Addis Ababa University
Addis Ababa Institute of Technology
School of Civil and Environmental Engineering

Implications of axle load limitation in Ethiopia
(The case study on axle load management at Holeta and Modjo weighbridge stations)

A Thesis Submitted to the School of Graduate Studies of Addis Ababa University in Partial Fulfillment of the Requirement for the Degree of Master of Science in Civil Engineering (Road and Transport Engineering)

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Contents

DECLARATION iv
ABSTRACT v
ACKNOWLEDGEMENT vii
ACRONYMS AND ABBREVIATIONS viii
LIST OF FIGURES x
LIST OF TABLES xi
1. INTRODUCTION 1
1.1 General 1
1.2 Problem statement 2
1.3 Organization of thesis 5
2. PURPOSE AND SCOPE 6
3. LITERATURE REVIEW 7
3.1 Overloading 7
3.1.1 Damaging effect of overloading 7
3.1.2 Cost of Overloading 9
3.2 Importance of Overload control 10
3.3 Axle load limits and control mechanisms 14
3.4 Good practices of control mechanism in Africa 19
3.5 Technical options for dealing with various aspects of overload control 19
3.5.1 Enforcement issues 19
3.5.2 Penalties 20
4. RESEARCH METHODOLOGY 27
4.1 Background and review 27
4.2 Methodology 27
4.2.1 Preparation Phase 28
4.2.2 Data collection 28
4.2.3 Data analysis 31
5. RESULTS AND DISCUSSION 33
5.1 Findings for overloading freight vehicles 33

5.2 Penalty implementation 38
5.3 Management of weigh bridges 42
6. CONCLUSIONS AND RECOMMENDATIONS 44
6.1 Conclusions 44
6.2 Recommendations 45
6.3 The way forward 47
7. REFERENCES 50
Appendix A 51
Appendix B 54
Appendix C 57
Appendix D 60
Appendix E 63

DECLARATION

I hereby declare that this thesis is my own work towards the Master of Science degree and that, to the best of my knowledge; it contains no material previously published by neither another person nor materials which have been submitted for the award of any other degree of the University.

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ABSTRACT

Roads and bridges are the two moral fibers of any good mobilization to and from its destination and origin. These structures have their own designed life span for which they are forecasted to serve. It means, the structures should serve entirely for their intended life span without seeking major maintenance activities, but minor maintenance measures could be undertaken.

Road infrastructure represents a huge investment for any country. To protect these assets against misuse and damage, Ethiopia has promulgated road traffic act that stipulate permissible maximum axle and vehicle mass and dimensions. These limits are meant to ensure that roads last for their full design life with normal maintenance expenditures.

The primary purpose of this study was to assess the axle load management at selected two stations; Holeta and Modjo weigh bridge stations. The main specific objective of the study was to contribute better to the axle load control mechanism on the selected corridors.

Data was collected from the axle load checked vehicles at different times. The data at Holleta was collected in the months of June, August and September for successive of seven days each. Besides, the data collected at Modjo weigh bridge station was collected in the months of October, November and December for seven consecutive days. Data was also collected using interview with different stake holders of the sector.

In one week of June 2013 a total of 797 vehicles have been checked at Holeta and 527 of them were found overloaded, which accounts 66%. Furthermore, 45.3% vehicles were found overloaded at Modjo weighbridge station. The penalty rate in Ethiopia differs from court to court and upon persistent offence on the drivers. Hence it ranges from 4 birr and 50/100 cents per quintal to 20 birr depending on the persistence of the offence and the type of product overloaded.

The absence of standardized, documented procedures for carrying out weighbridge operations and moreover the absence of well organized and binding legislation on the regulations of axle load management has led to inconsistency in overload control activities. The current low

penalties for overloading should be reviewed so that they are more deterrent and capable of being more uniformly applied for similar offences.

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ACRONYMS AND ABBREVIATIONS

WFP	World Food Program
USAID	United States Agency for International Development
MT	Metric Tone
ERTA	Ethiopian Road Transport Authority
ERA	Ethiopian Roads Authority
HGV	Heavy Goods Vehicle
HDM	Highway Design and Maintenance Manual
COMESA	Common Market for Eastern and Southern Africa
PTA	Preferential Trade Agreement (predecessor to COMESA)
GDP	Gross Domestic Product
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transport Officials
ESAL	Equivalent Single Axle Load
RSDP	Road Sector Development Program
USD	United States Dollars
CMS	Culvert Management System
MoFED	Ministry of Finance and Economic Development
ERCC	Ethiopian Road Construction Corporation
ETB	Ethiopian Birr
GoE	Government of Ethiopia
IDA	International Development Association
EU	European Union
ERTTP	Ethiopian Rural Travel and Transport Program
EFY	Ethiopian Fiscal Year
URRAP	Universal Rural Roads Access Program
AA	Addis Ababa
GVW	Gross Vehicle Weight

IGAD	Intergovernmental Authority for Development
ESA	Eastern and Southern Africa
SADC	Southern Africa Development Community
SATCC	Southern Africa Transport and Communications Commission
REC	Regional Economic Community
ECOWAS	Economic Community of West African States
CEMAC	Central African Economic and Monetary Community
EAC	East African Community
MoU	Memorandum of Understanding
RTQS	Road Transport Quality System
PAWC	Provincial Administration Western Cape
RTMS	Road Transport Management System
LSWIM	Low Speed Weigh-in-Motion
MSWIM	Medium Speed Weigh-in-Motion
HSWIM	High Speed Weigh-in-Motion
TCC	Traffic Control Centre
UNRA	Uganda National Roads Authority

LIST OF FIGURES

Figure 1-2: Age distribution of bridges in Ethiopia 4
Figure 4-1: Distribution of interviewed stakeholders 29
Figure 4-2: Axle load measurement at Holeta weighbridge 30
Figure 4-3: flow chart for the sequence of the research work 32

LIST OF TABLES

Table 1-1: Total checked front and and rear axles (ERA report, 2002/03-2011/12) 3
Table 1-2: Maintenance expenses for some routes due to overloading 4
Table 3-1: Incidence of overloading in SADC region 10
Table 3-2: COMESA and Ethiopian Axle Load Limits.. 13
Table 3-3: COMESA approach on axle legal limit... 15
Table 3-4: SADC approach on axle legal limit.. 16
Table 3-5: Comparison of REC vehicle load limits.. 17
Table 3-6: Variation in vehicle load limits in selected SADC and COMESA countries 18
Table 3-7: Levels of Overloading Fines in Kenya (EAC-Vehicle overload control)................... 22
Table 3-8: Maximum Fines/Fees for Vehicle Overloading (JICA study team)............................ 24
Table 4-1: Qualitative response of the stakeholders 31
Table 5-1: Vehicles checked, overloaded, off loaded in ton, penalized and birr collected from fine 3rd quarter 2012-13 (January) (ERA Axle load management office) 33
Table 5-2: Vehicles checked, overloaded, off loaded in ton, penalized and birr collected from fine 3rd quarter 2012-13 (February) (ERA Axle load management office) 34
Table 5-3: Vehicles checked, overloaded, off loaded in ton, penalized and birr collected from fine 3rd quarter 2012-13 (March) (ERA Axle load management office) 34
Table 5-4: Vehicles checked, overloaded, off loaded in ton, penalized and birr collected from fine 3rd quarter 2012-13 (ERA Axle load management office) 35
Table 5-5: Summary of overloaded vehicles 35
Table 5-6: Vehicles checked at Holleta 36
Table 5-7: Vehicles checked at Modjo 36
Table 5-8: Overloading status of freight vehicles at Modjo 37
Table 5-9: Overloading status of freight vehicles at Holeta 38
Table 5-10: Overloading fee collected at Holeta and Modjo weighbridges 39
Table 5-11: Maximum fines with respective countries.. 40
Table 5-12: Overloading fee collection at Modjo weigh bridge following Australian legislation 41
Table 5-13: Overloading fee collection at Holeta weighbridge following Australian legislation 42

1. INTRODUCTION

1.1 General

Ethiopia is intensively dependent on imported products. For import, Ethiopia uses basically the Djibouti port. Ethiopia's economy primarily depends on agriculture. For the effectiveness of the agricultural production the country imports an ample amount of fertilizer. Furthermore, the country is being assisted by various non-governmental donation institutions like WFP, USAID, etc to support the assurance of food security program.

For the aforementioned products and other cargo imported to the country, it is un doubtful that an effective axle load control mechanism should be available, so that to extend the life span of the roads and bridges to the possible maximum design period without seeking major maintenance activities.

Nine stationary weighbridges operate at strategically important sites throughout the country, excluding the recent opened weighbridge at sendafa. The weighbridges operate full time, 24 hours a day and 7 days a week and are located in such a way that they cover most of the main routes. Enforcement is further strengthened by employing the use of mobile weighbridges for random axle load control activities. Two mobile teams are dedicated to this task, operating in different areas of the country and covering those routes missed by the stationary weighbridges.

The scope of the study was working with an axle load management at Holeta and Modjo weigh bridge stations which made their maximum freight tonnage 40MT. Tire and axle limits are imposed for a number of reasons. Foremost is to ensure that loads carried by trucks are transported safely. Having defined load limits allows engineers to design pavements that will hold up under anticipated truck traffic with minimum maintenance required for fixing cracks, ruts and potholes. Load limits are also necessary for protecting bridges from structural weakening or fatigue, preventing unsafe conditions and early replacement of bridge structures. Even slight changes in load limits have major impacts on pavement and bridge performance. Both the axle and tire load affect pavements and bridges. Besides, the road network in sub Saharan African countries is a primary investment, the preservation of roads from undue deterioration has become one of the most important aspects of road sector development policies. In economic terms, the basic concept in the movement of goods is that a given load should be transported as economically as possible from its point of origin to the point of destination. This will ensure that transport is provided at a reasonable cost to enable road users to carry out their social and economic activities in a viable manner. It is important to bear in mind, however, that roads are load bearing structures designed to carry predetermined loads related to a limited road design life. A given road is built to be utilized for a specific number of years without requiring major maintenance investments. The nature and volume of goods carried as well as the quality of the road network determines the design of vehicles to be used on the road. Accordingly, the types of roads and their upgrade or rehabilitation depend upon the anticipated traffic volume on roads during their life time. Increasing axle weight limits will generally result in higher pavement costs, since pavement costs increase sharply with axle weight. However, past studies of truck size and weight limits have generally found that the increase in pavement costs would be much less than the decrease in goods movement costs associated with higher axle weights. Conversely, reducing axle weight limits would result in lower pavement costs; however, the savings would be much less than the increase in goods movement costs.

