Performance Based Railway Infrastructure Maintenance: Towards Achieving Maintenance Objectives

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***Abstract*— The measurement and management of railway infrastructure capacity has received increased attention in recent years due to the pressing need to optimally utilized the existing railway infrastructure capacity and as well create more capacity. In a bid to improve the maintenance function and utilization of the existing infrastructure, some of the infrastructure managers (IM) reviewed their approach to outsourcing of maintenance functions, giving larger responsibilities to maintenance agent called contractors. The growing responsibilities of the contractors are however resisted by some IM due to some unresolved doubts. This paper discusses the outcome oriented approach to maintenance outsourcing; performance based railway infrastructure maintenance contracting with its issues and challenges. A framework is described and performance monitoring tool is proposed to enhance Performance Based Railway Infrastructure Maintenance (PBRIM) contracting as a strategy for improving the effectiveness of maintenance function.**

***Keywords*— outsourcing, performance based railway infrastructure maintenance, input, output and outcome measures.**

I. INTRODUCTION

The non-stationary business environment of the railway transport requires continuous improvement of the maintenance process from the strategic point of view to the operational perspective. The demand for more effective maintenance is increasing due to changing structure and demands of the stakeholders, complex technology, legislations and also business goal to optimally utilize the existing railway infrastructure capacity and as well create more capacity. Aggregation of all these factors is an obvious demand for a dependable asset which consequently requires an effective maintenance. This challenge could be approached by taking advantage of the possibility of outsourcing due to its potential benefits.

According to Campbell [1], outsourcing of maintenance in whatsoever level should not be seen as automatic strategy to achieving maintenance objectives. The outsourcing of specific or general functions, maintenance services in packages or full service is not an undisputed path to maintenance excellence. Though it could have the potential to cut cost, make the maintenance more effective by improving the quality and quantity of service by means of reducing failure interruption of traffic. Martin [2] has explored the viable options of contracting out maintenance activities and the consequences of transferring maintenance management function to the contractor. Espling [3] has also studied the different railway infrastructure maintenance contracts within the Swedish transport administration pertaining to scope, objectives, forms and outcome. The result of her gap analysis pointed out improvement areas and also risk areas.

The adoption of performance based maintenance contract though not widely accepted in the railway maintenance is a well established practice in road maintenance. Detailed description of the business process of performance based road maintenance contract and the in-depth study of its deployment, evolution, monitoring and improvement have been studied [4], [5], [6]. The national cooperative highway research program provided a synthesis report of the state of the practice of this outsourcing strategy in road maintenance [7].

However a successful deployment of performance based maintenance contracting in the railway system will require a robust performance management process. A critical system in any performance management process is performance measurement system [8]. Bititci [8] also identified two key issues to be checked in the content and structure of a viable performance measurement system as integrity and deployment, these are vital for effective and efficient performance management process. Kumar and Parida [9] analyzed the need for maintenance performance measurement, issues on maintenance performance measurement MPM were discussed by them and they also reviewed the existing MPM systems. Åhren [10] had also contributed to the identification and development of maintenance performance indicator for the railway infrastructure. All of these are instrumental in the

ISBN 978-91-7439-379-8

assessment of the value contribution of maintenance function to the success of the business.

To harness the potential benefit of PBRIM contracting, a well structured monitoring tool has been formulated to assess the input, output and outcome of the maintenance outsourcing approach. This monitoring tool will indicate the level of the maintenance function and also the degree of asset preservation. The monitoring tool helps the IM to assess the performance of PBRIM contract and to identify improvement opportunities and also make other decisions to achieve the maintenance objectives and add more value to the business objectives. This article however does not cover the detailed procedure, design and contents of the PBRIM contract documentation.

II. Historical evolution of maintenance in Swedish transport administration

Traditionally, infrastructure such as roads, railway, communication networks, public buildings, dams, media distribution facilities and other public facilities are owned by governments. The maintenance of these infrastructures is done by dedicated in-house maintenance departments [11]. However for several reasons among which will be expounded later in this article there is a growing trend towards outsourcing these maintenance activities to external agents especially in Sweden, Finland and Holland.

