Journal of Social & Organizational Matters
Vol 4 No 4 (2025): 15-32

Performance Measurement System for Resilient Supply Chain Using Reverse Logistics in Railways: A Case from Pakistan

Muhammad Abdus Salam*[1], Rameela Akram[2], Mudasser Ali Khan[3]

[1]*PhD Scholar, University of Management and Technology, Lahore, Punjab, Pakistan.

[2]PhD Scholar, University of Management and Technology, Lahore, Punjab, Pakistan.

[3]PhD Scholar, College of Business Management, Institute of Business Management, Karachi, Sindh, Pakistan.

Corresponding author: m.abdussalam@gmail.com

Keywords: *Pakistan Railways (PR), Resilience, Reverse Logistics (RL), Performance Measurement (PM), Performance Measurement System (PMS), Key Performance Indicators (KPIs), Key Success Indicators (KSIs), Balanced Score Card (BSC) Method*

DOI No: https://doi.org/10.56976/jsom.v4i4.324

Pakistan Railways has an elaborated system of reverse logistics. Being a transport body itself, it has its unique capabilities of supplying the required material to the destinations within the organization and disposing off the undesired/ waste generated by the system. To make the system resilient in nature, reverse logistics is distinctive and quite sophisticated in nature. The problem is despite having such an elaborated system of reverse logistics resilience while dealing with diversified items, the key performance indicators also known as key success indicators yet need to be designed properly. The result of this lack of information is in undermining the whole process of reverse logistics. As such there is a simple system of performance measurement for the resilient supply chain's reverse logistics i.e., clearance of surplus items, value addition through workshops, and sale of scrap in terms of quantity and price only. This comes under recycling/disposal whereas the remaining areas are ignored while calculating the role of reverse logistics performance. The purpose of this study is to fill in the gaps and design a framework for performance measurement with respect to reverse logistics of Pakistan Railways and to make their supply chain more resilient specially in Post Covid era. The designed performance measurement system is based on KPIs which are different for Strategic, Tactical and Operational in the internal and external perspective while keeping in view the time horizon in short as well as long term.

1. Introduction

Railway is considered to be an engineering marvel in the world (Talbot, 2022). It is unique in its nature and operations (Pyrgidis, 2021). The engineering extensiveness of railways, its volume in terms of working, capital involved and logistics of a country, and its socio-economic effects made it an attractive field for researchers. Pakistan has 27th largest railway network in the world and it consists of 7791 route kilometres (PR YB 2014 - 15). PR is a state-owned public-sector institution employing over 78,000 employees (PR YB 2014 - 15). The core operational area is to carry passengers and freight across the country (Kurhan et al., 2022). The organization has its own forward and reverse logistics system (Muhammad et al., 2025). The level of sophistication and engineering involved within the organization including the volume of material involved gives it a distinctive expertise (Munawar et al., 2024). The organization has its own facilities for repairs (Kurhan et al., 2022).

The consuming departments of Pakistan Railways are; Mechanical, Civil, Electrical, Signal, Telecom, Medical and Workshops are provided with new material through forward logistics (Chan, 2023). For the purpose of reverse logistics, the below mentioned core functions of reverse logistics are applied (Kurhan et al., 2022). The core functions of reverse logistics are quite different namely warranty claims, surplus, repair, harvesting (reusability), condemnation, vehicle routing, transportation, material handling, storage, recycling/disposal (Chan, 2023). On the other hand, RL in Pakistan Railways is generally believed to be sale of scrap only. RL within PR is dealt at different levels by different bodies resulting in lesser benchmarking than required for different processes (Aslam, 2023). The warranty claims are dealt by the purchase department (PRSD n. d.). The KPIs are solely based on the number of successful warranty claims. The surplus items are dealt by the stores department (PRSD n. d.). The KPI is decreasing the number of surplus items over a given time period (Mahboob et al., 2024). The processes of repair, harvesting (reusability), condemnation, vehicle routing, transportation, and material handling are dealt by the concerned consuming departments in collaboration with the stores department (Farro, & Maddanu, 2022). The KPI is value addition through workshops. In some cases, like workshops of telecommunication department even this KPI yet needs to be introduced (Mahboob et al., 2024). The harvesting (reusability) at divisional/operational level hierarchy is yet needed to be benchmarked. The recycling/disposal is dealt by stores department, consuming department, and accounts department in close collaboration (PRSC n. d.). The RL is generally believed to be sale of scrap only. The sale of scrap targeted around 1000 million PKR annually (PRSD n. d.). showing its volume. When factors like warranty claims, reutilization through harvesting (reusability), value addition in workshops will be included the volume/scope will be enlarged even further.

The core activities of RL in Pakistan Railways are warranty claims, guarantee claims, surplus, repair, harvesting (reusability), condemnation, vehicle routing, transportation, material handling, recycling/disposal. RL is quite complex in nature involving different departments at a time. The detailed process of RL in Pakistan Railways is evident from figure 1, showing various core activities involved in the process of RL of Pakistan Railways.

1.1 Research-Questions

PMS is a feedback tool of planning and monitoring of different processes through historical data (Ramaa et al., 2009). Rushton (2010) defines the profitability enhanced through overall efficiency through effective control of processes. The following are the research questions of this study:

i. What are the factors that drive the PM of Pakistan Railways RL towards resilience?
ii. What are the constraints/problems in PM of Pakistan Railways RL becoming resilient?
iii. What would be the comprehensive framework for the PM of Pakistan Railways RL?

Figure No 1: Activities Involved in Reverse Logistics in Railways (PRSD n. d.).