1.2 Problem statement

Roads and bridges are the two moral fibers of any good mobilization to and from its destination and origin. These structures have their own designed life span for which they are forecasted to serve. It means, the structures should serve entirely for their intended life span without seeking major maintenance activities, but minor maintenance measures could be undertaken. One of the reasons for roads and bridges deterioration before their designed life span is transgressing the legal axle load limits of the country for which they are designed for. Different stakeholders do not clearly understand the benefits of abiding with legal load limit. The following problems are associated to axle over loading:

- Failure of roads and bridges before their intended life span;
- Over maintenance and rehabilitation expenditures of roads and bridges;
- High vehicle operating cost; and

- Significant effect on the life of bridges.

The legal condition on the effective axle load management in Ethiopia is poor and followed by unorganized rules, regulations and legislation as well. Some of the observed violation data from the two targeted weighbridge stations (Holeta and Modjo) are tabulated as follows.

Table 1-1: Total checked front and and rear axles (ERA report, 2002/03-2011/12)

Year	Axles				
	Total Checked			Illegal	Illegal %
	Front	Rear	Total		%
2002/2003	86,122	216,279	302,401	113,708	38
2003/2004	88,427	228,528	316,955	109,987	35
2004/2005	105,476	309,422	414,898	149,145	36
2005/2006	113,876	320,997	434,873	157,688	36
2006/2007	99,477	317,303	416,780	136,944	33
2007/2008	115,565	378,107	493,672	159,598	32
2008/2009	141,359	459,950	601,309	179,181	30
2009/2010	148,046	485,947	633,993	89,940	14
2010/2011	142,253	473,406	615,659	76,013	12
2011/2012	132,344	493,160	625,504	36,897	6

Overloading violation data

Bridges are designed to serve for a period of 50 years without seeking major maintenance activity. However, due to different reasons bridges in Ethiopia are being exposed to different deterioration conditions. For instance, the chart below shows the life of bridges in percentage due to overloading. Most of them are under poor condition of serviceability. The chart below shows age distribution of bridges of the country.

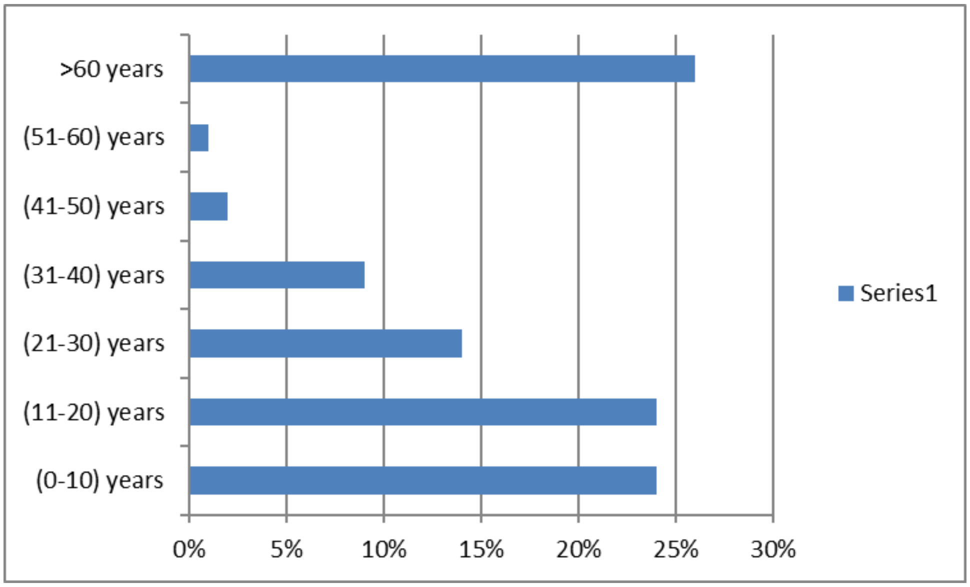

Figure 1-1: Age distribution of bridges in Ethiopia

Asphalt Roads are similarly being exposed to various distress conditions due to overloading. Initially they were designed to serve for a period of 20 years with minor routine and periodic maintenance activities. However, they are getting worse than before in serviceability view point. The following table shows finance disbursed for maintenance for some of the roads due to overloading.

Table 1-2: Maintenance expenses for some routes due to overloading

S.N.	Project	Surface type	Disbursement (millions ETB)
1	Adigrat-Adiabun	AC	20.6
2	Azezo-Metema	AC	50.3
3	Zuway-Butajura	DBST	23.4
4	Awash-Mille	AC	62.4
5	Adama-Awash	AC	58.9

1.3 Organization of thesis

In accordance with the master program, the thesis is organized in to seven chapters.

- Chapter 1 Introduction: This chapter consists of the back ground, the problem statement and the organization of the thesis itself.
- Chapter 2 Purpose and scope: This chapter comprises the general objective of the paper and its specific objectives as well.
- Chapter 3 Literature review: This chapter includes the different literatures targeted on damaging effect of overloading, importance of overload control, axle load limits and control mechanisms, good practices of control mechanisms in various countries in Africa and technical options for dealing with various aspects of overload control.
- Chapter 4 Methodology: This chapter presents the descriptions of the approaches and methodology being taken to achieve objectives of this research paper.
- Chapter 5 Results and discussion: This chapter consists of the findings of the thesis and analysis of the results obtained.
- Chapter 6 Conclusion and recommendations: This chapter gives an insight for the effective axle load management study in our country Ethiopia, depending on the results obtained.
- Chapter 7 References: This chapter presents the different reference books utilized for the effective completion of the thesis.

2. PURPOSE AND SCOPE

The primary purpose of this study was to assess the axle load management at selected two stations; Holeta and Modjo weigh bridge stations. Ethiopia has its own legal axle load limit, which is 58MT. Hence, roads and bridges are designed keeping the legal load limit in mind. Even though Ethiopia is exercising the aforementioned legal axle load limit, it is not adequately enforced due to different reasons. Therefore, the main objective of the thesis was to investigate and scrutinize the limitations and come up with an effective axle load management at the captioned stations. The scope of the study was limited to investigate the axle load operation in the country and the corresponding axle load management it should have. It has taken in to consideration the weigh bridges used to control the axle load of freight vehicles.

The specific objectives of this study were to:

- Describe the relevance of legal axle load limit and the importance of abiding with it;
- Assess the current axle load control mechanisms;
- Determine freight vehicles overloading;
- To contribute better to the axle load control mechanism on the selected corridors;
- To accelerate the implementation of the overload control program by enhancing the existing axle load management and by adopting good practices.

After meeting the aforementioned specific objectives the study will help to:

- Control vehicles, loading beyond the legal load limit;
- Alleviate the problems of over maintenance, rehabilitation and reconstruction costs of roads and bridges as a result of overloading; and
- Adopt the best possible axle load management approaches.

3. LITERATURE REVIEW

3.1 Overloading

Now a day than it was before road pavement damage associated with vehicle overloading particularly from those heavy vehicles are becoming increasingly threatening in Ethiopia. Most of the road pavements constructed since the last 10-15 years are deteriorating much before their useful design life (period) and are calling for early overlay if not for complete reconstruction. This is mainly associated with the growing economy of the nation and associated increase in transport demand. The ever growing demand in transport in turn calls for an effective transport system. One way of achieving this is currently manifested by introduction of heavy trucks and truck trailers for transporting goods. Although this is a normal trend in growing economies the damage that these vehicles induce on flexible bituminous surfaced roads is intensified by excessive overloading exceeding the permitted axle load limits (Daniel Legesse, 2013).

3.1.1 Damaging effect of overloading

Road pavements are designed to carry a range of standard axles over a period of time. The number of “Equivalent Standard Axles” (ESA) is determined with respect to the type of traffic expected to use the road over its design life. The American Association of State Highway & Transportation Officials (AASHTO) road tests that were carried out in the USA during the years 1959 – 61 established that the life of a given road is approximately proportional to the fourth power of the axle load for the same number of passes. The test resulted in the following well known formula – the Fourth Power Law – which postulates an exponential relationship between axle loads and damaging power.

The effect of overloading on bridges is another impediment to its effective life span. Hence, overloaded vehicles are major contributor to bridge deck deterioration. The extent of deterioration depends on the design loading adopted for the bridge. The impact of overloaded axles on short span bridges (< 20 m) relates primarily to tandem and tridem axles. Vehicles that significantly exceed the legal maximum vehicle mass limit raise the prospect of bridge failures, particularly those with short spans and/or low design standards. Overloading places transporters who abide by the regulations at a disadvantage as they are not able to compete with those transporters that overload. This has an adverse, knock-on effect on the industry as some transporters then resort to overloading in order to be able to compete with those who overload. The net effect is that a transporter's survival in a harshly competitive market is often related to how successful he is at getting away with overloading! Not surprisingly, overloading has become big business as in most cases the fines imposed by magistrates in a court of law remain unrealistically low compared with the higher profit made by the operator in transporting a heavier load. For improved road safety, fair competition, lower transport operating cost and lower road maintenance cost reasons it is essential to ensure that gross weight and axle weight overloading of all commercial vehicles is eliminated as far as possible. The current control system where such vehicles have to visit all weigh stations on route causes excessive delays, as all commercial vehicles have to form a queue on the access road and main road, waiting to get into the weigh station and on to the weighbridge. A notional 100 percent of vehicles are checked but incidences of reported overloading are few and fines are small, so in practice the exercise has little value. Better control can be established by a better understanding between Government and industry by issuing a certificate after an initial check at a weighbridge on route and random testing by the introduction of addition mobile weighbridge equipment operated by trusted inspectors in the Transport Authority. This would work on the main route to and from Djibouti but not be as effective on domestic short movements. There is also the problem of illiteracy with some drivers, but this is most likely in local domestic movements. Control will be more effective if we treat the different types of vehicle operation as separate entities as discussed in the main document. (Michael lan pinard, 2010)

3.1.2 Cost of Overloading

Cost components

The marginal cost associated with an overloaded vehicle on a road comprises three main components: (Michael Ian Pinard, 2010)

1. The increase in transport cost to other vehicles as a consequence of the overloading. This increase in transport cost reflects the deterioration caused and results in increased costs for operating the vehicle and lower speeds, resulting in higher time costs.
2. Assuming that routine maintenance actions are condition responsive, overloaded vehicles on a road would lead to earlier and more frequent routine maintenance interventions.
3. Overloading will lead to the road authority remedying the damage by way of periodic maintenance actions or reconstruction at an earlier date than would have been the case without the overloaded vehicle.

Incidence of overloading

Up-to-date, reliable statistics on overloading are generally not readily available. However, from a survey carried out in 2004 (ref. Overloading and Truck Taxation Survey, 2004, prepared by Gicon AS, Norway and Infra Africa Consultants, Botswana), the incidence of overloading reported by countries in the SADC region was as follows.

