

Analysis of User Problems in Construction Machinery Hiring

D A R Dolage, W R G A Wijesundara and D G Nandasiri

Abstract: In the years to come, the anticipated situations of low demand for large scale machinery and increasing demand for concreting machinery and equipment, road compacting plants and equipment etc. would necessitate hiring firms to be more organised to offer solutions to ensuing user problems. With the aid of interviews, the study identified 38 different problems facing the construction machinery users and these identified problems were later categorised into six generic types, relating to cost, availability, transport, machine operator, maintenance, hiring firm's responsibility and coordination. The main contribution of the study is that it has identified the ten most important user problems by adopting the technique of Relative Importance Index (RII) on the responses obtained from 43 industry professionals. Also it has analysed the ten user problems in an effort to identify the causes and the solutions. The study also proposes remedial measures, in general, to alleviate the problems machinery users are facing.

Keywords: Earthmoving machinery, Construction machinery, Construction industry

1. Introduction

It has been a long time since the construction machinery began to replace the use of labourers and animals. The use of machinery in construction industry has relatively a long history even in Sri Lanka. It is observed that the fleet of machinery currently deployed in the Sri Lankan construction industry is fairly old and susceptible to breakdown. Owing to reasons such as low exchange rate, high import levies, high freight costs, high insurance costs etc., it is almost impossible to purchase new machinery. Only the state sector organisations are capable of purchasing new machinery due to their privileged position. The hiring firms, mostly, come to the possession of machinery either through the purchase of used machinery at state vehicle auctions or purchase of used imported machinery. The machinery imported by large scale foreign contractors engaged in hydro power and road construction projects had a practice to give them to the local contractors by way of loan settlement, at the conclusion of the projects. This is another source of machinery, available to hiring firms. As a result, the machinery in the possession of hiring firms are hackneyed and old which are susceptible to recurrent breakdowns. However, the present trend is for such foreign contractors to take the used machinery back to their country.

It seems that machinery hiring firms do not prevail as business units that are only engaged in hiring. The machine hirers are either construction contractors or machine importers/sellers. However, some owner operator hiring firms which solely depend on hiring can be found in the industry. The 20 machinery hiring units established by the National Housing Development Authority in order to increase machinery availability became defunct after a lapse of a few years.

There is a decreasing demand for large scale construction machinery specially for earth moving machinery. The reasons are the difficulty in transportation to the site and within the site, higher repair costs, higher fuel consumption, higher losses and wastages in handling and the decrease in the large scale projects.

Eng. D.A.R.Dolage, CEng, FIE(Sri Lanka), BSc Eng. (Moratuwa), MSc (Reading), MA (Colombo), MBA (SJP), Senior Lecturer, Department of Civil Engineering, The Open University of Sri Lanka

Eng. W.R.G.A.Wijesundara, BScEng(Hons)(Sri Lanka), MPhil(OU SL), MIE(Sri Lanka), MIAE(Sri Lanka), CEng, Senior Lecturer, Department of Mechanical Engineering, The Open University of Sri Lanka

Eng. D.G. Nandasiri, CEng, MIE(Sri Lanka), BSc Eng. (Moratuwa), MTech (OU SL), Chief Engineer (Mechanical), Road Development Authority

The ongoing infrastructure development projects are Norochcholai coal power, Hambanthota port, Upper Kotmale hydro power, Southern Highway, Outer Circular Highway, Colombo Kandy Highway and Colombo Katunayaka and a few foreign funded road projects in the North & East.

The following projects have been earmarked for feasibility studies; Southern Airport, Water Supply project to Jaffna Peninsula and major road projects such as extension of Southern Highway to Hambantota, Hambantota-Kegalle Highway, Hambantota-Trincomalee Highway and several more roads connecting 3rd order cities to 2nd order cities which would be of strategic importance. The other projects likely to be implemented are rehabilitation and resettlement projects. Only a few projects will involve the handling of large volume of earth works.