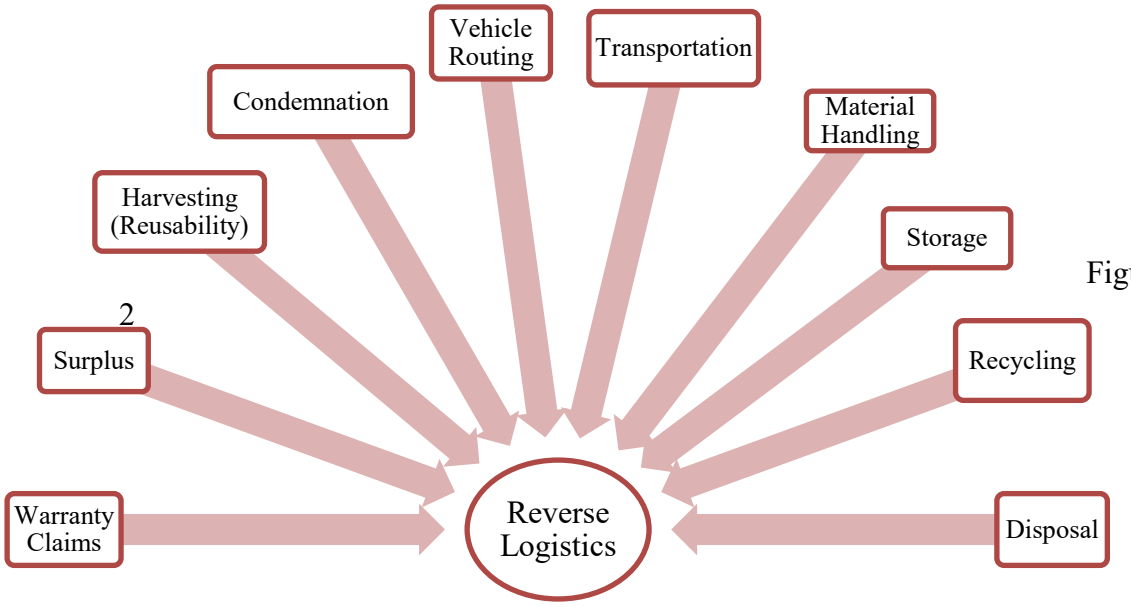


Figure 2

2. Literature Review

Although the concept of RL exists since long in different forms but RL as a whole distinct system is one of the new and emerging concepts. Stock (1992) introduced the term of RL in a white paper published by the Council of Logistics Management (CLM) as

"*The role of logistics in recycling, waste disposal, and management of hazardous materials; a broader perspective includes all issues relating to logistics activities carried out in source reduction, recycling, substitution, reuse of materials and disposal.*"

Canadian Association of Logistics Management (1998) defines logistics as,

"The process of planning, implementing, and controlling the efficient, cost-effective flow and storage of raw materials, in-process inventory, finished goods and related information from point of origin to point of consumption for the purpose of meeting customer requirements."

Rogers and Tibben-Lembke (1999) defined RL as,

"The process of planning, implementing, and controlling the efficient, cost-effective flow of raw materials, in-process inventory, finished goods, and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal."

The idea of RL is to complete the supply chain back to its origin i.e., from consumer to raw materials and the forward flow without a backward flow with finite resources of the planet is uncomprehend able. It is estimated that on average RL adds 3% - 4% towards the revenue generation of any organization and RL costs are estimated to be one percent of the United States GDP showing its volume and necessity in today's world. According to certain estimates the secondary market has a 2.28 percent share of the U.S. GDP (Rogers, D., 2013). When the associated activities are added the figures swell even more. Icenhour (2014) believed that RL plays a major role in terms of profit and competition for any company. He calls it the neglected dimension in profit enhancements in a company. Rogers (2013) has represented the RL as drainage simplifying the whole concept to removal of unwanted product out of the system and generating profit while doing so. In PR, around one billion rupees activity is based on RL through sale of scrap only PRSD, (n. d.) by including all associated activities related to RL the figures will soar much more than this.

Supply chain 4.0 has its strategic importance that to be considered as one of the important aspects of resilient supply chain specially in post Covid period. Many studies are carried out in the area in order to improve the performance of overall supply chain capacities along with the aspects of agility and responsiveness. Study conducted by Frederico (2021) provides the conceptual framework for strategic decision making for resilient supply chains in post pandemic world.

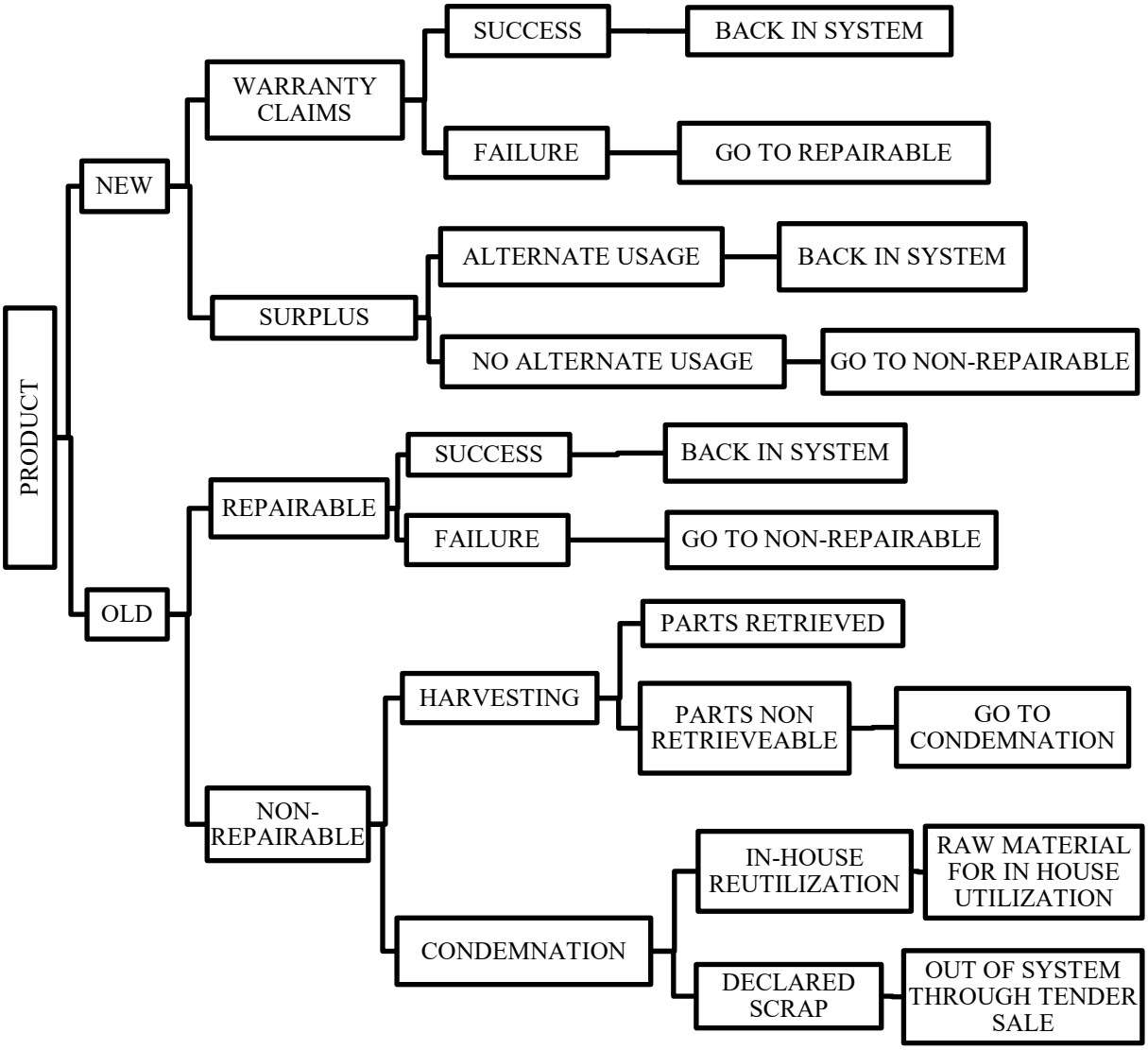
Many researchers have studied the implementation of RL in public sector organisation and circular economy like Upadhyay et al. (2020) studied crowd shipping measures by proposing a framework for logistics gaps in Indian Railways. Similar study carried out by Esposito & Soufani (2018) in postal services for managing the recovery of waste and urged that asset tracking, dismantling and toxic waste recovery is necessary within circular economies.