Table 3-1: Incidence of overloading in SADC region

S.No.	Country	Percent of overloading
1	Botswana	10-25
2	Lesotho	20-35
3	Malawi	30-40
4	Mozambique	50
5	Namibia	20
6	South Africa	15-20
7	Swaziland	20-40
8	Tanzania	20-30
9	Zambia	40
10	Zimbabwe	5-10

Road damage costs in South Africa caused by overloaded heavy vehicles have been estimated at approximately $170 million per annum plus an amount of $1 330 million for increased vehicle operating costs due to poorer road conditions. When such typical costs are extrapolated over the ESA region's main paved road network of approximately 90,000 km, where overload control is generally less effective than in South Africa, the estimated cost due to overloading is in excess of $4 billion per annum (SADC, 1993).

3.2 Importance of Overload control

Limits and the spectrum of observed axle loads have not been studied in detail for Ethiopia, even though recently ERA intended to work with Japanese government regarding axle load management. Recognizing the magnitude of the benefits which can arise from operating the road transport system under conditions which give rise to a minimum total cost, some developing countries are now attempting to rationalize the operation of their road transport system. An important step in this process is the selection of legal limits for axle loads. The total cost of operating the road transport system, including the cost of building and maintaining all roads and the total vehicle operating cost in a country, is usually very expensive. In many countries it accounts for about 10% of the total GDP (USAID report, September 2010). One of the reasons that governments have introduced axle load limits is because of the immense expense spent on the road sector, thereby, to regulate carrying capacities of road vehicles to minimize road deterioration through overloading and maintain efficiency of road transport.

The axle load regulation in Ethiopia was enacted in 1962 as part of the Transport Act under the Vehicles Size and Weight Regulations and amended in 1990 by Regulation No. 11/90. It was not until late1970s, however, that efforts were made by the government to make this regulation effective by fixing legal limits to the vehicle size and weight. Weight control stations were also established indifferent locations. Originally, the country had a total of 10 weighbridge stations established in 1976 and 1992 and were managed by the Ethiopian Road Transport Authority (ERTA). More recently, the Ethiopian Roads Authority (ERA) has taken over the responsibility for axle load control from ERTA on the grounds that it has a more direct interest in the collection of data for new road designs and the maintenance and rehabilitation of existing roads. Acknowledging the increased capabilities of modern HGVs, Ethiopia raised the basic axle load limits of six and eight tons for steering and drives axles, respectively, to eight and ten tons in1990, in conformity with the standardized regulations under COMESA (formerly the PTA). Ethiopia was among the first members of PTA to adopt the regulations. Ethiopia, as the table below shows, has adopted the COMESA axle load regulations with a few modifications. Both COMESA and Ethiopian regulations are the same for single steering and single drive axle loads (eight and ten tons, respectively). Differences only occur in the cases of tandem axle groups. For tandem axles, both COMESA and Ethiopia have adopted a maximum distance of 1,300 mm between the axle centers. If the distance between the axles exceeds 1,300mm, however, the Ethiopian law provides an allowance of up to 10 tons for each axle. For the triple axle group, COMESA provides for a maximum distance of 3,000 mm between the centers of the outermost axles. Under the tandem and triple axle group principle, the axles are required to be suspended and interconnected in such a manner that any load imposed on them will be distributed equally regardless of the road profile and condition. Ethiopian law also states that a gross weight with loads imposed on the highway on a group of three or more axles with a distance of more than 1,300 mm should not exceed 10 tons. Although COMESA has also established penalty rates for overloading based on the fourth power rule, many member states have not so far adopted them. Instead, many states have developed their own penalty rates (USAID report, September 2010).

The legal limits for axle loads in Ethiopia are proclaimed as: (Negarit Gazeta, 1990)

- ✓ The steering axle of a vehicle shall not carry a gross load in excess of 8 tons
- ✓ An axle of a vehicle equipped with a single tyre shall not carry a gross load in excess of 8 tons
- ✓ The rear axle of a vehicle equipped with dual tyres shall not carry a gross load in excess of 10 tons
- ✓ Gross weight with load imposed on the highway by a group of two axles of a vehicle shall not exceed 17 tons, where the distance between the said axles is not more than 1300mm
- ✓ Gross weight with load imposed on the highway by a group of two axles with a distance of more than 1300mm, or a group of three or more axles shall not exceed 10 tons per axle.
- ✓ The distance controlling the allowable gross weights shall be measured longitudinally between the centers of two consecutive axles.

To some extent these limits reflect the different environmental and social conditions of each country but economic analyses have rarely, if ever, been used to justify them. In many developing countries vehicles are often loaded above the legal load limits. In axle load surveys carried out in various countries it has been found that up to 70 per cent of commercial vehicles are overloaded in this way, a typical figure being about 30 per cent (Battelle Team, 1995). Not only is the number, of vehicles which are overloaded large but the magnitude of the overloading is high. Although the damaging effect of these heavily loaded vehicles on the pavement has been appreciated, the overall economic consequence of operating heavy vehicles with high axle loads has rarely been examined In particular axle relationship between the optimum axle load, the legal axle load (Battelle Team, 1995).

Table 3-2: COMESA and Ethiopian Axle Load Limits

Vehicle Configuration	Axle Load Limits (tons)	
	COMESA	Ethiopia
Single Steering Axle	8	8
Single Drive Axle	10	10
Tandem Axle Group	16	Up to 17
Triple Axle Group	24	Up to 10 tons each

Road transport plays a fundamental role in the social and economic development of many developing countries. In Ethiopia, it provides the dominant mode of freight and passenger transport and carries between eighty and ninety percent of the country's total trade in goods and services. Thus, in order to attain acceptable levels of road transport efficiency, the management and maintenance of road infrastructure form an important part of development programs in all countries. In this regard, the control of overloading is of paramount importance as it affects the rate of deterioration and maintenance costs of road pavements. Unfortunately, overloading of vehicles in Ethiopia has been an on-going and costly problem for years. When coupled with lack of adequate maintenance, it has resulted in the accelerated deterioration of the country's roads causing the loss of precious infrastructure worth millions of birr; this has had an adverse impact on the economy of the country (W.T consults, May 2009).

Road infrastructure represents a huge investment for any country. To protect these assets against misuse and damage, Ethiopia has promulgated road traffic act that stipulate permissible maximum axle and vehicle mass and dimensions. These limits are meant to ensure that roads last for their full design life with normal maintenance expenditures. In addition, control of axle loads to prescribed limits can be justified for the following reasons:

- Ensuring a level playing field between transporters;
- Limiting the extent of road maintenance required;
- Reducing the amount of fuel levy required; and
- Improving road safety.

3.3 Axle load limits and control mechanisms

Economic vehicle load limits

At the core of any system of overload control are the actual regulations that, amongst others, place limits on the permissible maximum axle, axle unit, vehicle and vehicle combination masses for vehicles using a country's road network. In theory, such limits should strike a balance between two important transport planning considerations:

- The benefits to be derived from a reduction in transport costs obtained from the economies of scale and the efficiency of operating larger and heavier vehicles; and
- The costs of road pavement provision and maintenance which are both related to axle loads, and bridge standards which are related to a vehicle's total mass.

The vehicle load limits in Eastern and Southern Africa can generally be said to have evolved over the years on no particular basis other than what might be described loosely as "historical trends". In the late 1980s both COMESA and SADC developed their own protocols to harmonize axle load limits and other aspects of overload control within their respective economic communities. The approaches adopted differ as described below (Michael lan pinard, 2010).

COMESA approach

In the absence of the availability of economic and engineering data that would be required to rationalize the setting of axle load limits, a 1988 PTA Study on the Harmonization of Road Tolls, Transit Charges, Axle Loads and Vehicle Dimensions took as its base the following:

- Facilitation of enforcement;
- Least modification of existing limits; and
- Technical considerations.

On the above basis, recommendations were put forward that would involve the least modification of regulations to the maximum number of countries. The recommendations, which are still in force, are as follows:

Table 3-3: COMESA approach on axle legal limit

S.No.	Axle type	Axle load
1	Steering axle	8
2	Single/drive axle	10
3	Tandem drive/load axle	16
4	Tridem axle	24
5	Permissible maximum combination mass	53

SADC approach

On the basis of an Axle Load Study for Southern Africa carried out by SATCC in 1999, optimum axle load and maximum vehicle mass limits (i.e. those limits which minimize the total transport cost on a regional basis for the regional economy) were determined using a techno-economic model – the World Bank's HDM-III model. Based on the outcome of the HDM-III analyses, the regional optimum single axle load limit was determined as 13 tons. However, based on consideration of the axle load Economic Efficiency Frontier, in terms of the benefits versus costs of increasing from the prevailing limits to the optimum limit, the harmonized limits recommended for the region were less than the optimum limits.

In addition to axle load economic efficiency considerations, there were a number of other reasons for recommending limits which were less than the optimum limits. These included the large proportion of sub-standard pavements, a significant amount of backlog maintenance and concern over the adequacy of future maintenance funding. In the event, the recommended regional axle load and gross combination mass limits for the SADC region were as follows:

Table 3-4: SADC approach on axle legal limit

S.No.	Axle type	Axle load (ton)
1	Steering axle	8
2	Single/drive axle	10
3	Tandem drive/load axle	18
4	Tridem axle	24
5	Permissible maximum combination mass	56

As is clear from the above, both the COMESA and SADC recommended limits are the same for steering, single/drive and tridem axles but differ for the tandem drive/load axles and the maximum combination mass. Thus, in theory, there is an agreed basis at REC level for inter-regional harmonization of axle load and maximum combination mass limits in the COMESA and SADC regions. However, by the same token, because some of the axle load and the maximum combination mass limits are different, there is no intra-regional harmonization of limits – a longstanding problem, amongst others, that continues to adversely affect the efficiency of intra-regional transport.

Comparison with other REC limits

Table 7 shows the comparison of the COMESA and SADC main vehicle load limits with those of other RECs in Eastern and Southern Africa.

Table 3-5: Comparison of REC vehicle load limits

REC	Axle load limit (tons)				
	Steering axle (2 tyres)	Single axle (4 tyres)	Tandem axle unit (8 tyres)	Tridem axle unit (12 tyres)	Perm max comb. Mass (tons)
COMESA	8	10	16	24	53
SADC	8	10	18	24	56
ECOWAS	8	12	21	25	51
CEMAC	8	13	21	27	50

As would be apparent from Table 5, vehicle load limits within various RECs vary considerably. Although some of the differences in limits may appear to be relatively small, the damaging effect on the road pavement can be substantial due to the exponential relationship between axle loads and damaging power. In practice, notwithstanding the recommended SADC and COMESA axle load and maximum combination mass limits, there is still lack of inter-regional harmonization. For example, in a number of EAC countries, a 32 ton quad axle configuration is allowed, although as from December 2007 it has become illegal in Kenya. In addition, as illustrated in Table 6, there are still many variations in load limits in the COMESA and SADC regions, made worse by some countries belonging to both RECs.