In the years to come, the anticipated situations of low demand for large scale machinery and increasing demand for concreting machinery & equipment, road compacting plants & equipment etc. would require hiring firms to be more organised in order to halt the aggravation of user problems. The hiring firms that are not adaptable have not been able to retain skilled operators and maintenance staff which have made matters worse. In view of this, the quality of the service offered by the machinery hiring firms have decreased considerably over the years and more prone to deteriorate in years to come. Under these circumstances, it is very important to study, in the context of Sri Lanka, the hardships encountered by the construction machinery users.

The objectives of this research study are (i) to identify the major user problems (ii) to assess the relative importance of these problems (iii) to make recommendations to mitigate the severity of problems encountered.

This paper is organised as follows; Section 2 deals with the literature review on user problems of the construction machinery hiring; Section 3 illustrates the methodology of the study; Section 4 provides the results, Section 5 presents the discussion and Section 6 deals with the recommendations.

2. Literature Review

The studies that have been conducted on various aspects of construction machinery in the local context are limited. In a pioneering study on 'Earth and Earth Moving Equipment', Mendis (1950) described machinery such as track laying tractor, bulldozer, carry-all scrapers, turnapulls, excavators, elevating graders and motor graders in the context of usage in major construction sites in Sri Lanka. The study shows how to use them in sites and demonstrates how to compute owning and operating costs. A later study by Pereira (1973), revealed that it is cheaper to use mobile conveyors than to use front-end loaders. The study also shows that they generate more employment. The study concludes that front-end loaders are not being put to the use for which they are designed and best suited and thus a drain on our scarce foreign exchange. A survey titled 'Standardisation of government heavy machinery, plants and road vehicles' was carried out in Sri Lanka in 1981 by Crown Agent of United Kingdom at the initiation of Ministry of Plan Implementation. The survey revealed different kinds of plant and equipment that belonged to 13 major public sector organisations.

Sivaloganathan (1984) advocates the rational maintenance of construction machinery which maximises the running time (hence minimise the downtime) and minimises the maintenance cost and investigate how to achieve this. Fernando (2002) in a recent study on 'Preventive maintenance: methods of preventing trouble', explored how the development of a comprehensive preventive maintenance program could benefit an organisation in multiple ways instead of ad-hoc maintenance methods often practiced in the industry. Based on a locally developed design, with the auspices of the Faculty of Engineering, University of Peradeniya, general purpose two-wheel tractors were produced in Sri Lanka (Ranathunga, 1977).

Most of the studies on construction machinery have been conducted in the areas of owning and operating costs, Lucko *et al.* (2007), Corps of Engineers (2001), Kastens (2002) and Lucko and Vorster (2003). Hence, evidently, no study has been carried out that analyses the user problems either locally or internationally.



There are several classifications adopted by various organisations to categorise different construction equipment. The basis for such classifications has been different. The classification systems are as appended below:

Society of Automotive Engineers (SAE) Classification
 Japan Construction Mechanization Association (JCMA) Classification
 Committee of International (CIB) Classification
 Institution for Construction Training and Development (ICTAD), Sri Lanka

The classification system adopted by the Institution for Construction Training and Development (ICTAD), Sri Lanka for evaluating technical abilities of the contractors in grading them recognises following equipment:

Earth Moving machinery
 Transport vehicles & machinery
 Lifting plants, machinery and equipment
 Concreting machinery and equipment
 Roads & compacting plants & equipment
 Dredging, reclamation and piling
 Other plants and equipment

3. Research Methodology

3.1 Data collection

A pilot study was undertaken in which five site engineers were interviewed in order to identify the problems faced by construction machinery users. As the outcome of the interviews, thirty eight problems were identified that were classified under six generic types, namely:

Cost related problems
 Availability related problems
 Transport related problems
 Machine Operator related problems
 Maintenance related problems
 Hiring firm's responsibility and coordination related problems

Based on the problems identified at these interviews, a primary questionnaire was developed to assess the perceptions of

contractors, consultants, designers and other professionals on the relative importance of the problems. The questionnaire was divided into three parts. The first part sought the background information about the respondent's discipline and the experience. The second part of the questionnaire focused on the respondent's assessment of the relative importance of user problems. The third part was to elicit any other problems encountered by the users not already addressed in the questionnaire. A five point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) was adopted to evaluate the importance of the user problems.