In today's competitive world, this is a huge amount especially for organizations that deal in multi-billions. Jayaraman (2007) is of the view, that materials have 70% cost share while producing a certain product from raw material whereas when remanufacturing is used this cost will be 40% resulting in direct savings of 30%. Moreover, transportation and engineering extensive organization like PR has a much elaborated and extensive requirement to setup a reverse flow of material because of various technical reasons, like wear and tear of rails, sleepers, locomotives, carriages and wagons besides various tools and plants including furniture etc. (PRSC, n. d.). Singh & Gupta (2020) explored the potential of metro system of railways for postal courier services which is currently used for passenger services only.

A new product even before its use may become useless because of various reasons like change in design/technology, policies or deterioration. Such products are reutilized either alternately or sold out at salvage value. When a product becomes unusable, if it is under

warranty, then the product will go to warranty claim department, if no then it will be evaluated for its reutilization in its own form or with some necessary alterations as per requirement. Next re-evaluation is to retrieve parts and use them elsewhere within the organization. After that if it is totally useless for reutilization at part level, it is sent to stores branch through traffic branch. Traffic branch deals with transportation and wagon routing to the destination. Stores branch is responsible for unloading, segregation, lot formation, survey and recycle/disposal of the material received. If the material can be reutilized within Railways in any form, it is reserved for the subject purpose. In case it is totally useless it is sold through tender sale (PRSC, n.d.).

Figure No 2: Reverse Logistics in Pakistan Railways



In order to measure the success of any system or process, an effective and efficient PMS is essential to make supply chain resilient. Garengo et al., (2005) has mentioned the necessity of an effective and efficient PMS for RL. While designing the framework of such a

system for any organization or process great care must be taken by taking into account; cultural issues, the organizational behaviour, ground realities, constraints and related issues. Unfortunately, in most cases the performance metrics is either missing altogether or is inefficient, inefficient or unrealistic in nature. Ravi and Shankar (2004) have indicated non availability of an effective and efficient PMS as one of the major issues of RL along with absence of customized technological systems which results in no or least information flow making it difficult to take fruitful decisions. Shepherd and Gunter (2006) also identified the problem that proper PMS is yet to be evolved for process of RL. So, it may safely be concluded that an efficient and effective framework of PMS must be developed to quantify and decide the performance of a system and that includes RL. Kongar (2004) offered a model based on BSC for PMS of RL. Jianhua et al. (2009) proposed a model of PMS on Reverse logistics based on Modified BSC. Jun (2009) recommended a model for PMS in the field of RL. Neely (1995) defined the process of measuring performance, through quantification, the effectiveness and efficiency of a process is called performance measurement. PM can be done through various ways and from different scenarios. Kaplan and Norton (2001) used Balanced Score Card (BSC) method for the measurement of performance. PMS are used to incorporate KPIs together to gauge the performance through performance information (Lohman et al., 2004). Vast portion of the PMS in the subject organization are based on KPIs and so is the proposed Framework of PMS.

Saripalle (2018) urged the profitability in Indian logistics by conducting research on 201 companies based on econometric models. Similarly, Garg and Kashav (2020) assessed the initiatives in the containerized freight of Indian railways by applying Fuzzy AHP Framework. A recent study by Kubasakova and Kubanova (2021) compared the implementation Items of Reverse Logistics Europe & Slovakia urged that importance of green logistics in modern era.

A KPI must also take into account the SWOT analysis as every organization/process has its strength, weaknesses, opportunities and threats which in turn arises the need of **S.W.O.T** analysis (KPI 101). The whole framework of PMS will be based on quantifiable performance and KPIs. KPIs are always quantifiable, used to evaluate the performance, and are considered to be critical in defining the success of an organization (Lindholm, 2010; Posset et al., 2010). Pollock (2007) is of the view that if the KPIs are not measurable then they are useless. According to Anon, “If you can't measure it, you can't manage it”. Hence it is established that KPIs plays crucial rule in the management of an organization and so is the case of RL of Pakistan Railways.