Table 3-6: Variation in vehicle load limits in selected SADC and COMESA countries

Countries by region	Steering axle		Non steering								Perm max comb. Mass(tons)
	Single	Tandem	Single		Tandem		Tridem		Quadrem		
	2 tyres	4 tyres	2 tyres	4 tyres	4 tyres	8 tyres	6 tyres	12 tyres	8 tyres	16 tyres	
SADC	8			10		18	24	24			56
Angola*	6			8		16		24			38
Botswana	7.7		8	8.2	15.4	16.4	23.1	24.6			50.2
DRC*											
Lesotho	7.7		8	8.2	15.4	16.4	21	21			49
Malawi*	8		8	10	16	18	24	24			56
Mozambique	8		8	8	16	16	24	24			38
Namibia*	7.7		8	9	16	18	24	24			56
South Africa	7.7	15.4	8	9	16	18	24	24			56
Swaziland*	7.7		8	8.2	15.4	16.4	21	21			50.2
Tanzania	8	12	8	10	12	18	15	24			56
Zambia*	8			10		18	12	24			56
Zimbabwe*	7.7		8	10	16	18	24	24			56
COMESA	8		8	10	16	16	24	24			53
Burundi	8			10		16		24	24	32	N/A
Ethiopia	8			10		16		24			58
Eritrea	6			8		16		24			46
Djibouti	6			8		16		24			46
Kenya	8		6	10	12	16	18	24			53
Sudan	7.7			10		16		24			46
Uganda	8	14	8	10	12	16	18	24	24	32	46
Rwanda	8			10		16	18	24	24	32	N/A

NB: * denotes country is also a member of COMESA

N/A= Not applicable

Denotes compliance with recommended limit

Other key aspects that vary between and among the EAC Partner States include the following:

3.4 Good practices of control mechanism in Africa

Good practice examples

There are within the region a number of examples of “good practice” which, in some way or another, have proved to be very efficient and effective over a sustained period of time in some aspect of overload control. Unfortunately, the examples of good practice have either not been written up properly or disseminated in the region. This is a pity, as many countries would undoubtedly benefit from the knowledge and application of such examples of good practice in their countries.

The synopsis of good practice examples being presented in this section are as follows (COMESA, 2010):

(a) Decriminalization of overloading in Zimbabwe;

(b) Progressive legislation and regulations on control in Namibia;

(c) Privatization of weighbridge operations in the Western Cape;

(d) Self-regulation of vehicle operations (load control, vehicle maintenance and driver wellness); and

(e) Cross-border overload control system.

3.5 Technical options for dealing with various aspects of overload control

3.5.1 Enforcement issues

The goal of overload control enforcement is to protect the road infrastructure and to promote road safety. To protect the road infrastructure it is necessary to ensure that the forces exerted by vehicles on the road infrastructure, such as the pavement layers and bridges, are not in excess of what the road infrastructure was designed for. To promote road safety it is necessary to ensure that the forces exerted on the vehicle by the load it is carrying, are not in excess of what the vehicle was designed for.

Regulations controlling the loads on vehicles therefore have to deal with both these aspects and the enforcement of the regulations dealing with both aspects must take place.

Regulations dealing with the protection of the road infrastructure prescribe the maximum load on axles and axle units, to protect the road itself, but also prescribe the maximum load on vehicles and combination of vehicles to protect bridges. A further protection of bridges is through regulations that aim to ensure that the forces exerted by vehicles on bridges are not too concentrated. These regulations are usually referred to as the “bridge formula”. Many countries do not include a bridge formula in their regulations. This shortcoming should be rectified as soon as possible.

Regulations dealing with the promotion of road safety limit the loads on vehicles to the values for which the vehicle was designed, such as the manufacturer’s ratings for axles, axle units and the total vehicle, the tyre manufacture’s ratings and the load on the vehicle in relation to the engine power of the vehicle. Further safety aspects to deal with are the load on the drive axle of a vehicle in relation to the total load on the vehicle and the minimum load on the steering axle.

For effective overload control regulations dealing with all these aspects must be in place and must be enforced. The regulation which prescribes the smallest permissible mass is the one that determines the legal mass for an axle, axle unit or total vehicle or vehicle combination for a particular vehicle. Some country’s regulations deal only with limits to protect the road infrastructure and do not consider either the maximum allowable load to protect bridges or road safety load limits on tyres and vehicles. These shortcomings should be rectified as soon as possible.

3.5.2 Penalties

Introduction

Vehicle overload control, the level of penalties, and the judicial/ administrative mechanisms to deal with the problem, have received considerable attention during the past three decades throughout the world. A primary factor has been the realization that an increase in axle load causes road damage to increase at an exponential rate, commonly taken as a fourth power effect.

The problems of vehicle overloading are exacerbated in the ESA region compared with more developed countries by numerous factors, chief amongst which are the enforcement and penalty aspects.

The fines imposed for overloading, both by traffic officers for admission of guilt and by magistrates in a court of law remain, in most cases, unrealistically low compared with the damage done by the vehicle on the road and the higher profit made by the hauler in transporting a heavier load. Fines do not have a significant effect on discouraging overloading and the income derived from these fines is insignificant compared to the road damage. Generally, the income from fines is paid into a "central account" and is not directly available for road maintenance purposes.

Fees for overloading

There is a need for the introduction of some form of economically based fees to recover costs of accelerated pavement damage from the operators of overloaded vehicles. Such a fee should include for the following:

- Pavement damage;
- Bridge damage;
- The extent of overload control;
- Travel distance; and
- Punitive effect.

Fee Schedules for Overloading were prepared by SATCC in 1993 with the various assumptions for calculating the fee schedule being based on the 1993 SADC Axle Load Study for Southern Africa (TOI report 180/1993). The underlying rationale within the proposed fee structure is that the fees levied will clearly outweigh any cost benefits to the operator to overload for commercial gain.

The SATCC fee schedules for overloading has provided the basis for charging for overloading by a number of countries in the ESA region. However, these schedules need to be updated based on the information contained in the study carried out for SADC on Implementation of Harmonized Road User Charges System in the SADC. June 2007.

Penalty Comparison

Kenya

Vehicle overloading is checked at the weighbridge stations along the major corridors by KeNHA. The police also works with KeNHA at the weighbridge stations and is responsible for taking drivers of overloaded vehicles to court to report the level of overloading. The overloading fines are ultimately charged and collected by the court and transferred to the general budget. The levels of the overloading fines are shown in the following table.

Table 3-7: Levels of Overloading Fines in Kenya (EAC-Vehicle overload control)

Degree of Overloading per Axle or Excess Gross Vehicle Weight in Kilograms (kg.)	**Fine (KES)**	
	Fine on First Conviction	**Fine on Second or Subsequent Conviction**
Less than 1,000 kg	5,000	10,000
1,000 kg or more but less than 2,000 kg	10,000	20,000
2,000 kg or more but less than 3,000 kg	15,000	30,000
3,000 kg or more but less than 4,000 kg	20,000	40,000
4,000 kg or more but less than 5,000 kg	30,000	60,000
5,000 kg or more but less than 6,000 kg	50,000	100,000
6,000 kg or more but less than 7,000 kg	75,000	150,000
7,000 kg or more but less than 8,000 kg	100,000	200,000
8,000 kg or more but less than 9,000 kg	150,000	300,000
9,000 kg or more but less than 10,000 kg	175,000	350,000
10,000 kg or more	200,000	400,000

Source: The Traffic Act, Legal Notice No. 65, Kenya Gazette Supplement No. 65, 12th September 2008

Current System to Collect Overload Charges

The level of legal enforcement, equipment installment, and organization structure regarding overload control to enable efficient overloading control are various in the five member states. While Kenya, Tanzania and Uganda have been developing more organized systems for overload control, those in Rwanda and Burundi are hardly under the control of the government. In Kenya, a fine of so called “overload fines” exists and is collected by the court. KeNHA is the organization which checks the gross and axle weight of vehicles using weighbridges. Police also work in cooperation with KeNHA and take drivers of overloaded vehicles to the court. The fines collected by the court are transferred not to the road fund but to the general revenue. According to the Revenue Authority, there is an idea that overload fines are a fee which disappears. Therefore, they consider that the fine should not be included in the road maintenance budgets which are connected to the road agency relevant to road maintenance matters.

In Tanzania, the overload "fee" is collected by TANROADS and transferred to the road maintenance budget. The system of the weighbridge operation by the road agency in cooperation with police is similar to that of Kenya. The major difference here is TANROADS itself can collect the fee directly from the drivers.

In Rwanda, there is a fine of so called "overloading penalties" in the system. However, in reality it has never been collected. There are only some weighbridges at the declaration points owned by Revenue Authority but no weighbridge is controlled by the road agency. Although overloading penalties are supposed to be transferred to the road maintenance budget, the road fund has never received that money, according to our interview.

Here, the current situation of Burundi is very similar to that of Rwanda. Although there are defined fines for each range of axle overloading and gross weight overloading, there is no weighbridge to measure them. There are only some weighbridges owned by Revenue Authority to check only gross weight at the customs declaration points. Even though there is a definition of such fines in the regulations, they have actually never been collected.

Uganda is currently under the process of developing a weighbridge operation system as well as the relevant regulations. They have been introducing Weigh in Motion equipment, and are planning to introduce a computerized system, and an organized data capture system. Fines are to be collected by UNRA directly in the near future.

The maximum fines/fees for vehicle overloading expressed in USD equivalent in the five Partner States are shown in Table below:

Table 3-8: Maximum Fines/Fees for Vehicle Overloading (JICA study team)

Country	Maximum Fines/Fees in National Currency	Maximum Fines/Fees In USD
Burundi	BIF 2,000	2
Kenya	KES 200,000–400,000 (first and subsequent offenses, respectively)	2500-5000
Rwanda	RWF 90,000–180,000 (first and subsequent offenses, respectively)	150-300
Tanzania	-	35,000
Uganda	UGX 300,000–600,000 (first and subsequent offenses, respectively) + UGX 200,000 (for each day the offense continues) + UGX 600,000	(120–250) + (80/day) + 250

Penalties for overloading differ from country to country. For instance, in our neighbor country Kenya the first conviction for overloading attracts fines of between Sh5000 and Sh200000. Depending on the excess weights carried ranging from one tone to 10 tones. Repeat offenders are fined between Sh10,000 and Sh400,000. (JICA study team)

In Australia the maximum fine which the court can impose depends on: (Australian Roads, 2010)

- The “risk category” of the offence (i.e. how much you were over the allowable weight);
- Whether the defendant is an individual or body corporate; and
- Whether the offence is a first or subsequent offence.

The maximum fines available to the court can be very substantial. The local court may impose a fine up to $55,000 for overloading offence.

Minor risk breaches (up to 5% over the allowable weight)

Any overload up to 5% over the allowable weight is categorized as a "minor risk breach" (for example, where a vehicle has an allowable gross mass of 42.5 tones, and has an actual mass of 44.2 tonnes, being an overload of 4%).