The conventional structure of railway administration had been combined responsibilities of both train operation and infrastructure management. The demand for higher excellence both financially and quality wise in the offered service and infrastructure has led to several segregations and separation of duties in the railway sector. The witnessed segregation in timeline has been both vertical and horizontal segregation. Over two decades ago, demands on increasing the effectiveness and efficiency of railway transport and other reasons of deregulation have led to the segregation of the railways into traffic operators and infrastructure managers in some countries. It has also become common to outsource the maintenance activities of both the rolling stocks and the infrastructure. A recount of the experience in Swedish Transport Administration "Trafikverket" could be traced back to 1988 when the Swedish railways was vertically separated into two parts: the Swedish National Rail Administration, with responsibility for the infrastructure management; and the Swedish railways with responsibility of running train services [12].

The tasks of the new infrastructure administration include: the management responsibility of delivering train paths by producing and selling capacity on the tracks to railway companies and traffic organizations. It extends to the development of the state-owned railway network by planning and expanding the network for current and future passengers and purchasers of transport [13]. The later responsibility involves services and maintenance works on the infrastructure to keep the asset in a reliable, available and safe state. As at this time the maintenance and renewal works were done with in-house resources with little or no engagement of private or external agents in the engineering works.

The restructuring process proceeded in 1998 when the infrastructure administration was horizontally separated into two parts: the infrastructure administration named Banverket, and Banverket Production which had the task of maintenance, rebuilding and new construction of the railway infrastructure. This structure was often referred to as client-contractor, which involves a service buyer - infrastructure administration, and a service provider – maintenance contractor [14]. Since 2010, the maintenance service provider has become an independent state company competing with other private contractors in the railway infrastructure maintenance contract market.

The contracting out of maintenance works to competitive market started in 2001 with few players and few contracts. The type of outsourcing differs in volume of work and responsibility of the contractors. The involvement of the maintenance service providers called the contractors in the maintenance process also vary. However at the early stage of the outsourcing, the labour and equipment of the contractors were utilized while most of the engineering analysis and technical function were done in house by the infrastructure manager. The evolution of the maintenance function in recent years has seen a greater involvement of contractors in the maintenance management of the infrastructure. Some infrastructure regions within Swedish Transport Administration now employ outcome based or functional contracting strategy. Figure 1 shows a picture of the evolution of maintenance organization with different scenario in timeline and parties involved.

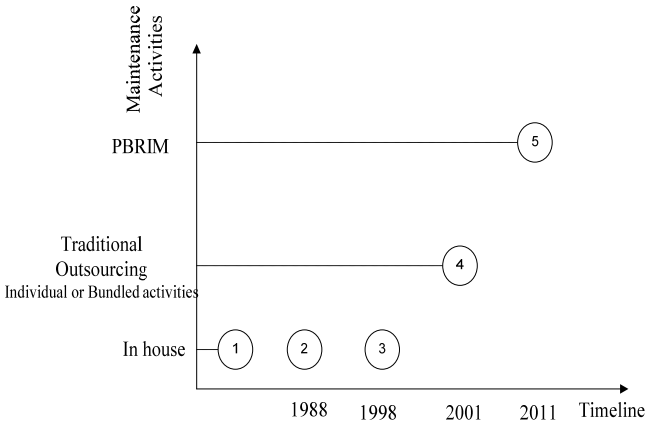

Fig. 1: Evolution of railway infrastructure maintenance at Swedish Transport Administration

1- All operations done by SJ, 2- traffic operations by SJ and infrastructure management by Trafikverket, 3- Maintenance outsourced to a public company, 4- Competitive contractor market with single or bundled activities being outsourced, 5- Full maintenance service outsourced with performance specification.

In this new trend in maintenance outsourcing, the contractors become largely involved in the maintenance process not only at the operational level but also right in the strategic level.

ISBN 978-91-7439-379-8

III. PERFORMANCE BASED MAINTENANCE CONTRACTING

It is the management practice of transferring or subcontracting some functions, activities and responsibilities performed in-house to external agents with a specified level of service to be met. A performance based maintenance contracting is an approach to contracting that provides incentives and penalties to the contractor to achieve specified targets for measurable outcomes and outputs [7]. The performance measures are related to the condition of the different asset type and also the outcomes of maintenance on operation, safety and economy.