The KPIs must be **SMART** in nature i.e., Specific, Measurable Achievable, Relevant and Time bound. The key element of KPIs and PIs is 3E i.e., economy, efficiency and effectiveness (KPI 101). The document further points out the need to decide whether an indicator qualifies to be a KPI is to decide that do the management “need to know” this indicator or it is just “nice to know” about it. Mostly the information is totally insignificant giving rise to more inefficiency by just collecting data and performing analysis without any enhancement in the efficiency or effectiveness in performance. Contrary to this, a well-designed KPI will result in efficient and effective performance growth by keeping in focus

the targeted information and leaving behind the useless ones. An effective PMS in an organization reduces the inefficiencies and increases the performance.

The key stakeholders in the case of RL of Pakistan Railways are top management (for decision making), consuming departments (for returns of material in terms of either warranties or repairs/disposal/recycling), traffic department for smooth and efficient movement of items involved in RL and stores department (for unloading, warehousing, segregation, lots formation, assessing reusability within the organization through own workshops or disposal through tender sale of scrap by careful examination by the survey committees formed for the subject purpose), purchase branch (for warrant claims), contractors (purchasers of scrap or condemned material), and third party logistics providers (PRJPOC, n. d.). Sometimes contractors also act as third-party logistics. Based on the role of stakeholders involved in the current setup, the division is made in terms of internal and external point of views (Bourne et al., 2000; Maria et al., 2015).

The context of long term and short term is referred by researchers including Garcia et al., (2012); Krauth et al., (2005); & Lauman et al., (2004), and is common while defining KPIs. The short-term goals of an organization focus on economical, efficient and effective RL system while generating maximum profit. The long-term goals are entirely different and detailed. They include consistent policies, need of material handling equipment, planning, managing and organizing quality and skilled human resource, excellent collaboration with stakeholders taking into account conflict resolution, better long-term relationship with contractors, and keeping government policies and environmental policies in check and consideration etc. Long term goals are mostly strategic in nature, whereas short term goals are generally operational in nature. Panfilov and Eidarawany (2021) urged that importance of digital ecosystem based KPIs for reporting in Russian railway networks. Similar study carried out by Suleykin and Panfilov (2020) proposing digital eco-system framework driven by Big data analytics for a railway company in Vienna.

Some key decisions taken in short term are inventory control, inventory storage and delivery, controlling the returns of material/equipment/items, return schedules and route selection. Short term decisions may be reviewed each month through their respective KPIs. Key long-term decision includes site location layout and design, process planning, RL network design, PMS based on KPIs (must be long term but flexible to adapt any change) and for inventory management with returns.

PMS is also sub-divided in terms of strategic, tactical and operational level Lambert et al., (2011) separately both for external as well as internal point of views for RL of Pakistan Railways. Petersson and Zantvoort (2012) considered that Strategic Performance Measurement is most important, then comes Tactical and Operational Performance Measurement in the field of logistics. They are also of the view that Balanced Score Cards may be used to quantify the unquantifiable KPIs.

Rogers (2013) based his performance indicators on two factors only first disposal in terms of time and secondly the value recovered from this disposal. Landrieu (2001) based the PM on profit maximization.

PR primary measurement technique of gauging the performance is the contribution towards generation of revenues from scrap or RL (PRSD, n. d.). The noticeable thing in this regard is the warranty claims, reusability and harvesting must also be included towards calculation of the contribution towards the system of RL.

3. Research Methodology

In order to address the subject research questions, the method of triangulation is used. The deductive approach and qualitative method is applied, in view of the research questions. Literature review, review of source documents, personal inferences, and interviews of the employees working in the system is relied upon. Being a concept paper, the outcome of the proposal is a proposed framework for the performance measurement of the system.

4. Discussion and Analysis

4.1 Drivers of Performance Measurement

In order to keep on improving and enhancing the capacity and efficiency of organization and so for resilient supply chain, PM plays an important role. According to Anon *"You cannot manage what you cannot measure".* The major drivers of PM of Pakistan Railways RL are:

- **Economic:** as per discussion in the above sections, the reverse logistics volumes are more than a billion PKR in PR. This is huge number for any type of business. Moreover, the managers dealing with forward logistics and operations are also dealing with RL. Integration of forward logistics and reverse logistics results in significant overall cost reductions (Rahman & Subramanian, 2012). Hence the cost is minimal while the contribution towards revenue is significant.
- **Check/analyse room for improvement:** By assessing the patterns of replacement, warranty/guarantee, repairs, harvesting, reutilization, surplus, or the whole life cycle of the product.
- **Top Management Decisions:** Top management is in a better decision-making position by forecasting the future departmental needs and performance based on concrete evidence of previous behaviour of a certain product. (Berrah & Cliville, 2007)
- **Environmental/Green:** The environmental laws are getting strict every day. Moreover, modern societies are getting more conscious day by day regarding recycling and reduction of pollution. As most of the scrap is of ferrous nature and is remelt able hence the activity will be environmentally friendly and act as recycling (PRSD, n. d.).
- **Governmental Policies:** Being a state-owned organization and having a history of more than 100 years, the procedure of disposal of unwanted material needs to be followed (PRSC, n. d.).
- **Tracking & Monitoring:** By implementing a comprehensive framework of PMS it is easier to recognize, track, monitor and optimize progress, targets and objectives.

- **Industrial & International Standards:** Enhancing performance to achieve industry or international standards will result in morale boost of the personnel of the organization and goodwill of the organization.
- **SWOT Analysis**: By implementing effective PMS the management may assess perfectly Strength, Weakness, Opportunities, Threats related to organizations at any given point.
- It will help in setting up realistic goals and targets regarding RL.
- It will act as a feedback system for necessary organizational and policy changes.
- Assets Protection and Accountable is easier and definitive in nature. It rechecks the presence of product within the system (PRSC, n. d.).
- Operational capabilities are enhanced by proper monitoring and setting up of targets. Micro level KPIs or individual KPIs will ensure better performance.
- Reduced failure cost by providing more insight about the product's whole life cycle and choosing better quality products in every subsequent procurement.
- Determine the role, problems, contribution of each branch in RL of Pakistan Railways and how to move forward to enhance collaboratively for overall betterment of the organization.