The data were obtained from a sample of construction professionals who either work in semi government organisations or private sector organisations. Due to the possible poor response for questionnaires, 43 personally known professionals were engaged in the questionnaire survey.

In addition to the 38 questions listed in the questionnaire, a separate request was made to mention any other problems encountered by the machinery users.

3.2 Calculation of relative importance of user problems

Kometa *et al.* (1994) adopted the technique of Relative Importance Index (RII) to determine the relative importance of the various causes of the delays. The same technique was adopted in this study. The five-point scale that ranged from 1 (strongly disagree) to 5 (strongly agree) was adopted in order to evaluate the relative importance of user problems. The RII of each user problem was computed by adopting the following formula:

$$RII = \frac{\sum W}{A * N}$$

where W is the weighting given to each factor by the respondents (ranging from 1 to 5), A is the highest weight (5 in this case) and N is the total number of respondents. It can be stated safely that the responses of the experienced professionals should be given a higher weighting than that of less experienced counterparts. In order to obtain the effective years of experience for each year of experience log linear model (LLM) was adopted. The values of equivalent years of experience for

each year of experience and the cumulative equivalent years of experience obtained for each year of experience are tabulated in Table 1. At the eighth year, the equivalent years of experience for a year reaches a plateau but the cumulative equivalent experience continues to increase. Table 1 does not represent years beyond nine in order to save space.

Table 1: Cumulative equivalent number of years

No. of Years	Equivalent number of years	Cumulative equivalent number of years
01	1.00	1.00
02	1.20	2.20
03	1.32	3.52
04	1.40	4.92
05	1.46	6.38
06	1.51	7.89
07	1.55	9.44
08	1.60	11.04
09	1.60	12.64

As the next step, all the values of the responses given by the respondents should be multiplied by their respective 'cumulative equivalent number of years'. In an effort to get more accurate values for RII, the value of N should be revised to represent the 'summation of cumulative equivalent number of years'. The values of RII ranged from 0 to 1 (0 not inclusive), the higher the value of RII, the more severe was the user problem as each question has been designed to evaluate the respondents' degree of agreement on problems that the machinery users are experiencing. The RII was used to rank the different user problems. These rankings made it possible to cross-compare the relative severity of the user problems as perceived by the respondents. The RII of each individual user problem was adopted to assess the general and overall rankings of each user problem.

4. Results

The summary of the characteristics of the respondents who participated in the questionnaire survey are presented in Table 2. The primary data collected from the second part of the questionnaire, in relation to user problems was analysed. Table 3 depicts the RII and the rankings of user problems. The user

problems were ranked based on the RII values. From this, it was possible to identify the most important user problems.

Table 2: Characteristics of the respondents

Attribute	Percentages
Field of engagement	
Civil	93
Mechanical	05
Other	02
The experience of the users in various areas of civil engineering (in years)	
Buildings	16
Highways	41
Bridges	19
Irrigation and power generation	08
Water supply and land drainage	08
Low lying and reclamation	00
Other areas	08

The average values for RII for the broad categories of user problems were computed and depicted in Table 4. The additional problems the respondents identified in the third part of the questionnaire are stated below:

- 1) The competition in the industry is below the desired optimum for users to be benefited by the competition.
- 2) The information in the possession of the hiring firm regarding the machine is not adequate.
- 3) A hiring firm does not have sufficient competent staff to advise the client on the selection of a suitable machine for a given task.
- 4) At the time the order is placed, a hiring firm is not certain as to which machine will be delivered to the user.
- 5) The terms and conditions imposed by a hiring firm regarding a machine are usually unfavourable to the users.
- 6) The site staff has no control over the administration and the discipline of operators.
- 7) A hiring firm is reluctant to hire for short periods.
- 8) The machines hired on dry-lease rate are found to have varying fuel consumption rates.
- 9) A hiring firm is not adequately knowledgeable about the modern machinery.