There are different levels and different scenarios of maintenance outsourcing. Murthy [11] described the various contract scenarios based on the activities that is outsourced. The three key responsibilities differentiating these different scenarios are who determines: (i) What asset type to be maintained (ii) When to maintain (iii) How to maintain. The scenarios of outsourcing could also be explained using the responsibilities of client (i.e. Infrastructure Manager) and contractor in the maintenance process. Table 1 depicts the possible outsourcing scenarios. The scenario where the contractors have major responsibilities to decide what, when and how questions, is referred to as the performance based maintenance. A remarkable feature of performance based maintenance is that asset owner or IM does not specify the maintenance technique but rather define the performance requirement of the maintenance function. Its appellation differs in various industries and part of the world but the concept remains the same. It is often called functional guarantee contract, performance based contract, output based contract, full service maintenance, performance specified maintenance contract, total maintenance contract, performance contract etc.

TABLE I
OUTSOURCING SCENARIOS

Activities	What	When	How	Risk owner	Contracting
Planning	Yes	Yes			
Scheduling	Yes	Yes			
Execution			Yes		
Assessment					
Improvement	Yes				
Responsible Actors	IM	IM	IM	IM	In-house
	IM	IM	MC	IM	Traditional Outsourcing
	MC	MC	MC	MC + IM	Full service PBRIM

MC- Maintenance Contractor

Stremersch et al [15] has also described outsourcing based on two dimensions of service packaging/bundling and extension in customer need. The first dimension focuses on the maintenance service offer; is it single unbundled service or complete bundled maintenance service. The later describes the extent to which the customer needs are satisfied.

The different types of performance based maintenance contracts could be distinguished based on these two dimensions of activity scope and asset coverage [7], [14]. It could be a single activity such as snow cleaning, grinding, lubrication or single asset such as track maintenance, tunnel maintenance, level crossing maintenance. It could be more comprehensive in the form of work package on few asset types such as maintenance of all track structures, maintenance of all signal facilities. Furthermore a more intensive performance based maintenance contracts entails bundling of nearly all the maintenance activities on all infrastructure asset types for a contractor or a team of contractors with an expectation of a certain level of outcome. Figure 2 shows the two dimensions and the different types of performance based maintenance contracting.

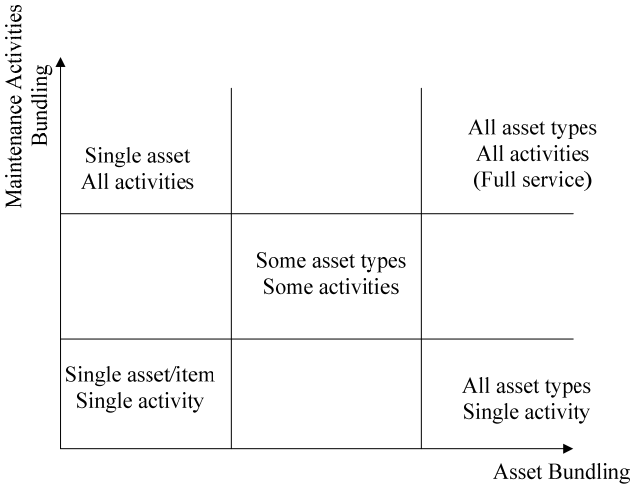

Fig. 2: Performance based maintenance contracting strategies based on method of delivery

IV. MOTIVATION FOR PERFORMANCE BASED MAINTENANCE CONTRACTING

The motivation and advantages of performance based maintenance contracting as identified by national cooperative highway research program [7] include;

1. Potential to reduce maintenance costs
2. Potential to improve level of service
3. The transfer of risk to the contractor
4. It encourages practical innovation
5. Better competence and skills with higher availability

ISBN 978-91-7439-379-8

6. Enhanced asset management
7. Change in performance criteria from a focus on inputs and outputs to customer-oriented outcomes
8. Reduction in contract administration requirements
9. Promise of stable financial obligation and reduced lifecycle cost

V. Issues of Performance based maintenance contracting

The fundamental issues to be addressed in outsourcing of maintenance activities were discussed by Campbell [1]. The readiness of the company to outsource, what to outsource and six practical steps to evaluate the outsourcing process are the major issues addressed by Campbell, check [1] for further reading. In railway infrastructure maintenance, these issues could be technical, management, economic or legal.