If the defendant is an individual, the maximum penalty for a minor risk offence is:

- $1100 for a first offence; and
- $2200 for a second or subsequent offence.

If the defendant is a body corporate, the maximum penalty for a minor risk offence is:

- $5500 for a first offence; and
- $11,000 for a second or subsequent offence.

Substantial risk breaches (between 5% and 20% over the allowable weight)

If the defendant is an individual, the maximum penalty for a substantial risk offence is:

- $2200 for a first offence; and
- $4400 for a second or subsequent offence.

If the defendant is a body corporate, the maximum penalty for a substantial risk offence is:

- $11,000 for a first offence; and
- $22,000 for a second or subsequent offence.

Severe risk breaches (20% or more over the allowable weight)

Any overload which is 20% or more over the allowable weight is categorized as a "severe risk breach" (for example where a vehicle has an allowable gross mass of 42.5 tonnes, and has an actual mass of 52.5 tonnes, being an overload of 24%)

The maximum penalties for severe risk offences are calculated by direct reference to the overload amount, and increases with every percent that the overload exceeds 20% of the allowable weight.

If the defendant is an individual, the maximum penalty for a severe risk offence is:

- $5500 plus $550 for every additional 1% that the overload exceeds 20% of the allowable weight for a first offence; and
- $11,000 plus $1,100 for every additional 1% that the overload exceeds 20% of the allowable weight for a second or subsequent offence.

If the defendant is a body corporate, the maximum penalty for a substantial risk offence is:

- $27,500 plus $2750 for every additional 1% that the overload exceeds 20% of the allowable weight for a first offence; and
- $55,000 plus $5500 for every additional 1% that the overload exceeds 20% of the allowable weight for a second or subsequent offence.

4. RESEARCH METHODOLOGY

4.1 Background and review

Heavy goods vehicle overloading is a serious problem across the main roads of the country. Such overloading not only significantly accelerates the rate of deterioration of road pavements but, when coupled with inadequate funding for road maintenance, it contributes significantly to poor road conditions and high transport costs. Therefore, unless the problem is tackled head on, it will negate the expected benefits from the huge amounts of resources that the country and donors are investing into improved road infrastructure across Ethiopia. Load limits restrict how much weight can be carried on an axle, a single tire or pair of tires, and on the vehicle or vehicle combination in total. Roads and bridges are suffering from overloading freight vehicles, consequently deteriorating before their designed life span and thereby causing for an additional unnecessary costs in different directions. Therefore, these infrastructures should be saved from deterioration by implementing effective axle load management mechanisms and practices. However; in the case study areas, it was found that overloading becoming a serious problem to roads and bridges followed by poor axle load management mechanism emanated from various reasons. As there is no existing documented and well organized regulation to effectively manage the legal axle load limit, the problem of overloading is aggravating from time to time. Since the last 15 to 20 years the Government of Ethiopian is increasingly focusing towards expanding its road network and is allocating the lion share of its capital budget. Nevertheless most of the roads, particularly paved ones are also increasingly becoming victims of overloading. The cost associated with vehicle overloading can be avoided through effective control measures.

4.2 Methodology

The research is conducted following several stages or phases that have been identified right from the onset and refined in due course of the research work. The chart below illustrates a flow of methods adapted and these are briefly described in the following sections.

4.2.1 Preparation Phase

Up on setting the project objectives review of a number of literatures and legal limit regulations and penalties in practice by different countries especially with direct relevance to the Ethiopian conditions have been reviewed. This is then followed by data collection.

4.2.2 Data collection

The weighbridges are strategically located at main junctions of the country to the metropolitan city, though they are not sufficient to control the axle loads of all freight vehicles getting to the country as well as to the capital. For instance, around the borders of Kenya, Djibouti, port of Sudan etc.

The target site visit areas for the thesis were Holleta and Modjo weighbridge stations, two of the main corridors to the capital Addis Ababa. Data was collected from the axle load checked vehicles at different times. The data at Holleta was collected in the months of June, August and September for successive of seven days each. Besides, the data collected at Modjo weigh bridge station was collected at the months of October, November and December for a random of seven consecutive days.

Data was also collected using interview with different stake holders of the sector. The interviewed concerned bodies were:

- Drivers/operators including operator helpers;
- Owners of trucks;
- Weigh bridge operators;
- Traffic police; and
- ERA axle load management office officials.

The sample size of the interviewed stakeholders was 150 persons. The sample was taken conveniently as it was difficult to obtain the population size of each of the stakeholders from the concerned bureaus. The following chart shows the distribution of the respondents.

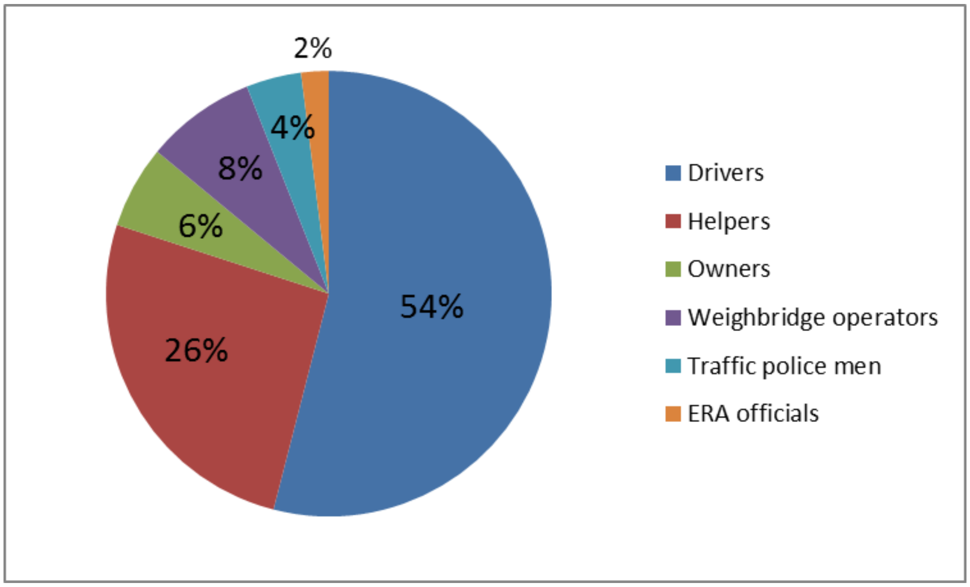

Figure 4-1: Distribution of interviewed stakeholders

From the above stakeholders most of the interviewed ones were drivers, they account 81 in number. Besides, 39 operator helpers, 9 owners, 12 weighbridge operators, 6 traffic police men and 3 ERA officials were interviewed on the following critical issues.

The above listed stake holders had different reaction concerning overloading and effective axle load management mechanisms.

- The responsibility of the particular body behind the safety of the roads;
- Whether the stakeholder is content with the sufficiency of the control mechanism; and
- The way forward to the effective axle load management.

Figure 4-2: Axle load measurement at Holeta weighbridge

There are about nine functional stationary weighbridges excluding the newly emerged weigh bridge of at sendafa and two mobile weighbridges in the country. These weighbridges mainly check the axle load of freight vehicles to assist the limited legal axle load of the country. The legal axle load limit of the country is 58MT. except the steering single axle, declared as 8MT; all axles are allowed to be loaded up to a maximum axle load of 10MT. Therefore, in this study every freight vehicle is checked against the total legal axle load of 58MT. if a vehicle is found to be loaded beyond this legal axle load limit, it will be penalized and off loaded. Besides, secondary data was collected from Ethiopian Roads Authority (ERA), to compare the findings with that of institution's report.

4.2.3 Data analysis

The following response was found from the interviewed stakeholders.

Table 4-1: Qualitative response of the stakeholders

S.N.	Description	Drivers	Helpers	Owners	Weighbridge operators	Traffic police	ERA officials
1	Responsibility of the stake holder	Bad	Bad	Good	Fair	Good	Good
2	Sufficiency of the control mechanism	Content	Content	Dissatisfied	Content	Dissatisfied	Content
3	The way forward on the effective control mechanism	Bad	Bad	Good	Good	Good	Good

The domain of the response obtained from the captioned stake holders was totally discouraging to the effective axle load management. The ERA officials, drivers with their helpers and weighbridge operators are satisfied with the current control mechanism, as they are beneficiary from the transgression of the legislation. However, the owners and the traffic police men are not content with existing mechanism.

The percentage of overloaded freight vehicles found was again compared with that of ERA's report on the third quarter of 2013. All data was analyzed through simple excel spreadsheet software.

The following chart dictates the sequence of the research work.