Table 3: Ranking of user problems

	User Problems	RII	Rank
	<i>Cost related problems</i>		
4	Hire rates are greater than the estimated rate	0.643	23
23	Disregarding the nature of work for which the machine is used (heavy or light) hire rates are similar	0.726	13
36	With the latest models, irrespective of whether all the features are used or not, the same hire rate has to be paid	0.699	16
38	On account of limited choice of machine, machines with capacity higher or lower than the required capacity have to be used	0.701	15
	<i>Availability related problems</i>		
3	Machines are not properly maintained and susceptible to breakdown	0.669	19
31	Machines are old and used and as a result do not function properly	0.788	1
32	Work cannot progress to schedule due to recurrent stoppages, required to attend to breakdown maintenance	0.752	7
33	Machines do not perform at the rated output	0.735	10
34	Market does not have adequate number of machine hiring firms	0.695	17
37	Hiring firm does not have a designated person to negotiate the hire	0.551	36
	<i>Transport related problems</i>		
2	Machines are not delivered at site on time	0.730	11
5	Vehicles available to transport machinery are limited in supply	0.759	5
28	Hiring firms evade the question as to when they can deliver the machine	0.770	3
	<i>Machine operator related problems</i>		
13	A lot of time is wasted in trying to rectify their mistakes	0.633	25
14	Has an attitude for not being responsible for the work they perform	0.580	34
15	Overconfident	0.602	30
16	Tendency to deviate from the instructions given	0.612	28
18	Work as if they are doing a favour to the site engineer rather than an obligation	0.506	38
19	Taking disciplinary action against workers can be disruptive	0.569	35
	<i>Maintenance related problems</i>		
6	Routine maintenance takes up longer time than scheduled	0.744	9
7	The level of skill of the maintenance crew assigned to attend to routine and breakdown maintenance is inadequate	0.726	12
8	Maintenance crew is not as motivated as the construction staff in achieving targets	0.752	8
9	Difficult to have a smooth dialogue with the maintenance staff	0.597	31
10	Maintenance crew is willing to take instructions from the site engineer rather than the site supervisors	0.660	21
11	Maintenance crew is not concerned about cost controlling	0.608	29
12	Time taken for maintenance is unduly long	0.621	26
17	Maintenance crew is not disciplined enough	0.595	33
20	Taking disciplinary actions against maintenance crew can result in costly consequences	0.619	27
21	Maintenance crew does not accept their mistakes	0.715	14
	<i>Hiring firm's responsibility and coordination related problems</i>		
1	Hiring firm is not interested in finding out client satisfaction once a machine has been deployed	0.596	32
22	Operators of hired machines are reluctant to engage machines on difficult	0.667	20



	work		
24	Contractor prefers deploying his own machinery rather than dealing with a less organised hiring firm	0.687	18
25	Due to financial and accountability concerns the contractor cannot hire from the most reliable hiring firm	0.633	24
26	Since most of the hiring firms play the role of contractor, the users may have hardships	0.765	4
27	The interest the hiring firm showed at the time of negotiating the machine is not found at the time the machine is delivered and in use	0.758	6
29	Hiring firm has not assigned a responsible person to deal with new clients who wants to hire machinery	0.539	37
30	Hiring firms do not make adequate efforts to deliver the machinery on time	0.656	22
35	After a machine has been ordered from a hiring firm it is necessary to follow up until the machine is delivered	0.774	2

Table 4: Ranking of broad categories of user problems

	Broad categories of User Problems	RII	Rank
1	Cost related problems	0.692	3
2	Availability related problems	0.699	2
3	Transport related problems	0.753	1
4	Machine operator related problems	0.584	6
5	Maintenance related problems	0.664	5
6	Hiring firm's responsibility and coordination related problems	0.674	4

5. Discussion

The first objective of the study was to identify the user problems of the construction machinery. A total of 38 user problems were identified that was later classified under six relatively mutually exclusive groups. The second objective was to rank these user problems using the values of RII. In this section, the ten most important user problems that were identified based on the RII rankings (as shown in Table 3) are discussed. The ten most important user problems are given below:

1. Since machines are old and used, they do not function properly (RII=0.788)
2. The hiring firms need to be pressurised to deliver the machine in time after an order has been placed (RII=0.774)
3. Hiring firms are not definite as to when they can deliver the machine to the site (RII=0.770)

4. Machine may not be delivered at all, particularly, when the hiring firms themselves undertake construction work (RII=0.765)
5. Vehicles available to transport machinery are limited in supply (RII=0.759)
6. The keenness the hiring firm showed at the time of negotiating and reserving the machine could regress when the machine is to be delivered and in operation (RII=0.758)
7. Work cannot progress according to schedule due to recurrent stoppages on account of routine and breakdown maintenance (RII=0.752)
8. The goals of maintenance crew are different from that of the construction staff when it comes to job objectives (RII=0.752)
9. Routine maintenance takes up longer time than scheduled (RII=0.744)
10. Machines do not perform at the output they claim to have (RII=0.735)

5.1 Since machines are old and used, they do not function properly

Some of the machines used in the industry are as old as 30 to 40 years and also heavily used. The machines in the possession of hirers are either bought at the auctions of government institutions or imported used machinery. The government institutions usually decide to sell machines through auctions only when they find that it is no longer economical to continue to use them with repairs. The imported second hand machines are usually around five years old. The users of these face difficulties since these machines being 'domestic' models in the country of origin are fitted with highly sophisticated control devices for which neither spare parts nor the required technology to repair are locally available. Further, these



devices can be susceptible to frequent breakdowns when handled in the incorrect way and the ensuing repair costs are exorbitant. Furthermore, it is costly to modify the interfaces for manual control systems.

5.2 The hiring firms need to be pressurised to deliver the machine in time after an order has been placed

It is observed that the majority of hiring firms do not have a designated person to deal with the customers who expect to hire machines. Often when an order is placed with a staff member of the hiring firm, the same person is not available to answer when the user is in contact with the firm to have the machine delivered to the site. As a result, a prospective user has to go to great trouble by way of additional calls and visits in order to pressurise the hiring firms to make the machine available. A major reason for this situation is that authority has not been delegated adequately to a particular person who is likely to meet with the client, negotiate the deal and make the reservation in order to handle the delivery of the machine. Generally, with regard to the 'owner-operator' firms the situation is better as the owners themselves take part in accepting the order and in the discussion of how the machine will be delivered. Nonetheless, the users have to be wary about the following three aspects when dealing with 'owner-operator' firms:

- They do not have financial capacity and technical expertise to handle a major repair and also to import spare parts specifying part numbers etc. if so required.
- As a result of not having a goodwill they tend to go back on the promises made at the time the order was placed.
- When they realise the urgency of the client to complete the job, there is a tendency to exploit.

5.3 Hiring firms are not definite as to when they can deliver the machine to the site

Usually, at the time an order is placed for the hire of a machine, it is in operation with another user and the prospective users can receive it only after its return by the former user. On account of greater unpredictability in

the construction work as well as the unreliability of the machinery, the machines cannot be returned on the agreed date. As a result, the hiring firm is reluctant to propose a suitable delivery date to the prospective user. Most of the hiring firms do not have a practice whereby the operators communicate with the hiring firm on a regular basis in order to intimate the progress of work and the condition of the machine. The maintenance staff have a tendency to provide improvised temporary solutions to breakdowns that occur towards the conclusion of a project. Usually, after the return, the machine is offered to the next client in the same condition without attending to the expected repair as anticipated. As a result, the machine is prone to breakdown while it is in operation with the subsequent user.

5.4 The machine may not be delivered at all at the site particularly in situations where the hiring firm also undertakes construction work

There is a trend among the hiring firms to undertake construction work themselves in order to maximise profits. The person from the hiring firm who accepts the order for a machine has no authority to stick to it when the higher authority decides to deploy the machine in their own project. A hiring firm can minimise this problem by informing the subsequent user about such an eventuality well in advance in order for him to take mitigatory measures. Further, when a contractor gets in touch with a hiring firm to order a machine there is a tendency among hiring firms to make an offer to do that part of the work as a subcontractor.

