures have not increased considerably by investment in improving activities related to HRs. LPI is governed by various several other factors like infrastructure, government regulations and use of information technology. Improvement in these factors also is a must to study the impact of LPI improvement at the organisation and country level.
From the simulations, it can be concluded the organisation should focus on investment in imparting training and improving the working conditions of the employees. Superior performance of firms depends upon work outcomes of their employees that are strongly committed to their organisation. For gaining this commitment, wages and welfare can be improved after the results of improvement in training and working conditions are visible.

8 Managerial implications

The role of supervisors is very important for creating a learning environment in the organisation. Even if it is strategically decided to invest in HRs, without managerial support it becomes very difficult for the employees to reap maximum benefits from the training programs and other employee benefit programs. Also, to take maximum utilisation of a learned employee and keeping him motivated is also in the hands of the manager. Also, utilising the full knowledge of a trained employee is also in the hands of the manager. As indicated in the study, improvement in training and working condition can improve the profit by 25% along with improvement in performance measures, therefore, the managers should focus on reaping the maximum benefits so that the organisations see investment in HRs as an opportunity rather than a burden.

Also, what factors are to be considered for improving the working conditions have to be decided by the managers themselves. The manager needs to build a right rapport with the employees so that they can give their suggestions freely and the investment amount is invested in the needed areas, so that a better working place will be provided to the employees.

After the improvement in HRs, retaining and attracting the right pool of employees becomes very necessary. At present, the recruitment and selection process is very weak in the Indian logistics sector. Therefore, following the correct recruitment process, retaining the right staff will be the ultimate answer to the above investments because it will indicate that the attractiveness of the logistics industry is improving.

9 Future scope

This paper can be extended further to study the effect of improvement in LPI for various investment amounts and plans. The developed model can be used to study different scenarios and variables. The model can be tailored to examine the policies of different small as well large 3PLs.

References