4.2 Constraints/Problems

The constraints/problems in PM of Pakistan Railways RL are;

- All the activities mentioned in previous sections need to be bench marked in the specific perspective of RL.
- Performance should always be measured in quantifiable terms. It may be measured through KPIs, Balance Score Card or any other way.
- Mostly, organizations fear to measure performance in order to avoid unfavourable results. The need of the hour is to eliminate this fear and make the realization that instead of non-measurement of performance, measure, gauge, reflect, make necessary changes and improve the process in order to enhance the efficiencies and effectiveness of the system making it stronger and even better than before.
- As many branches are involved, hence setting the goals by assessing the total amount of activities of RL at each stage is difficult.
- Difficulties in Conflict Resolution between all stake holders, due to different objectives. This includes both internal stake holders and external stake holders.
- The biggest volume of material involved is ferrous scrap. All types of scrap have different rates each day, therefore, efficient time line of processes and involvement of stakeholders keeping in view market trends is difficult.
- Lack of an effective and sophisticated software system or an ERP system especially designed for the RL of Pakistan Railways. Market available ERP packages lack the ability of RL system integration.
- Lack of awareness about the whole dynamics of RL in connection to its PM in the internal and external perspective.
- Lack of stakeholders' commitment towards the whole process of RL.

- Defining the KPIs with special reference to all the activities involved in RL.
- Surplus material must be avoided. Mostly surplus is generated due to Bull Whip Effect on the consumer side (consumer branches like Mechanical, Electrical, Civil, Signal, Telecom, Traffic, and medical branches). The consuming departments must avoid over-ordering. The change in technology or policies must be taken into account at an appropriate time and relevant corner must be informed about the decrease in consumption immediately after realizing the same. Ordering quantities should also be adjusted accordingly. In case of surplus, the items should be cleared at the earliest. The financial effects are usually exponential in such scenarios (PRSC, n. d.).

4.3 Proposed Framework of PMS For Pakistan Railways RL

Figure No 3: Proposed Framework of Performance Measurement System PMS of Pakistan Railways in terms of KPIs

Bassioni et al. (2004) has the opinion that a PMS is different from a performance measurement framework. According to him, PMS refers to the actual system of measurement enforced by the organization and is in practice or practically tested whereas performance measurement framework is a general theoretical framework developed through research and may act as a foundation of organization's PMS. As per above mentioned research, the PMS proposed in this paper is a performance measurement framework rather than a PMS. Although the proposed framework is designed and defined with much care yet it may have some deficiencies as argued by (Bassioni, 2004). The deficits may include selection criteria of KPI, relationship between KPIs, unorganized/illogical design pattern, practical implications and their resolution when applied, and resilience in the longer run (Bassioni et al., 2004).

Different researchers used different techniques of differentiating the PMS as explained in detail in the literature review section. Some have divided it into internal and external while others have gone for time horizons like long term and short term. The most common was strategic, tactical, and operational to make supply chain resilient. However, the proposed framework takes into account all the above-mentioned factors.

4. 3.1 Internal Strategic KPIs

1. Availability of Human Resource (%) = (On roll Strength / Sanctioned Strength) X 100
2. % decrease in generation of Surplus = (Amount of new Surplus this year / Average Surplus generated in Previous Years) X 100
3. Flexibility in Policies = Number of policies required to be changed along with tangible effects.
4. Material Handling Capacity of the system along with bottlenecks.
5. % increase in amount of product reserved/reutilized/harvested with in Pakistan Railways = (Actual Value/Targeted Value) X 100
6. % increase in amount of sold material = (Actual Value/Targeted Value) X 100
7. Infrastructure/Assets remaining life = BSC method
8. Infrastructure/Assets Development/Maintenance = BSC method
9. Productivity = (No. of sale orders completed in an year / No. of months) (Bowersox et al., 2013).
10. Strength of the RL System (should increase)
11. Weaknesses of the RL system (should decrease)
12. % Increase/decrease in sales of disposable material due to Market Trend.
13. Loading/unloading efficiency = Labour Productivity Level + MHE
    - 13.1 Labour Productivity Level = ((Actual Productivity of each labour X No. of Labourers in a month / Defined Productivity of each labour X No. of Labourers in a month)) X 100.
    - 13.2 Material Handling Equipment (MHE) = ((Actual Productivity of each MHE X No. of MHE available in a month / Defined Productivity of each MHE X No. of MHE in a month)) X 100.

4.3.2 Tactical KPIs

1. Inventory Shrinkage Rate (ISR) = BSC
2. Revenue earned vs targets.
3. (Interim/Stock) Storage time = Average storage time of a product (Should be lesser than previous year)
4. % of material recycled within PR = (Value of Material Recycled through reutilization / harvesting / remelting in a year ÷ Value of Total Material in a year) X 100.
5. Yearly increase/decline in amount of products in RL.
6. Depreciation in material due to non-sale.
7. % of conflicts resolved within PR = (No. of conflicts resolved/No. of conflicts arised) X 100
    - 7.1 No. of Conflicts arise.
    - 7.2 No. of Conflicts resolved.
8. Efficiency of conflicts resolution within PR = ∑ (time taken in conflict resolution) / No. of conflicts. Benchmark average no. of working days for conflict resolution.
    - 8.1 Time taken in conflict resolution.
    - 8.2 No. of conflicts.

9. % utilization of reserved lots = (Utilized Amount of reserved material in Metric Tons in a year / Total amount of Reserved material in Metric Ton in a year) X 100

4.3.3 Operational KPIs

1. Cost to profit ratio
   1.1 % increase in Economic Value Addition = (2.1 + 2.2 – Yearly Operational Cost) / Previous Year Values X 100
   1.1.1 Revenue Generation through Sale of scrap / year = Amount in PKR