The risks of outsourcing maintenance activities are perceived to be higher if the PBRIM is employed compared to other outsourcing approaches. Maintenance of railway infrastructure was admitted to be a core activity for the infrastructure [16] while some other literatures referred to it as a strategic/significant support function. Moreover with due consideration to both views, the potential benefits of PBRIM could be harnessed. The significance of PBRIM is very high for infrastructure manager since maintenance is a strategic function which has high influence on the business success. An unforeseen or unnoticed deficiency in maintenance service by the contractor would not only be of operational and economic impact but could also be catastrophic. This thereby informs a framework for the initiation, design & procurement and implementation for PBRIM. It further demands a well structured and robust monitoring system for the appropriate performance measures.

It is very important for business owners (infrastructure manager in the context of this article) to carry out a proper evaluation of the implications of outsourcing their maintenance. If done properly, outsourcing can be more effective than in-house maintenance, facilitating the achievements of maintenance objectives and greater business productivity. For successful PBRIM contracting, it is also necessary to investigate the possible challenges of the approach.

VI. Framework for PBRIM contracting

The involvement of external agents in the management of maintenance means a large influence of these agents on the productivity of the client. The deficiency of the maintenance function under PBRIM when unnoticed could be costly, catastrophic and in worst scenario lead to the exit of the client in business. The attainability of the maintenance objectives (dependable asset, safe and comfortable traffic and also support for capacity expansion) together with the sustainability of the relationship of the client-contractor requires a well structured procedure or framework. This practical framework of a PBRIM could be distinctively separated into four stages and each of the stages has its own element which must be well studied, defined and structured to enhance the potential of this outsourcing technique.

- ✓ Initiation or conception stage
- ✓ Design or development stage
- ✓ Implementation stage
- ✓ Monitoring and Control stage

A. Initiation or conception stage

This is the first stage in the process of PBRIM contracting, it is essential to check the readiness of the IM to employ this strategy. The existing IM maintenance policy, tradition, business objectives, regulations and government legislations should be properly checked for conflicts. It is a preliminary assessment of the feasibility of PBRIM, this entail an initial comparison analysis of the possible alternatives for getting the job done. This entails a methodological identification of the need for PBRIM, and also justification of the evaluation criteria for the decision for PBRIM. At this stage in a critical assessment of the business environment and criteria for PBRIM, it is of necessity to answer the questions below:

Are the in house resources, skills and competence insufficient to meet the desired criteria?

What are the deficiencies in the employment of traditional outsourcing strategy where single maintenance services are outsourced or services are bundled in packages with specification of maintenance technique or methods?

Are the evaluation criteria specific, measurable, achievable and realistic under the specified conditions?

The above questions are guidelines for the assessment of the appropriateness of PBRIM at the conception stage. Clear and positive answers to this preliminary assessment would be a spring board to the second stage of the process towards a goal oriented maintenance function under the PBRIM approach.

B. Design and development stage

This is a significant part of the framework as most of the work is done here. A logical design and development of the PBRIM contract is needed for objective oriented infrastructure maintenance. It is no automatic path to maintenance success thus a gradual build up of the elements of this stage is of great importance. This is the core of PBRIM since its success depends on it. The elements of this stage include;

- ✓ Definition of responsibilities and conditions of assets
- ✓ Determination of incentives and disincentives
- ✓ Performance measures, targets and procedure
- ✓ Procurement

ISBN 978-91-7439-379-8

All the four activities mentioned above must be well designed; their procedures and modalities should be clearly stated.

The infrastructure manager should specify what is expected of the contractor in terms of cooperation forms, responsibilities and scope of the contracts. Though the maintenance technique or policy is not given but the vivid description of the railway lines to be maintained should be given. The asset register should be updated with a detailed description of the asset condition. It is also needful to define the responsibilities of the IM for conflict avoidance and other undesired negligent scenario.

A significant issue to be addressed in any maintenance program is the degradation of the asset. Since degradation is connected to the operational profile, or traffic on the infrastructure, it is the responsibility of the IM to ensure the traffic characteristics agreed upon. Changes in traffic volume, speed, axle load and other traffic parameter should be communicated to the contractor for a review of maintenance.