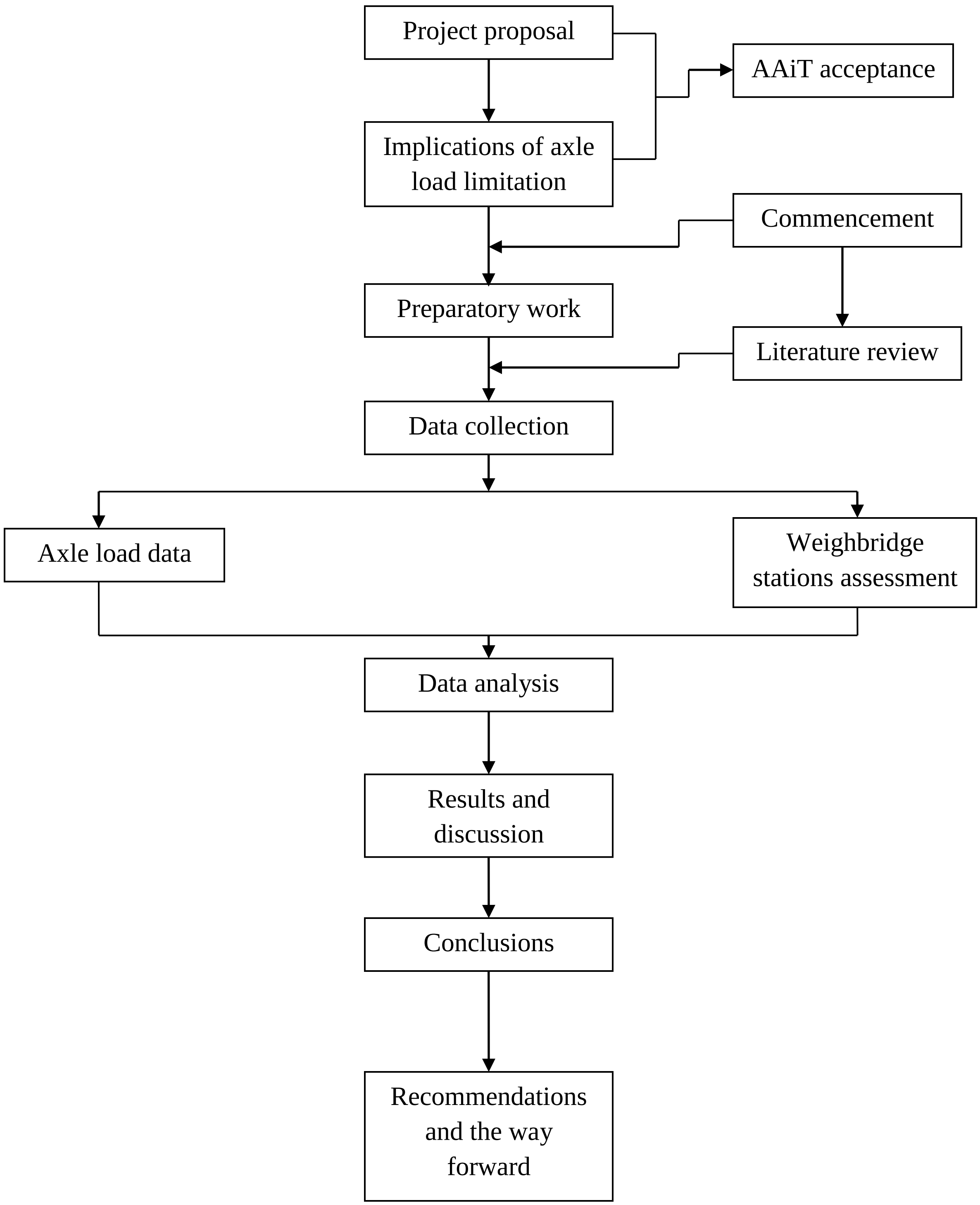

Figure 4-3: flow chart for the sequence of the research work

5. RESULTS AND DISCUSSION

5.1 Findings for overloading freight vehicles

Axle load of freight vehicles was checked against the legal load limit of the country in all weighbridge stations. The following table shows the checked freight vehicles in the third quarter of the year 2013.

Table 5-1: Vehicles checked, overloaded, off loaded in ton, penalized and birr collected from fine 3rd quarter 2012-13 (January) (ERA Axle load management office)

Jan-13						
Station	Checked	O/load	Sealed	Off loaded	Penal	Birr
Alemge	995	21		73.2	20	3180
Deng	796	32	5		18	31380
Awash	3300	371	279	154	324	288275
Holeta	2942	113	2	96	99	20511
Jimma	298	10			7	1100
Kombol	183	7			7	10770
Modjo	4779	344		413.3	295	101730
Sululta	1655	133	1	204.4	144	16685
Shashe	486	14			16	5080
Total	15434	1045	287	940.9	930	478711

Table 5-2: Vehicles checked, overloaded, off loaded in ton, penalized and birr collected from fine 3rd quarter 2012-13 (February) (ERA Axle load management office)

Feb-13						
Station	Checked	O/load	Sealed	Off loaded	Penal	Birr
Alemge	1170	32		62.7		4370
Deng	794	46	5	14	54	44180
Awash	2911	260	189	204	366	244225
Holeta	2850	100	13	730.8	98	18110
Jimma	260	12			10	1870
Kombol	181	6			6	4580
Modjo	4554	324		496		110680
Sululta	1539	142	1	107.6	86	11740
Shashe	459	15	5		22	6250
Total	14718	937	213	1615.1	642	446005

Table 5-3: Vehicles checked, overloaded, off loaded in ton, penalized and birr collected from fine 3rd quarter 2012-13 (March) (ERA Axle load management office)

Mar-13						
Station	Checked	O/load	Sealed	Off loaded	Penal	Birr
Alemge	1074	43		187.7	34	4020
Deng	895	45	8	13	42	29589
Awash	3422	229	189	167	230	205150
Holeta	3107	121	9	929	114	21900
Jimma	399	28	2	19.1	20	3290
Kombol	216	10			10	7550
Modjo	5045	342		714	313	107860
Sululta	1788	190	8	323	142	20670
Shashe	617	32	7	106.1	23	6960
Total	16563	1040	223	2458.9	928	406989

Table 5-4: Vehicles checked, overloaded, off loaded in ton, penalized and birr collected from fine 3rd quarter 2012-13 (ERA Axle load management office)

Station	Checked	O/load	Sealed	Off loaded	Penal	Birr	% overload
Alemge	3239	96		323.6	54	11570	3
Deng	2485	123	18	27	114	105149	5
Awash	9633	860	657	525	920	737650	9
Holeta	8899	334	24	1755.8	311	60521	4
Jimma	957	50	2	19.1	37	6260	5
Kombol	580	23			23	22900	4
Modjo	14378	1010		1623.3	608	320270	7
Sululta	4982	465	10	635	372	49095	9
Shashe	1562	61	12	106.1	61	18290	4
Total	46715	3022	723	5014.9	2500	1331705	6

The aforementioned results for the overloaded vehicles could be tabulated as follows,

Table 5-5: Summary of overloaded vehicles

	2012-13 Budget year	
vehicles checked	over loaded	% of over loaded
46715	3022	6

Freight vehicles were checked against the legal axle load limit set at Holleta weighbridge station and found the following outputs.

Table 5-6: Vehicles checked at Holleta

Days									
Month	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Total	Overloaded
June	102	121	113	122	134	98	107	797	527
August	96	94	101	99	106	85	91	672	420
September	109	116	97	104	99	109	125	759	598
							Total	2228	1545

Table 5-7: Vehicles checked at Modjo

Days									
Month	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Total	Overloaded
Oct	172	165	193	146	177	159	135	1147	624
Nov	132	145	173	129	165	134	155	1033	378
Dec	109	161	157	149	120	128	136	960	421
							Total	3140	1423

As per ERA's data 4% of freight vehicles have been registered as overloaded vehicles at Holleta weigh bridge station. However, this data is by far biased as compared to mine. For instance, in one week of the month of June a total of 797 vehicles have been checked and 527 of them were found overloaded, which accounts 66%. In a random week of the month of August, total HGV's of 672 were checked to have 420 vehicles overloaded. In this week 62.5% of vehicles were overloaded. Lastly, in a random week of the month of September, total vehicles checked were 759 and 598 of them have been found overloaded, accounting 78.8% of the checked vehicles. Hence, the averaged value found was 69.3%.

Similarly, ERA has reported 7% of HGV's checked were found overloaded at Modjo weigh bridge station. However, in the month of October 624 vehicles have been overloaded out of 1147 registered which accounts 54.4%. Similarly, in the month of November, 378 vehicles were found overloaded which accounts 36.5% out of 1033 freight vehicles. Lastly, 421 vehicles which means 43.8% of freight vehicles were found overloaded out of the 960 vehicles tested.

Therefore, averagely 45.3% of the checked vehicles at Modjo weighbridge station were found overloaded. This results from different legislation and human factor problems.

As a good benchmark, It was found that the Australian government axle load enforcement strategy effective and feasible. Accordingly, the overloaded freight vehicles was cross checked against the Australian government overloading control legislation and come up with the following results.

Table 5-8: Overloading status of freight vehicles at Modjo

S.No.	Steering	Non steering					Gross vehicle weight (Kg)	Extent of overloading (%) due to GVW			overloading frequency	Ownership	
	S	NS1	NS2	NS3	NS4	NS5		<5	5-20	>20		Individual	Corporate
1	8040	11760	11020	11040	9240	10280	61380		➤		1	➤	
2	7840	9220	10060	10660	11000	9020	57800				1		
3	7880	10340	10180	12080	12740	11020	64240		➤		1		➤
4	8020	13400	9180	9020	11140	12020	62780		➤		1		➤
5	8040	11220	11240	10380	9220	10440	60540	➤			1		➤
6	7840	11020	12220	9080	13460	10240	63860		➤		1	➤	
7	7860	10080	10560	10440	9480	9660	58080	➤			1		➤
8	8000	12820	10380	9660	9620	10380	60860	➤			1		➤

As we can see from the above table, most of the operators found overloaded. Besides, the extent of overloading registered was in the range of (5-20%) of the gross vehicular weight. Similarly, a sample of eight freight vehicles were taken at Holeta weighbridge station and the following output was registered.

Table 5-9: Overloading status of freight vehicles at Holeta

S.No.	Steering	Non steering					Gross vehicle weight (Kg)	Extent of overloading (%) due to GVW			overloading frequency	Ownership	
	S	NS1	NS2	NS3	NS4	NS5		<5	5-20	>20		Individual	Corporate
1	8020	10740	11000	10440	12220	9660	62080		➤		1		➤
2	8000	9200	11040	9980	10340	10340	58900	➤			1	➤	
3	7860	9340	9180	10780	9880	11220	58260	➤			1	➤	
4	8000	12320	10100	9880	10220	12460	62980		➤		1		➤
5	8080	10220	9240	10200	9440	10240	57420				1		
6	7640	10080	11120	10240	11640	9460	60180	➤			1		➤
7	7660	10040	9480	12540	10120	12340	62180		➤		1		➤
8	8020	11020	9220	10360	11220	9000	58840	➤			1	➤	

As we can see from the above table, most of the operators found overloaded. Besides, the extent of overloading registered was <5% of the gross vehicular weight.

5.2 Penalty implementation

A fine is imposed on a truck or truck with trailer when it is found overloaded. Different countries adopt different penalty approach and fine collection mechanism. The main implementation stakeholders for the penalty and fine collection in Ethiopia are two bodies. These are the Ethiopian Roads Authority (ERA), the regulatory of all the roads in the country and the judiciary, the court. When a vehicle is found overloaded, it will be offloaded to be followed by the penalty charge that will be given to the Driver/Operator, thereby going to the court nearby and fined the amount set by the court. The penalty rate in Ethiopia differs from court to court and upon persistent offence on the drivers. Hence it ranges from 4 birr and 50/100 cents per quintal to 20 birr depending on the persistence of the offence and the type of product overloaded. The table below shows a fine amount registered at both stations.

Table 5-10: Overloading fee collected at Holeta and Modjo weighbridges

S.No.	Overloading(Qtl)		Fine collected (ETB)	
	Holeta	Modjo	Holeta	Modjo
1	85	102	637.5	867
2	56	110	700	594
3	122	90	780.8	504
4	51	95	382.5	807.5
		Total	2500.8	2772.5
		Overloading fee per quintal (ETB)	7.96	6.98

Fine amount

The penalty rate on overloading is neither deterrent nor discouraging for offenders to overload another time. Conversely, drivers calculate the cost of overloading fine to the benefit they get from. The fine collected from overloading should cover the major part of expense of maintenance of roads. However, in Ethiopia the expense incurred to maintenance and the fine collected from overloading are by far incomparable.

Penalty comparison

The penalty imposed to overloading varies from country to country. As per the interview conducted with different truck with trailer operators, the maximum overload that a truck with trailer can sustain is 50 quintal. Keeping in mind this overload amount the maximum fines of the countries has been compared in the table depicted below. The table below shows the maximum penalty rate per quintal for different countries.