   1.1.2 Revenue Savings through reutilization / harvesting / remelting etc within PR / year = Amount in PKR.

2. Amount to be reserved / sold = Yearly Demand of PR : Yearly Generation (keeping in view the depreciation cost per year)
3. Disposition cycle time = Average Time spent by a product in RL
4. Material Handling Efficiency = (Total Material Handled per month / Material To be Handled) X 100.
5. Amount of Demurrage = 0 (if not than close to zero with reasons that must be avoided in future)
6. Lot size flexibility.
7. Performance measurements costs
8. Loading / Unloading time = Average Time/ M. Ton/ Month retailor from Garcia, (2012).
9. Material Handling Cost / M. Ton / Month.
10. Wagons / MBFR / Tank Wagon utilization rates = Average Time Taken by a Wagon / MBFR / Tank Wagon in RL.
    10.1 Loading Time.
    10.2 Transport Time.
    10.3 Unloading Time.
    10.4 Time to make it available again for service.
11. Contingency allowance. (Kravokics et al., 2008)
    11.1 Pilferage / Deterioration / Wastage (Less than 3% value of total product available in RL)
    11.2 No. of Accidents (should be least).
12. Dispatch/Receipt of Material at a certain point.
13. Loading capacity (Σ Utilized capacity per journey per wagon / Total loading capacity per Journey per wagon) X 100 Krauth et al., (2004; 2005)

4.4 External Strategic KPIs

1. % Increase in PKR from sale of scrap / year = (Amount in PKR of New Contracts / Total Amount in PKR of all contracts of Last Year) X 100.
2. % Increase in customers gained = ∑ (Number of New Customers in a year / Total Number of Existing Customers per year) X 100%.
3. Cost minimization through timely disposal and less wastage/deterioration.

4. Profit maximization by creating win-win situation = increase in sale of scrap. Long Term Customer Relationship development and Retention.
5. On-time delivery performance (Monitoring and Evaluation, 2015)
6. Overall customer satisfaction.
    6.1 % of Customer complain resolution = (No. of customer complains resolved in a year / No. of Complains in a year) X 100
    6.2 No. of customer complains resolved in a year.
    6.3 No. of Complains in a year.
7. Realization of sustainability goals of the RL system with respect to external market/customers etc.
8. Flexible warranty Claim policies.
9. Efficient disposal = (Scrap in M. Ton sold per year / Scrap generated in M. Ton per year) X 100
10. Opportunity analysis = Opportunities available for disposal of scrap
11. Threats to the RL with respect to external market/customers etc.
12. Projected Cost Variance (PCV) = Expected gain / loss due to market trend

4.4.1 Tactical KPIs

1. % increase in number of sale orders = (No. of New Sale orders / No. of last year's sale orders) X 100.
    1.1 No. of New Sale orders.
    1.2 No. of previous year's sale orders.
2. % increase in yearly revenue from each customer = (Increase in Amount in PKR from each customer in a year / Amount in PKR from each customer last year) X 100.
    2.1 Increase in Amount in PKR from each customer in a year = Current Year's amount in PKR from each customer – Last Year's Amount in PKR from each customer.
        2.1.1 Current Year's amount in PKR from each customer
        2.1.2 Last Year's Amount in PKR from each customer.
3. Taxes to the national treasury. (Goodwill of the Department)
4. Transparency in contracts.
5. Customer Performance Index (CPI) = (Σ No. of claims of customer's responsibility / Total No. of Sale Orders) x 100 reshaped from Garcia et al. (2012)
6. Time Out Deliveries (Σ No. of time out deliveries / Total No. of deliveries) x 100 Garcia et al. (2012)
7. Effective disposal of scrap. BSC
8. % of conflicts resolved outside PR = (No. of conflicts resolved/No. of conflicts arise) X 100
        8.1 No. of Conflicts arise.
        8.2 No. of Conflicts resolved.
9. Efficiency of conflicts resolution outside PR = ∑ (time taken in conflict resolution) / No. of conflicts. Benchmark average no. of working days for conflict resolution.
        9.1 Time taken in conflict resolution.
        9.2 No. of conflicts.

10. % of incomplete sale orders in a year = (No. of Incomplete Sale orders in a year / Total Sale Orders in a year) X 100.
    10.1 No. of incomplete sale orders.
    10.2 Total sale orders in a year.

4.4.2 Operational KPIs

1. % of sold but not lifted scrap = (Amount of scrap sold but not lifted in PKR in a year / Amount of total scrap sold in PKR in a year) X 100.
   1.1 Amount of scrap sold but not lifted in PKR in a year.
   1.2 Amount of total scrap sold in PKR in a year.
2. % of scrap made available for disposal = (M. Ton of scrap made available for disposal in a year / M. Ton of total scrap received in a year) X 100.
   2.1 M. Ton of scrap made available for disposal in a year.
   2.2 M. Ton of total scrap received in a year.
3. Amount of scrap sold and lifted in M. Tons. in a year. Modified from Krauth et al., (2004; 2005)
4. Recovery cycle time = Average time for repair, refund or exchange of warranty items.
5. % increase /decline in warranty claims = (No. of warranty claims in a year / Total no. of warranty claims of last year) X 100
6. Controllable expenses / Uncontrollable expenses
7. % returned items as % of purchase order = % of Items returned/rejected under warranty in a purchase order = ∑ ((total returned or rejected items / total items in a purchase order) / no. of purchase orders) X 100
   7.1 Total returned or rejected items.
   7.2 Total items in a purchase order.
   7.3 No. of purchase orders.
8. Efficiency of claims = (Successful claims / Total claims) X 100
   8.1 Successful claims.
   8.2 Total claims.
9. Timeliness of claims = ∑ (time taken in successful claims) / No. of claims benchmark in No. of working days.
   9.1 Time taken in successful claims
   9.2 No. of claims
10. No of completed sale orders.
11. Service level
    11.1 Correct deliveries = (Σ (Orders delivered without errors or damages) / Total no. of orders)) X 100
    11.2 Complete deliveries = (Σ (Orders delivered completely / Total no. of orders)) X 100
    11.3 On-time deliveries = Σ (Orders delivered in time / Total no. of orders) X 100. Redefined from Garcia et al. (2012); Schonsleben (2011)

5. Conclusion

RL plays a pivotal role in the success of any organization in today's competitive world. In fact, the idea is essential on this planet earth because of the finite resources. The

sooner the whole world will realize the importance of finite resources, the better for the whole world. The system of RL is a source of satisfaction for the environmentalist and towards conservation of nature. The system of RL should be resilient, efficient and effective. In order to achieve this goal, a remarkable devised PMS is need of the hour. The PMS will enhance the performance of the system with continuous monitoring and feedback. In the absence of a well-designed and tailor-made ERP system, the efficient and effective working of any kind of PMS is a difficult task and is a major limitation towards the implementation of this study. Many kinds of PMSs are available for various supply chains including FL and RL, however for the purpose of RL for engineering extensive, geographically distributed, public sector, logistics organization, the design of a proper PMS is rare. The purpose of this study is to propose a framework for PMS in the specific scenario specially the post pandemic era for Pakistan Railways' RL, a case study. The proposed framework is based on various KPIs. These KPIs are further subdivided to indicate and monitor strategic, tactical, and operational matters in internal and external perspectives. The whole KPIs are designed from literature review and experience of the organization. The list of KPIs needs to be further verified, and validated through qualitative or quantitative analysis.