Also important to mention about the condition of asset during the contract are the boundary condition**s,** which can affect the outcome of the maintenance function. Boundary conditions in a PBRIM contract are those factors that might alter the maintenance deficiency beyond what the contractors are able to have any influence over. It is necessary to consider factors such as climate (snow, wind and thunderstorm), especially when setting the expected outcome for contract.

Another important element at the design stage is the determination of what to do when the performance target is either surpassed or not met **(Incentives/disincentives).** The target should preferable be in a range, the upper limit, which is often called the goal limit and the lower limit often referred to as the contractual limit. This specifies the performance level for incentives to encourage maintenance excellence and disincentives to penalize poor maintenance performance. The gainshare- painshare mechanism as described by [17] is relevant in the design of the reward and penalty for the performance of both the contract.

A well designed risk reward process will contribute immensely to the success of PBRIM as both IM and contractors are confident that their respective goals will be reached. The risk taken by contractors to meet some performance target will be rewarded when met which leads to good return for the contractor and dependable asset for the IM. This encourages the contractor against unnecessary cost cutting which could be detrimental to the infrastructure performance. A typical risk and excellence reward process is shown in figure 3. The target for any performance measure (asset based) is not a fixed value as it is a constraint function which depends on inherent capability of the asset, operating condition, age, environmental condition.

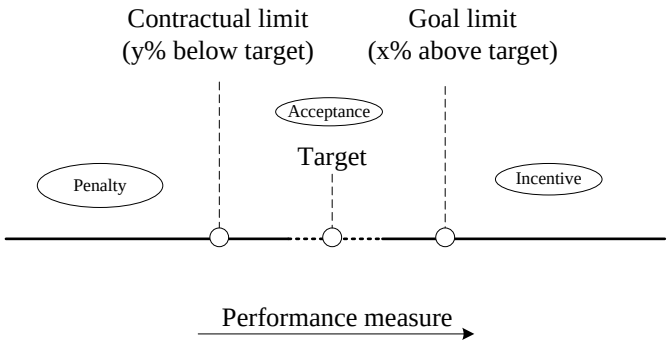

Fig. 3: Prototype of performance target

The third element is the core of this research, creating a monitoring tool for the performance of the PBRIM contract. The performance measures, targets and the procedure should be developed before the maintenance procurements. The questions of what to measure, how to measure and also the target to meet are cogent for the success of PBRIM and thus should be really given enough concentration during the design stage. A detailed description of the monitoring tool is given later in the article.

The procurement process of the maintenance comes before the PBRIM outsourcing technique is implemented. A multi-criteria decision making technique might be needed to examine the potential contractor market for the desired contractor selection criteria. These criteria might include; contractor's technical understanding of the maintenance work, organisational competence or staffing, past experience, cost and so on. For further reading on low bid- best value procedure and detailed procurement process for a typical performance based maintenance contract we refer to [7] and [5].

C. Implementation stage

This is the stage where the PBRIM is introduced into the railway infrastructure management. The contractors take over the maintenance function with focus on meeting the established targets. The IM assesses and monitors the performance of the contractors and deficiency is penalized with disincentives while excellence is rewarded with incentives. A necessary factor of this stage is the sustenance of a successful working relationship (partnering) between the IM, contractors and other stakeholders. The efficient management of the different interfaces is a key factor to success. The framework for partnering developed by Olsson & Espling [14] could be used in addressing the relationship factor in this outsourcing approach. In coherence with the outsourcing approach considered in this article, the most vital factors of partnering relations that could influence the outcome of PBRIM are partnering process elements and success elements as described by Olsson & Espling [14].

ISBN 978-91-7439-379-8

These factors should be considered for the hitch free implementation of PBRIM to enhance the potential for achieving the business goal and create an innovative climate. In addition, emphasis should be laid on feedback management, client contractor meetings and effective communication, contract review process, conflict resolution, goal clarification, good flow of information and data between clients and contractors (this data should include, failure data, maintenance data, operation data, renewal data, condition data of infrastructure and also rolling stock). The frequency of the client contractor meetings could be high at the commencement and gradually reduces as the volume of pressing issues and conflicts would be reducing with time. Nonetheless it is expedient to have periodic schedule for the meeting (monthly, quarterly etc) to review the outsourcing process, especially the performance target. Furthermore it is necessary to involve the manufacturers, suppliers, and train operators at some points in this relationship management as they are significant stakeholders that could influence the potential of this approach.