5.5 Vehicles available to transport machinery are limited in supply

In Sri Lanka, the machines currently being used are heavy and large, requiring large vehicles such as low-bed trailers to transport them from site to site. The low-bed trailers are in short supply and in most of the cases even if the machine is ready to be released it cannot be moved to the next site on account of not having a suitable vehicle to transport. This problem will become less serious in the future because the current trend is for small scale and mini-size machinery such as D4, D40 dozers, mini excavators etc. for which special vehicles are not required for transportation and instead they

can be transported in a typical truck or some machines in a farm tractor.

5.6 The keenness, the hiring firm showed at the time of negotiating and reserving the machine has regressed when the machine is delivered and in operation

Mostly, the attitude of the hiring firms, when a client calls at or phones up to hire a machine, is to over-sell the machine in an effort to get the order. Usually, the firms are very keen to satisfy the customer in different aspects; speed of delivery, reliability of the machine, performance of the machine, routine maintenance requirements and fuel efficiency etc. However, it is experienced that when the machine is in service, usually, the same enthusiasm would not prevail and the hiring firms are not committed to the initial promises. In case of a costly repair, there is a tendency for hiring firms to postpone the repair and instead they provide an improvised solution which restricts its scope of application.

5.7 Work cannot progress according to the schedule due to recurrent stoppages on account of breakdown maintenance

The activities in a construction site are usually sequential and interrelated that result in a high degree of interdependence among activities. As a result, the completion of individual activities according to the schedule is of great importance. Most of the machines that are hired are susceptible to frequent breakdowns that require considerable time to put them right. Not only the hiring firms but also the local agents and spare part retailers do not keep sufficient stocks of most spare parts due to the financial implications of storing costly spare parts. Further, due to the variety of makes and models of machinery for which parts are required to be stored, the financial implications are even more complicated. This indicates remedial measures are costly. The greater the reliability expected of a machine the higher will be the maintenance cost.

5.8 The goals of maintenance crew are different from that of the construction staff when it comes to job objectives

The goals of the construction staff are to complete the project according to a time

schedule and to a budget while attaining the expected quality. The goal of the maintenance crew, when it comes to breakdown maintenance is to provide a long-lasting solution. As a result, when a machine breaks down while it is engaged in a scheduled activity, a conflict in the goals of the two parties may arise. Hence, it is important, when the two parties foresee such a situation that precautionary measures are planned. If this does not take place as planned, the intervention of the middle management of both parties is required to reach an amicable solution.

5.9 Routine maintenance takes up longer time than scheduled

The time required for routine maintenance has been accounted for in preparing schedules, based on the information provided by the hiring firm. However, it is experienced that, usually, the time required for routine maintenance and the extent of the activity is greater than what is planned for; for example, what was anticipated was to replace the filter but in the end, what was required to do was to replace both the filter and filter head or studs etc.

It is noted that the time taken for the routine maintenance and the frequency with which it is required are more than what the hiring firm claims necessary. Therefore, it is necessary to obtain more realistic information from the hiring firm before starting the maintenance task to avoid disappointment and having to make changes to the work programme.

5.10 Machines do not perform at the rated output they claim to have

On account of wear and tear and poor maintenance, the rated output of a machine is prone to decrease in the long run. The hiring firms are oblivious to this aspect and continue to quote the originally rated output for their machinery. As a result, there is a tendency for the hiring firm to quote higher capacity regarding machines at the time the reservation is made for machinery. When the users of these machines find that the machines are producing lower outputs they tend to make complaints to the hiring firm.