5.1 Future Research

Similar analysis can be performed on top management, medium management and lower management, instead of internal/external perspectives. In this way the detailed role of 3-tier management will be defined clearly for short term as well as for long term in terms of strategic, tactical and operational terms and to achieve the goal of resilient supply chains. A similar analysis must also be done to determine the key risk indicator (KRIs). Different weights may be defined to calculate each KPIs depending on its significance and the results be evaluated for any positive change in the PMS. Further research can be conducted for the correct alignment of defined KPIs of different internal departments of PR.

6. References

Aslam, A. M. (2023). Unlocking Pakistan Railways dead capital. In *3rd Rasta Conference*.

Bassioni, H. A. (2004). A framework for measuring business performance in construction contracting organizations. *PhD Thesis, Loughborough University*, UK.

Bassioni, H. A., Price, A. D. F., & Hassan, T. M. (2004). Performance measurement in construction firms. *Journal of Management in Engineering*, *20*(2), 42-50.

Berrah, L., & Cliville, V. (2007). Towards an aggregation performance measurement system model in a supply chain context. *Production Planning and Control*, *58*, 709- 719.

Bourne, M., Wilcox, M., Neely, A., & Platts, K., (2000). Designing, implementing and updating performance measurement systems. *International Journal of Operations and Production Management*, *20*(7), 754-771.

Bowersox, D. J., Closs, D. J., Cooper, M., & Bowersox, J., (2013). *Supply Chain Logistics Management* (4th ed.). New York: McGraw-Hill.

Canadian Association of Logistics Management, from *http://www.calm.org/calm/AboutCALM/AboutCALM.html, 12 Feb, 1998*

Chan, K. (2023). *Fast Track: State Capacity and Railway Bureaucracies in China and India* (Doctoral dissertation, Princeton University).

Domingues, L. M., Reis,V., & Macario, R. (2015). A comprehensive framework for measuring performance in a third party logistics provider. *18th Euro Working Group on Transportation, EWGT 2015*, 14-16 July 2015, Delft, The Netherlands

Esposito, M., Tse, T., & Soufani, K. (2018). Reverse logistics for postal services within a circular economy. *Thunderbird International Business Review*, *60*(5), 741-745.

Farro, A. L., & Maddanu, S. (2022). *Restless Cities on the Edge: Collective Actions, Immigration and Populism*. . Cham, Switzerland: Palgrave Macmillan.

Frederico, G. F. (2021). Towards a supply chain 4.0 on the post-COVID-19 pandemic: a conceptual and strategic discussion for more resilient supply chains. *Rajagiri Management Journal*.

Garcia, F. A., Marchetta, M. G., Camargo, M., Morel, L., & Forradellas, R. Q. (2012). A framework for measuring logistics performance in the wine industry. *International Journal of Production Economics*, *135*(1), 284-298.

Garengo, P., Biazzo, S., & Bititci, U.S. (2005). Performance measurement systems in SMEs: A review for a research agenda. *International Journal of Management Reviews*, *7*(1), 25-47.

Garg, C. P., & Kashav, V. (2020). Assessment of Sustainable Initiatives in the Containerized Freight Railways of India using Fuzzy AHP Framework. *Transportation Research Procedia*, *48*, 522-539.

Greve, C., & Davis, J., (n.d.). *Recovering Lost Profits by Improving Reverse Logistics*. Website: https://www.ups.com/media/en/Reverse_Logistics_wp.pdf

Icenhour, M. R. (2014). Reverse Logistics Planning: A Strategic Way to Address Environmental Sustainability While Creating a Competitive Advantage. *University of Tennessee Honors Thesis Projects.*

Jayaraman, Vaidyanathan, & Luo Yadong. (2007). Creating Competitive Advantages Through New Value Creation: A Reverse Logistics Perspective. *Academy Of Management Perspectives, 21*(2), 56-73.

Jianhua, Y., Lidong, Z., & Zhangang, H. (2009). Study on the Performance Evaluation System of Reverse Supply Chain Based on BSC and Triangular Fuzzy Number AHP. *International Conference on Information Engineering and Computer Science*, 1-4.

Jun, W. (2009). A Fuzzy Evaluation Model of the Performance Evaluation for the Reverse Logistics Management. *WRI World Congress on Computer Science and Information Engineering*, *1*, 724-727.

Kaplan, R. S. (2001). Strategic Performance Measurement and Management in Nonprofit Organizations. *Nonprofit Management & Leadership*, *11*(3), 353-370.

Kaplan, Robert S. & David P. Norton, (1993). Putting the Balanced Scorecard to Work. *Harvard Business Review*, Sep/Oct 1993.

Kaplan, Robert S. & Norton, David P. Using the Balanced Scorecard as a Strategic Management System. *Harvard Business Review*, Jan/Feb 1996.

Kongar, E. (2004). Performance measurement for supply chain management and evaluation criteria determination for reverse supply chain management. *Proceedings of SPIE*, Bellingham, WA, 106-117.

KPI 101, from *http://smartkpis.kpiinstitute.org/kpi-101/kpis-naturally*

Krakovics, F., Leal, J., Mendes, P., & Lorenzo, R. (2008). Defining and calibrating performance indicators of a 4PL in the chemical industry in Brazil. *International Journal of Production Economics*, *115*(2), 502-514.

Krauth, E., Moonen, H., Popova, V., & Schut, M. (2005). Performance Measurement and Control in Logistics Service Providing. *ICEIS, 2*, 239-247.