D. Monitoring and Control stage

It is supposed that the monitoring tool or technique would have been designed at the earlier stage of this process. The monitoring tool or technique specifies what is to be assured in terms of both quality of the asset and quality of the service. During the period of the contract, the major responsibility of the IM is to manage the contract by implementing the designed monitoring tool and resolve issues that evolve. The strategic monitoring and control of the maintenance checks the input and output of related activities, work and processes. It also checks consequential outcome of the maintenance function as well as some other requirements and specifications in the contract. This involves some relevant analysis and improvement suggestions. The monitoring is a continuous process, though the data for some measures are collected on asset specified frequency. Data collection that requires track possession for infrastructure inspection depends on the inspection regulation for maintenance or safety needs. Other measures could be monitored randomly, periodically or based on complaints by users.

VII. PERFORMANCE MONITORING TOOL FOR PBRIM

As mentioned in previous section of this article, the core of this research is the development of a monitoring tool to follow up the outcome of the discussed maintenance outsourcing strategy for railway infrastructure. There is need to assess if the specified performance target is achieved by the contractor. An early detection of gap or disparity would alert the infrastructure manager for quick intervention.

Kumar & Parida [9] emphasize on the need to develop formal measures of maintenance performance to evaluate, control and improve the maintenance activities for ensuring achievement of organizational goals and objectives. In a strategy such as examined in this report PBRIM, the underlying concept for its formulation is specification of maintenance performance and not maintenance strategy, the measurement of the maintenance performance becomes of extreme significance for the infrastructure manager.

MPM is a complex task involving the measurement of various inputs and outputs and also outcome of the maintenance process. Kumar & Parida [9] in their MPM system emphasized the need for the performance measures to consider different perspectives and components of the maintenance process in an integrated manner. The performance measures should be robust enough to detect shortfalls, predict negative consequences and perhaps insight into the root cause. The intriguing questions are what to measure, how to measure and how to extract necessary information about the level of service of the PBRIM contractors.

Åhren [10] had identified and analyzed some performance indicators for railway infrastructure. Some of the indicators are used in the development of the monitoring tool for PBRIM contract; additional specific measures are also gathered from literature surveys and also synthesis of similar practices in other industries.

In the development of the robust performance monitoring tool for PBRIM, the different stages of maintenance process were put into consideration and a three component tool was formed. This tool monitors the maintenance to quantify its efficiency and effectiveness, and the components are

- ✓ Input measures
- ✓ Output measures
- ✓ Outcome measures

A short description of these measures is shown in figure 4 and thereafter explained in the succeeding text.

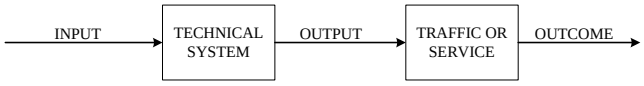

Fig. 4: Components of a PBRIM monitoring tool

1) *Input Measures*: The commitment and effort of the contractor into the maintenance process can be assessed. The resources which are expended on the maintenance service could be collected and analysed. The resources include;

- Number and skills of crews at the time of establishing maintenance work
- Total maintenance man hour per track kilometer or per asset type
- Technology and innovation of the contractors
- Number of training for personnel (quality improvement, safety, capacity development).
- Number of infrastructure improvement suggestions

ISBN 978-91-7439-379-8

The input measures could serve as lead indicators since they are performance drivers which stir maintenance performance. Some other literature referred to this tool as forecasting tool. Though the infrastructure manager does not specify the input parameters into the maintenance process in PBRIM, nonetheless a robust monitoring tool requires a follow up of the input resources for early detection of deficiency which could lead to failure to meet the maintenance objectives.

2) *Output Measures:* The direct result of the maintenance process is referred to as output; it also defines the rate of performing the maintenance activities. Output measures consist of some direct maintenance service measures such as response time, mean time to repair and number of failures. These are intermediate measures between input measures and outcome measures as they give some information about the level of performance of the PBRIM. More detailed measure that gives clearer indication of the influence of the maintenance work on asset condition, asset performance and business success is the outcome measure. Examples of the output measures are:

- Logistics Delay (Response timeliness)
- MTTR
- MTBF
- Number of maintenance backlog
- Achievable availability
- Corrective maintenance hour/ Total maintenance hour
- Actual maintenance to planning estimate (overdue)
- Number of reported failure
- Task rate: Rate at which some preventive maintenance tasks or inspection are being executed. For example;
    - Length of track ground per specified time.
    - Length of track inspected per specified time.
    - Length of track tamped per specified time.