Table 5-11: Maximum fines with respective countries

Country	Maximum Fines/Fees in National Currency	Maximum Fines/Fees In USD
Ethiopia	ETB 1000	49.9
Burundi	BIF 2,000	2
Kenya	KES 400,000	5000
Rwanda	RWF 180,000	300
Tanzania	-	35,000
Uganda	600,000 UGX 600,000	250
Australia		55,000

From the above table it can be clearly shown that Ethiopia has the lowest overloading fee rate next to Burundi. Ethiopia's overloading fee differs from area to area. The maximum overloading fine imposed is at Dengego (Eastern Ethiopia), i.e. 20 ETB per quintal. Considering the maximum overloading capacity of truck with trailers to be 50 quintal, the maximum fine could be determined as ETB 1000 or equivalently $49.9, which is by far small to its corresponding countries.

However, if Ethiopia had adopted the axle load control strategy of Australian government, the overloading fee to be collected would have been an immense. The following table illustrates the amount that would be generated if Ethiopia had the same axle load control legislation as Australia.

Table 5-12: Overloading fee collection at Modjo weigh bridge following Australian legislation

S.N.	Gross vehicle weight	Extent of overloadin g (%) due to GVW			overloadin	Ownership		Risk category	Overloading fee (USD)
		<5	5-20	>20		Individual	Corporate		
1	61380		➤		1	➤		Substantial	2,200
2	57800				1			N/A	
3	64240		➤		1		➤	Substantial	11,000
4	62780		➤		1		➤	Substantial	11,000
5	60540	➤			1		➤	Minor	5,500
6	63860		➤		1	➤		Substantial	2,200
7	58080	➤			1		➤	Minor	5,500
8	60860	➤			1		➤	Minor	5,500
								Total	42,900

From the above we can understand that, the total amount of overloading fee, that would be obtained from eight freight vehicles was discouraging to drivers and operators. Therefore, operators would not overload their freight vehicle as they would fear the amount of penalty. Hence, the amount could serve as preventive measure for the safety of roads and bridges in the country.

Similarly, if we had followed an Australian legislation the overloading fee to be collected at Holeta weighbridge would have been as follows.

Table 5-13: Overloading fee collection at Holeta weighbridge following Australian legislation

S.N.	Gross vehicle weight	Extent of overloadin g (%) due to GVW			overloadin	Ownership		Risk category	Overloading fee (USD)
		<5	5-20	>20		Individual	Corporate		
1	62080		➤		1		➤	Substantial	11,000
2	58900	➤			1	➤		Minor	1,100
3	58260	➤			1	➤		Minor	1,000
4	62980		➤		1		➤	Substantial	11,000
5	57420				1			N/A	
6	60180	➤			1		➤	Minor	5,500
7	62180		➤		1		➤	Substantial	11,000
8	58840	➤			1	➤		Minor	1,100
								Total	41,700

From the above table the overloading fee that would be collected is preventive. It could also substantially cover the expense for the undue deterioration created due to overloading of freight vehicles.

5.3 Management of weigh bridges

Main findings: The Ethiopian Roads Authority is responsible for the weighing of vehicles whilst the enforcement of regulations is carried out by the respective nearby courts at the different weigh bridge stations. However, the efforts of these separate bodies are often uncoordinated leading to loopholes that are exploited by unscrupulous transporters. Although ERA is required in its Roads Act to operate in a commercialized manner and to focus on core strategic activities, the institution is not acting accordingly to make overloading fee as one wing of the maintenance program, which might well be more cost-effectively carried out with the involvement of the private sector.

Weighbridge Operations and Procedures

Main findings: A number of shortcomings were identified by stakeholders related to weighbridge operations and procedures in Holeta and Modjo weigh bridge stations. These include:

• Weighbridge operation procedures are generally not properly documented;

• There is no system for maintenance and repair of weighbridges;

• There is no experience sharing system among weighbridges in the country about the procedures of weighbridge operation;

• Weighbridges are generally not linked to each other and to a central control unit.

• The quality and extent of data that is collected at weighbridges varies enormously between the two weighbridge stations and what is collected is not shared among the weighbridges in the country.

Inadequacy of weighbridges

Ethiopia's total road network was 48,793Km as per road sector development program IV report in 2011. For the effectiveness of axle load management system the country's functional weigh bridges were nine. However, Tanzania's road network was 33,012Km by the same year with 31 functional stationary weigh bridges to save its roads and bridges from deterioration, which is by far ample in number comparing with Ethiopia's weighbridge distribution. Even though, the existing weighbridges are located at the main corridors to the capital; they are not sufficient to the road network of the country.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Although the weighbridges are strategically placed at major road junctions, the management of Ethiopian axle load regulations is still ineffective and has not saved its roads from deterioration through overloading. The country's original 10 weighbridge stations have now been reduced to nine, excluding the recently opened weighbridge station at sendafa. Each of these stations has one weighbridge. As most of the stations are located on the main routes passing through Addis Ababa, several roads are still not covered, although the stations are required based on the traffic density. Additional areas requiring new stations include those on the boarders with Djibouti and Kenya. Because the existing weighbridges are old and outmoded, data generated through them in various stations was unreliable and can hardly be useful in evaluating the extent of overloading or for pavement design. Human factors related to the management of the stations, such as corruption, further reduce reliability of the data. As many freight transport operators and their drivers are unaware of the importance of the weighbridges and of the overloading problem, conformity to axle load regulations is weak. Increased awareness needs to be created among the truck operators, HGV drivers and the public in general. Penalties for overloading usually vary from one court to another and are mostly so small that they neither discourage overloading nor reflect the amount of road damage caused by overloaded vehicles. From the study we can draw the following conclusion:

- There is an indication of Human factors. Bribery actions and corruption could be the main problems in controlling mechanism of the legal axle load as the weighted average of the checked vehicles at Holeta, 69.3% of freight vehicles have been found overloaded which is by far greater than the 4% reported overloaded vehicles by ERA and 45.3% at Modjo weighbridge station was found overloaded which was again greater than the 7% reported by ERA.
- No uniform penalty rate is adopted between the weighbridge stations;
- There is no linkage between the studied weighbridge stations and no central control unit is existed to all weigh bridge stations;
- Penalty is imposed based on the gross vehicle weight rather than relying on the axle units;

- Most overloaded vehicles that exceed the permitted tolerance are allowed to travel further without the overloading adjustment;
- The absence of standardized, documented procedures for carrying out weighbridge operations and moreover the absence of well organized and binding legislation on the regulations of axle load management has led to inconsistency in overload control activities. Besides, lack of mutual intra and interconnection of countries in the region and in the continent as well has diluted the efficiency and effectiveness of overload control operations;
- Low and no deterrent penalty is imposed relative to other countries, as in most countries an overloading fine constitute the major part of road maintenance;
- A low level of awareness and knowledge among the stakeholders is making the axle load control mechanism difficult;
- The existing weighbridges are inadequate and old fashioned, neither covering to its road network nor equipped with the current facility to satisfy the growing demand of the country in its axle load control mechanism;
- The penalty rate is not hierarchical depending on the extent of overloading and other relevant factors, rather it is per quintal based overloading fee; and
- Roads and bridges are being maintained before their designed life span due to the poor controlling mechanism of axle load management, thereby exposing the economy for un necessary expenses.

6.2 Recommendations

Improvement in the management of axle load limits is critical to the effective reduction of road deterioration through overloading. Under listed points on axle load management are expected to come up with mitigation measures that may help the government in designing strategies for such improvements. A number of recommendations may be made on the basis of the conclusions identified above. They include the following:

Weighbridges

Additional locations requiring weighbridges should be identified, and more weighbridge stations opened as the existing nine stations seem to be inadequate. The existing aging machines should be properly maintained and provided with an adequate supply of spares. In view of the importance of enforcement of overloading regulations, the weighbridges should be modernized, to improve reliability of data on overloading; in such a way that Developing a networking system of all the weighbridge facilities to each other and with the central control unit that might be located at the head quarters for monitoring the operations and minimizing human interventions, such as corruption and therefore malpractices. In addition, the number of mobile load meters should be increased since at the moment there are two such machines in the country. Fines collected in respect to overloading should be allocated for road and bridge maintenance.

Increased awareness

There is a need to increase awareness among all stakeholders (including freight transport operators and their drivers, farmers, manufactures, and other members of the public) on the critical importance of reducing overloading on the country's roads. This could be achieved through seminars, the media, demonstrations, workshops and exhibitions. At the same time, rules and regulations governing overloading should be made readily available to all transporters and other stakeholders. Importers of freight vehicles particularly should be made aware of the legal specifications under the overloading regulations, so that they avoid importation of vehicles that exceed the legal limits. In this manner an axle load certificate should be issued at the place of loading for all HGVs to avoid disagreements at checkpoints. This will also facilitate the weighing process since the driver will know the weight for each axle prior to checking. Consequently, the current practice where the certificate is issued for the gross weight of the vehicle and not for the weight of each axle should be discontinued.

Penalties

The current low penalties for overloading should be reviewed so that they are more deterrent and capable of being more uniformly applied for similar offences. Moreover, the penalties should be made applicable per axle, measured on site, rather than on the basis of GVW, as the latter basis may disguise the road damaging effect of individual axles. For convenience, following the proposed improvements above, penalties should be imposed and collected on site. To make enforcement more effective and to discourage overloading, the driver, and the vehicle and cargo owner should be charged with the overloading offence whenever there is an incident of overloading. This will ensure that these parties are all responsible for the overloading.

Privatization

If all stakeholders are involved and adequate consultations are held with the stakeholders, as proposed, the possibility of privatizing the ownership and management of weighbridges should be explored to encourage the introduction of efficient private sector management styles in this area.

6.3 The way forward

Improved axle load control

Special attention has been given to the enforcement of axle load limits by the Ethiopian Roads Authority. To assist with effective enforcement the operation of the weighbridge stations falls under the direct supervision of ERA. Data on individual axles of each heavy vehicle is recorded, with each station sending summary reports of the recorded data to ERA headquarters. Reports are sent on a monthly basis and are collated and analyzed at head office. A summary of the annual axle load information forms part of the annual road condition report. These reports provide detailed information on the level of overloading at each station. The principle of the Off-loading of excess loads commenced in March 2004 at all weighbridge stations, though it is being practiced with a low level. Vehicles, found to be overloaded, are forced to offload excess cargo and operators can be penalized at the nearby courts. This has brought a significant improvement in the enforcement effort. However, the level of penalty is so small that it does not have a serious effect on persistent offenders. Maintenance of weighbridges, renovation of stations to improve the working conditions at the stations, regular monitoring and intensive use of the mobile weigh scales are some of the activities currently being undertaken by ERA. ERA is considering modernizing weigh bridges at its existing stations and open 9 new stations in order to improve the efficiency and transparency of axle load control with Japanese Government grant.