Krauth, E., Moonen, H., Popova, V., & Schut, M. (2005). Performance Indicators in Logistics Service Provision and Warehouse Management. *A Literature Review and Framework. Euroma International Conference*, 19-22.

Kubasakova, I., & Kubanova, J. (2021). The Comparison of Implementation Items of Reverse Logistics in Terms of Chosen Companies in Europe and Slovakia. *Transportation Research Procedia, 53*, 167-173.

Kurhan, M. B., Kurhan, D. M., Husak, M. A., & Hmelevska, N. (2022). Increasing the efficiency of the railway operation in the specialization of directions for freight and passenger transportation.

Lambert, S., Riopel, D., & Abdul-Kader, W. (2011). A reverse logistics decisions conceptual framework. *Computers & Industrial Engineering*, *61*(3), 561-581.

Landrieu, A. (2001). Logistique inverse et collecte des produits techniques en fin de vie. Tourne´ees de v´ehicles avec contraintes. *PhD thesis, Institut National Polytechnique de Grenoble, Grenoble, France*. PhD Thesis.

Lindholm, M. (2010). A sustainable perspective on urban freight transport: Factors affecting local authorities in the planning procedures. *Procedia - Social and Behavioural Sciences*, *2*(3), 6205-6216.

Lohman, C., Fortuin, L., & Wouters, M. (2004). Designing a performance measurement system: A case study. *European Journal of Operational Research*, *156*, 267-286.

Mahboob, Q., Aalam, M. A., Tahir, S., Wang, Z., Mao, Q., & Tan, Z. (2024). Incorporating KPIs in the Quantification of Overall Efficiency of Rolling Stock of Railways. *Engineering Proceedings*, *75*(1), 14.

Monitoring & Evaluation (2015). From *http://dlca.logcluster.org/display/LOG/Monitoring+and+Evaluation*

Muhammad, A. S., Akram, R., & Khan, M. A. (2025). Framework for Performance Measurement System for Internal Supply Chain of Railways: A Study from Pakistan. *Journal of Political Stability Archive*, *3*(3), 1117-1134.

Munawar, F., Gull, M., Hassan, S., Farasat, M., & Capraz, K. (2024). The crisis of Pakistan railways: unveiling the nexus of competence and corruption. *Liberal Arts and Social Sciences International Journal (LASSIJ)*, *8*(1), 64-87.

Neely, A., Gregory, M., & Platts, K. (1995). Performance measurement system design: a literature review and research agenda, International, *Journal of Operations & Production Management*, *15*(4), 80-116.

Pakistan Railways Joint Procedure Office Orders (PRJPOC, n. d.)

Pakistan Railways Source Documents (PRSD, n. d.)

Pakistan Railways Yearbook (PR YB 2014 – 15)

Panfilov, P., Suleykin, A., & Eidarawany, A. (2021, November). Digital Ecosystem-Based KPI-Driven Railway Communication Network Reporting System. *In Proceedings of the 13th International Conference on Management of Digital Eco Systems* (163-166).

Petersson, P. & Zantvoort, T.R. (2012). Fourth-party logistics: A case study on performance measurement. *Master Thesis, Jonkoping International Business School*.

Pollock, K. W. (2007). *Using Key Performance Indicators (KPIs) to Measure and Track the Success of Your Services Operation* from website: http://www.s4growth.com/publications/articles/28.cfm

Posset, M., Gronalt, M., & Hauslmayer, H. (2010). COCKPIIT – Clear, Operable and Comparable Key Performance Indicators for Intermodal Transportation. *Wien*.

PR Stores Code (PRSC, n.d.)

Pyrgidis, C. N. (2021). *Railway transportation systems: design, construction and operation*. CRC press.

Rahman, S., & Subramanian, N. (2012). Factors for implementing end-of-life computer recycling operations in reverse supply chains. *International Journal of Production Economics*, *140*(1), 239-248.

Ramaa, A., Rangaswamy, T. M., & Subramanya, K. N. (2009). A Review of Literature on Performance Measurement of Supply Chain Network. *Emerging Trends in Engineering and Technology (ICETET)*, 2009 2nd International Conference, 802-807.

Ravi, V. & Shankar, R. (2004). Analysis of interactions among the barriers of reverse logistics. *Technological Forecasting & Social Change*, *72*(8), 1-18.

Rogers, D. (2013). *LM Exclusive: Taking Control of Reverse Logistics*. Website: http://www.logisticsmgmt.com/article/lm_exclusive_taking_control_of_reverse_logistics

Rogers, D.S. & Tibben-Lembke, R.S. (1999). Going Backwards: Reverse Logistics Trends and Practices. *Reverse Logistics Executive Council*, Pittsburgh, PA.

Rushton, A., Croucher, P., & Baker, P. (2010). *The Handbook of Logistics & Distribution Management* (4th ed.). The Chartered Institute of Logistics and Transport (UK).

Saripalle, M. (2018). Determinants of profitability in the Indian logistics industry. International *Journal of Logistics Economics and Globalisation*, 7(1), 13-27.

Schonsleben, P. (2012). *Integral Logistics Management: Operations and Supply Chain Management Within and Across Companies* (4th ed.). US:CRC Press.

Sheperd, C. & Gunter, H. (2006). Measuring supply chain performance: current research and future directions. *International Journal of Productivity and Performance Management*, *55*(3/4), 242-258.

Singh, M., & Gupta, S. (2020). Urban rail system for freight distribution in a mega city: case study of Delhi, India. *Transportation Research Procedia*, *48*, 452-466.

Stock, J.R. (1992). *Reverse Logistics*. Council of Logistics Management, Oak Brook, IL.

Suleykin, A., & Panfilov, P. (2020). BIG DATA-DRIVEN DIGITAL ECOSYSTEM FRAMEWORK FOR RAILWAY REPORTING. *Annals of DAAAM & Proceedings*, *7*(1).

Talbot, F. A. (2022). *Railway wonders of the world*. BoD–Books on Demand.

Upadhyay, C. K., Vasantha, G. A., Tiwari, V., Tiwari, V., & Pandiya, B. (2020). Strategic upturn of reverse logistics with Crowd shipping: Transportation explication for India. *Transportation Research Procedia*, *48*, 247-259.