3) *Outcome Measures:* These are lagging indicators that give the level of performance of the maintenance process. It is an indication of the quality of the maintenance process and quantification of benefits or additional value of the maintenance to traffic operation. They provide basis for assessing the deviations of performance from targets after the completion of the maintenance activities. The outcome measure could be divided into strategic areas representing the basic maintenance objectives.

TABLE 2

OUTCOME MEASURES

Objectives	Strategic/ Result areas	Measures
Safety	Safety Performance Environmental Performance	• Number of accidents/incidents • Derailments • Number of Level crossing accidents • Noise, vibration
Cost effectiveness	Cost performance	• Maintenance cost per tonnage kilometre • Maintenance cost per train kilometre • Maintenance cost for corrective maintenance?
Dependability	Asset Quality Performance	• Track quality index (Q-factor) • Number of defects per track kilometre • Number of failures per track kilometre • Number of inspections remark leading to corrective maintenance per track kilometre • Maintenance hour per train kilometre • Maintenance hour per tonnage kilometre • Number of speed restrictions and number of affected train.
Comfort	Customer oriented performance	• Delay hour per passenger kilometre • Number of traffic influencing functional failure per track km • Freight train delay hour per tonnage kilometre • Q-factor

Note: All the measures are only infrastructure related quantification

VIII. DISCUSSION

A well structured PBRIM offers the potential for achieving the maintenance objectives, making the support function more effective in terms of its contribution to quality and quantity of train operations. It is important to comment that maintenance expertise within the client's (IM) organization should not be wholly discarded; they are needed to administer and supervise PBRIM contracts. This is necessary since the inspection of the asset and monitoring of the performance of the contractors is

retained by the IM. In addition the renewal or new investment should be the sole obligation of the IM, the strategy for this should be developed by the IM and not the contractor [16]. The collaboration between the contractor and the IM should not be underestimated as this might be helpful in developing a good maintenance strategy. The contribution of the IM maintenance expert would be valuable for the success of the PBRIM due to the long term experience and knowledge with the infrastructure.

The performance measurement procedures should be handled by the IM and the result of the analysis should be promptly addressed for improvement. As practiced in road maintenance, a third party might be employed for the measurement procedure [7], though this might result in reduced need for skilful expert within the IM organization which is undesirable. However the performance measurement procedure should be clearly known by the contractor. In addition, collaboration between the IM and contractor in the analysis of the performance measure and target would enhance the identification of improvement area in the maintenance process.

The performance target should be specific, realistic and should reflect the past performance, present state and traffic operation on the infrastructure. Standards and Benchmarks could be used in developing the target where necessary. It is important to review the performance target since it is dynamic and a function of the age, usage profile, and environment of the asset. A review of the outsourcing process including the target should be initiated when the target are not met and not just a kick out of the contractor

IX. CONCLUSION

PBRIM contract is a tool for achieving maintenance objectives if the environment and philosophy of the IM is affirmed suitable. This article has identified important considerations and framework in the development and implementation of PBRIM. With the three level monitoring tool, the performance of a PBRIM contract can be assessed and tracked for early detection of deficiency in maintenance and also for improvement. The earliest alarm or signature for deviation from objective oriented maintenance could be seen in the input measures, since the IM would not want to wait till the end of the contract or for a catastrophic consequence of the maintenance deficiency before they act. On the second level, the output measure, this could serve as both lead and lag indicators depending on the process and perspective of the analysis; however, clue could be extracted on what the performance of the PBRIM could be ahead of time. Also unnecessary cost cutting at the detriment of the level of service of the maintenance function could be detected. Finally at the end of the contract or at any other instance where review is necessary, the output measures are useful for assessment of the performance of the PBRIM. A deployment of a well structured PBRIM contract with an effective monitoring tool is potent towards achieving maintenance objectives.

ACKNOWLEDGMENT

The authors wish to acknowledge Prof P-O Larsson-Kråik for his technical contribution and also Trafikverket for the financial support provided for this research.

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ISBN 978-91-7439-379-8