Benchmarking of good practice

The effective axle load control mechanism of countries should be taken as a benchmark and adopted with necessary modifications according to the socio-economical conditions of the country. For instance, in this study the experience of Australia with some amendments on the amount of the fines could be undertaken and adopted. This is because, the Australian axle load management system follows a well organized hierarchical order depending on the severity of the overloading and it further categorizes the offenders in to individuals and corporate institutions to decide with the amount of the fine.

Research needs

Research is needed to develop improved load-equivalence factors for use in truck size and weight analyses, highway cost allocation studies, and other policy studies. The AASHTO load-equivalence factors that are currently used in most studies were developed using data from the AASHTO Road Test conducted in the 1950's. Since the primary purpose behind the development of these factors was to provide measures of total traffic loadings for use in pavement design, relatively little attention was paid to the quantifying the relative impacts of different truck characteristics on pavements. The development of improved load-equivalence factors should address the following issues:

- The relative impacts of single axles, tandem axles, and tridem axles;
- The effects of tire type, width, and pressure;
- The effects of different types of suspensions; and
- Axle weight.

The research should provide the following:

- The best possible set of load-equivalence factors based on available data;
- Some indication of the level of uncertainty associated with these factors; and

- Identification of new data collection activities that should be initiated.

In addition to better load-equivalence factors, research is needed to identify and assess the potential merit of alternative approaches to regulating tire pressure and other tire characteristics. For each approach identified, the investigation should

- Assess the feasibility and costs of enforcement;
- Estimate benefits in terms of reduced pavement costs;
- Estimate costs to the trucking industry of complying with the regulations; and
- Identify and estimate other potentially important benefits and costs.

Consideration should also be given to the development of performance specifications for truck suspension systems to reduce dynamic loading impacts on pavements.

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Appendix A

Questionnaire for Drivers on axle load management

Instructions

(a) Please answer all questions to the best of your knowledge.
(b) Where a YES or NO answer is required, please circle the correct response.
(c) Where an explanation is needed-please be informative

Respondent Information

(a) Full Name………
(b) Profession………
(c) Age……….
(d) Email address……………………………………………………………………………………………………
(e) Cell phone No……………………………………………………………………………………………………
(f) Organization…………………………………………………………………………………………………

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(A) Which stakeholder is responsible for effective axle load management;

i. Drivers
ii. Helpers
iii. Weighbridge operators
iv. Traffic police
v. ERA officials
vi. Others

If your response is (vi) please cite the stakeholder.

(B) Are you responsible for the axle load legislation of the country

(i) YES
(ii) NO
(iii) No answer

If your answer is (ii) or (iii), why?………
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(C) Are your comfortable with the existing road condition of the country and with the road network in use?

(i) Yes

(ii) No

(iii) No answer

If your answer is (ii) or (iii) please explain your reason

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D) How much is your salary (ETB)?

(i) 1000-3000
(ii) 3000-5000
(iii) 5000-7000
(iv) 7000-9000
(v) 11000-13000
(vi) 13000-15000
(vii) >15000

E) Are you satisfied with what you are earning?

(i) Yes

(ii) No

If your answer is (ii) how did you accommodate your needs?

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F) What do you think is your responsibility to the effective axle load management?

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G) Are you satisfied with the current axle load control mechanism of the country?

(i) Yes

(ii) No

If your answer for the above question is (ii) what is your reason?

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H) What would be your reaction if the government declared new penalty fee greater that the existing for those who overload to make the overloading fee one part of the maintenance expense? Would you agree and accept? if no why?

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I) have you ever been charged of overloading?

(i) Yes

(ii) No

J) What shall be done for the future to assist the effective axle load management?

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Appendix B

Questionnaire for Operator helpers on axle load management

Instructions

(a) Please answer all questions to the best of your knowledge.
(b) Where a YES or NO answer is required, please circle the correct response.
(c) Where an explanation is needed-please be informative

Respondent Information

(a) Full Name……
(b) Profession……
(c) Age……….
(d) Email address………
(e) Cell phone No………
(f) Organization……

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(A) Which stakeholder is responsible for effective axle load management;

(i) Drivers
(ii) Helpers
(iii) Weighbridge operators
(iv) Traffic police
(v) ERA officials
(vi) Others

If your response is (vi) please cite the stakeholder.

(B) Are you responsible for the axle load legislation of the country

(i) YES
(ii) NO
(iii) No answer

If your answer is (ii) or (iii), why?………
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(D) Are your comfortable with the existing road condition of the country and with the road network in use?

(i) Yes

(ii) No

(iii) No answer

If your answer is (ii) or (iii) please explain your reason

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D) How much is your salary (ETB)?

(i) 1000-3000
(ii) 3000-5000
(iii) 5000-7000
(iv) 7000-9000
(v) 11000-13000
(vi) 13000-15000
(vii) >15000

E) Are you satisfied with what you are earning?

(i) Yes

(ii) No

If your answer is (ii) how did you accommodate your needs?

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F) what do you think is your responsibility to the effective axle load management?

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G) Are you satisfied with the current axle load control mechanism of the country?

(i) Yes

(ii) No

If your answer for the above question is (ii) what is your reason?

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H) What would be your reaction if the government declared new penalty fee greater that the existing for those who overload to make the overloading fee one part of the maintenance expense? Would you agree and accept? if no why?

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I) have you ever been charged of overloading?

(i) Yes

(ii) No

J) What shall be done for the future to assist the effective axle load management?

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Appendix C

Questionnaire for Weighbridge operators on axle load management

Instructions

(a) Please answer all questions to the best of your knowledge.
(b) Where a YES or NO answer is required, please circle the correct response.
(c) Where an explanation is needed-please be informative

Respondent Information

(a) Full Name………
(b) Profession………
(c) Age……..
(d) Email address……
(e) Cell phone No……
(f) Organization………………………………………………………………………………………………………

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(A) Which stakeholder is responsible for effective axle load management;

(i) Drivers
(ii) Helpers
(iii) Weighbridge operators
(iv) Traffic police
(v) ERA officials
(vi) Others

If your response is (vi) please cite the stakeholder.

(B) Are you responsible for the axle load legislation of the country

(i) YES
(ii) NO
(iii) No answer

If your answer is (ii) or (iii), why?………
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(C) Are your comfortable with the existing road condition of the country and with the road network in use?

(i) Yes

(ii) No

(iii) No answer

If your answer is (ii) or (iii) please explain your reason

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D) How much is your salary (ETB)?

(i) 1000-3000
(ii) 3000-5000
(iii) 5000-7000
(iv) 7000-9000
(v) 11000-13000
(vi) 13000-15000
(vii) >15000

E) Are you satisfied with what you are earning?

(i) Yes

(ii) No

If your answer is (ii) how did you accommodate your needs?

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F) what do you think is your responsibility to the effective axle load management?

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G) Are you satisfied with the current axle load control mechanism of the country?

(i) Yes

(ii) No

If your answer for the above question is (ii) what is your reason?

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H) What would be your reaction if the government declared new penalty fee greater that the existing for those who overload to make the overloading fee one part of the maintenance expense? Would you agree and accept? if no why?

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I) What shall be done for the future to assist the effective axle load management?

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Appendix D

Questionnaire for Traffic police on axle load management

Instructions

(i) Please answer all questions to the best of your knowledge.
(ii) Where a YES or NO answer is required, please circle the correct response.
(iii) Where an explanation is needed-please be informative

Respondent Information

(i) Full Name……………………………………………………………………………………………………
(ii) Profession……………………………………………………………………………………………………
(iii) Age……
(iv) Email address………………………………………………………………………………………………
(v) Cell phone No………………………………………………………………………………………………
(vi) Organization……………………………………………………………………………………………

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A) Which stakeholder is responsible for effective axle load management;

(i) Drivers
(ii) Helpers
(iii) Weighbridge operators
(iv) Traffic police
(v) ERA officials
(vi) Others

If your response is (vi) please cite the stakeholder.

B) Are you responsible for the axle load legislation of the country

(i) YES
(ii) NO
(iii) No answer

If your answer is (ii) or (iii), why?……
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C) Are your comfortable with the existing road condition of the country and with the road network in use?

(i) Yes

(ii) No

(iii) No answer

If your answer is (ii) or (iii) please explain your reason

………
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………

D) How much is your salary (ETB)?

(i) 1000-3000
(ii) 3000-5000
(iii) 5000-7000
(iv) 7000-9000
(v) 11000-13000
(vi) 13000-15000
(vii) >15000

E) Are you satisfied with what you are earning?

(i) Yes

(ii) No

If your answer is (ii) how did you accommodate your needs?

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F) what do you think is your responsibility to the effective axle load management?

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G) Are you satisfied with the current axle load control mechanism of the country?

(i) Yes

(ii) No

If your answer for the above question is (ii) what is your reason?

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H) What would be your reaction if the government declared new penalty fee greater that the existing for those who overload to make the overloading fee one part of the maintenance expense? Would you agree and accept? if no why?

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I) What shall be done for the future to assist the effective axle load management?

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Appendix E

Questionnaire for ERA officials on axle load management

Instructions

(a) Please answer all questions to the best of your knowledge.
(b) Where a YES or NO answer is required, please circle the correct response.
(c) Where an explanation is needed-please be informative

Respondent Information

(a) Full Name……
(b) Profession……
(c) Age……..
(d) Email address………
(e) Cell phone No……
(f) Organization……

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A) Which stakeholder is responsible for effective axle load management;
   (i) Drivers
   (ii) Helpers
   (iii) Weighbridge operators
   (iv) Traffic police
   (v) ERA officials
   (vi) Others

If your response is (vi) please cite the stakeholder.

B) Are you responsible for the axle load legislation of the country
   (i) YES
   (ii) NO
   (iii) No answer

If your answer is (ii) or (iii), why?………
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C) Are your comfortable with the existing road condition of the country and with the road network in use?

(i) Yes

(ii) No

(iii) No answer

If your answer is (ii) or (iii) please explain your reason

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D) How much is your salary (ETB)?

(i) 1000-3000
(ii) 3000-5000
(iii) 5000-7000
(iv) 7000-9000
(v) 11000-13000
(vi) 13000-15000
(vii) >15000

E) Are you satisfied with what you are earning?

(i) Yes

(ii) No

If your answer is (ii) how did you accommodate your needs?

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F) what do you think is your responsibility to the effective axle load management?

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G) Are you satisfied with the current axle load control mechanism of the country?

(i) Yes

(ii) No

If your answer for the above question is (ii) what is your reason?

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H) What would be your reaction if the government declared new penalty fee greater that the existing for those who overload to make the overloading fee one part of the maintenance expense? Would you agree and accept? if no why?

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I) What shall be done for the future to assist the effective axle load management?

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