6. Conclusions and Recommendations

The study shows that the users are facing severe hardships as a result of several issues connected with the use of construction machinery. The ten most important reasons deemed to be the main causes of user problems have been identified after a rigorous analysis. The machinery currently available in the construction industry are old, used and belong to various makes and models. As a result, their preventive maintenance and repairs have become complicated. It was observed that, mostly, machinery hiring firms do not operate as pure hiring firms and hence do not consider satisfying the customers as an important requirement to stay competitive in the machinery hiring. The immediate attention of the hiring firms and the associated governing bodies should be drawn to address the identified problems. The following recommendations can be made to alleviate problems causing this situation. Initially, the standardization of machinery (having machines from one make and model for each category) seemed to be a solution to address the availability issue of spare parts and to reduce complications in maintenance. However, it was found that this approach has become a failure due to the supplier taking undue advantage by increasing the prices of machine units and spare parts due to the non competitive situation created.

- The machinery should be graded based on their real output and not on the rated output. When machines are hired, the users should be made aware of the real output.
- A systematic procedure has to be followed by the user as well as the hiring firm in selecting the most appropriate machine in terms of size and type in order to execute the tasks economically.
- When a user is in contact with the hiring firm regarding a machine, it is beneficial to both parties to make a visit to the site in an effort to study the site condition. As a result, the most appropriate machine for the job and a favourable hire rate can be negotiated. Further, this helps to develop the commitment of the hiring firm to the task and to make him understand the

urgency and the seriousness of the task.

- The hiring firms need to provide a front office service with a person dedicated to liaise with the clients from their first visit until the time the machine is handed over and to employ professionally qualified staff in order to provide the best possible solutions in the event of problems.
- At the time of delivery, the hiring firm should hand over proper documentation regarding the nature of the required routine maintenance regarding the machine and the firms' maintenance policy.
- The hiring firm should closely monitor the availability of machines and inform the clients well in advance about impending delays.
- It is necessary to initiate an informal forum of the hiring firms and contractors in order to improve their relationships. It is proposed that ICTAD take the initiative to maintain a data base on the web which carries the details of the machinery availability of contractors (and also existing hiring firms if possible to help contractors). This would not be a difficult task as they have provided updated information about the machinery in their possession at the time of renewing the registration.
- In situations where mobilizations of specialized machinery are required it is recommended to subcontract the job to the hiring firm rather than having the contractor do it with hired machinery. This practice can be observed in the construction of bored piles for foundations.
- In situations where construction sites are located in hazardous environment (for eg. costal development works, rock blasting etc.) it is advisable for the users to go for their own machinery (purchased old machinery). This helps to avert potential unpleasant situations such as the hiring firm discontinuing the contract after the realization of the hazardous state of the site and the possible damage to the machine.

Contractors need to have an adequate fleet of machinery to apply for the relevant ICTAD grading. This makes contractors ending up owning more machinery than demand permits. In Sri Lanka, even the major contractors do not have a practice of hiring or disposing of machines even when they are lying idle for long periods. As a result, the contractors who need to purchase such machinery miss the opportunity. On the other hand, the draining of foreign exchange in having to import similar machinery by the other firms cannot be avoided. The reasons for doing this are two fold; firstly, to enable them to apply for higher ICTAD grading, owing to the improved capabilities; secondly, to prevent rival firms taking possession of machinery, cheaply (particularly who are inclined to undertake earthwork contract themselves). Therefore, the criteria for registration of contractors by ICTAD should be revisited with respect to this aspect and steps need to be taken to promote hiring of idle machinery.

- Some machinery sold at auctions are bought for their value in scrap metal. Most of the time these machinery have expensive and rare spare parts that are still usable. It is recommended that registered hiring firms (or contractors) be given an opportunity to cannibalize spares and components prior to their disposal as scrap metals. This helps to bring down the maintenance cost of machinery, save foreign exchange and lower the hiring rates. The sellers of used spare parts have a practice of buying used machinery at auctions with the intention of cannibalizing. However, they are wary about the high capital-tie up as parts cannot be sold immediately.
- The piled-up machinery awaiting sale on the road-sides is evidence of the difficulty of the importers in affecting sales of these items. It is proposed that a study be carried out on the feasibility of importers leasing out such machinery on long-term leases to the contractors with a buy-back guarantee at the end of the lease.

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