



## CHAPTER II

### LITERATURE REVIEW

This chapter discusses the current situation of road networks in Lao PDR and gives the literature review relating to mobile inspection processes' suitability evaluation criteria. Several different types of suitable criteria have been found in the literature, ranging from the simple mobile inspection level to complex level of service analysis.

#### 2.1 Road Inventory and Condition in Lao PDR

##### 2.1.1 Present Road Network

According to the World Bank and SIDA study (MCTPC, 2004) the total road network in Lao PDR is 13,100 kilometers, consisting of national, provincial, urban and local roads, excluding the special or mining roads. The road condition is generally poor only 19 percent of the total length is paved. In particular, firstly, the national road network is 3,390 kilometers long, of which the paved road are only 1,620 kilometers while the rest, linking from the major towns to the provincial capitals and connecting the neighboring countries, have gravel or earth surface. Secondly, the provincial road network is 5,440 kilometers in total length, but only 485 kilometers are paved while the remainders, comprising the provincial road network linking from the major towns to larger villages within the province, are mostly gravel or earth surfaced. Lastly, local roads network, including district road and urban road with the total length 4,270 kilometers, are mostly earth-surfaced and poor-conditioned. Figure 2.1 and Table 2.1 show total road network in Lao PDR.

Generally the national road and provincial road network, which provides connections to all important towns, provincial capitals and border crossings, is considered adequate; however, most of them are in poor condition and needs to be

upgraded. The deteriorated state of the road network involves many issues such as negligence in maintenance, protracted war, and the succeeding period of government reorganization, limited financial resource, and lack of road maintenance equipment. Moreover, most of the national and provincial road network were constructed in the 1930s and 1940s and were not designed for the heavy commercial vehicles of the types now in use, which results in high maintenance cost and thus delay in maintenance due to the tight finance budget.



Figure: 2.1. Road Network for National and Rural Development Projects in Lao PDR.

Source: [http://www.adb.org/Documents/Environment/LAO/lao\\_roads\\_rural\\_dev.pdf](http://www.adb.org/Documents/Environment/LAO/lao_roads_rural_dev.pdf)

**Table 2.1 Lao PDR Road Network**

Road type	Road Surface						All surfaces	
	Paved		Gravel		Earth			
	Km	%	Km	%	Km	%	Km	%
<b>National</b>	3,771	53	2,244	31	1,126	16	7,141	23
<b>Provincial</b>	198	3	3,038	47	3,249	50	6,485	21
<b>District</b>	31	0.8	1,826	47	2,008	52	3,865	12
<b>Rural</b>	14	0.1	1,815	16	9,527	84	11,356	36
<b>Urban</b>	429	24	871	49	465	26	1,765	6
<b>Special</b>	54	9	304	50	249	41	607	2
<b>Total</b>	4,497	14	10,098	32	16,624	53	31,219	100

**Source:** Department of Roads Summary of Road Statistics, 2003, MCTPC

According to the Road Law, the roads are classified into six categories: national, provincial, district, urban, rural and special. The majority of the roads are national roads (24%), provincial roads (35%) and local roads (38%). These national and provincial roads has a generally low level of traffic through Lao PDR

### 2.1.2 Maintenance and Improvement Activities

The Road Law has formally defined road categories based on their functions. Table 2.2 categorizes the road types based on their purposes, specific for the roads serving, economic or national defense and security purpose. For administration and management purposes, a distinction is made between the National Road Network (NRN), consisting of National roads, and the Local Road Network (LRN), consisting of the provincial. District and rural roads are grouped together. Ministry of Communication, Transportation, Post and Construction (MCTPC) have responsibility of managing National roads on behalf of Lao PDR Government, while Local roads are the responsibility of provinces, such as a recent study (MCTPC, 2004).

**Table 2.2 Road Categories in Lao PDR**

<b>Road Category</b>	<b>Brief Description</b>
National Roads	Connecting the capital to the provincial and special and special zone capitals and to international borders and other major roads of strategic significance for national defense and security

Provincial Roads	Linking provinces to the national capital and to other provinces and provincial capitals to district centers and other important locations within the province
District Roads	Connecting district to districts and district centers to villages and other Important locations within the district
Rural Roads	Connecting villages to other villages and to production and service centers serving the village

**Source:** Road Law, No 04/99/NA, 3rd April 1999.

In addition, the maintenance activities are typically divided into three distinct categories according to the range of activities. These aim at retaining roads in a condition to fulfill their function, timing and nature of work, routine maintenance, periodic maintenance and emergency maintenance. Table 2.3 depicts the distinction between maintenance activities to preserve the road asset and rehabilitation and improvement activities.

**Table 2.3** Types of Road Maintenance and Improvement

<b>Maintenance Activities</b>	
<b>Routine maintenance</b>	Operations such as vegetation control, shoulder rebuilding, drainage and pothole repair required to be carried out one or more times per year on section of road. These operations are typically simple and on a small scale, but are widely dispersed. They usually require unskilled or semi-skilled labor which can be estimated and planned for on a regular basis.
<b>Periodic maintenance</b>	Operations such as resurfacing required after a number of years. These operations are normally large-scaled and require specialist equipment, skilled resources and materials (e.g. gravel) to implement, and usually necessitate the temporary deployment of resources on one road section at a time. These operations are costly and require specific identification and planning for implementation, and may require design.
<b>Emergency maintenance</b>	Emergency operations to repair road sections, culverts and bridges damaged by natural calamities - floods, storms, earthquakes or traffic accidents.
<b>Improvement Activities</b>	
<b>Rehabilitation</b>	Operations to restore the original standard of a road, typically when maintenance has been neglected for many years.
<b>Improvement or Upgrading</b>	Improvement in the original standard of an existing road or track, for example application of a gravel wearing course and construction of culverts but not total reconstruction.

<b>Spot improvement</b>	Rehabilitation or improvement of short deteriorated sections of roads which are otherwise in an acceptable condition. This can be effective on roads with low traffic volumes.
<b>Reconstruction and new construction</b>	Reconstruction is a major improvement of the original standard of an existing road, almost equivalent to new construction. New construction is a completely new road.

**Source:** Ministry of Communication, Transport, Post and Construction (MCTPC).

## 2.2 Mobile Inspection System

Early research works on roadway inventory data collection in the remote location have mostly concentrated on improving the efficiency, timeliness and accuracy of the inspection process, supporting the portability of information collected at remote field location. Utilization of mobile handheld inspection was conducted in many agencies. One of them is the of City of Kerrville Public Works, Department of Engineering Division (City of Kerrvill., TX, 2002). Another is the application of handheld personal computer (Compaq iPAQ400 MHz PC with 64 MB on board memory) for street inventory running on ArcPad 6.0 software (Kimberly M.R. 2004). The other created paperless form that user will fill out using dropdown menus for each field of data in ArcPad Application Builder (Asphalt Institute Executive office and Research Center).

In addition, in 1999, the Geological Survey of Western Australian started the inventory of the abandoned mine sites for the state by using the field equipments. One of them was the Differential Global Positioning System (DGPS) connected to a Cassiopeia hand-held personal computer, which had been selected for data capture. In 2004, the Engineering Department in Martin County, Florida, applied the mobile handheld field inspection to expand the initial single inventory database (Strickland, Colin, Forbes, and Michael, 2004). Utilizing mobile handheld computers, ArcPad 6.0.2 and ArcPad Studio 6.0.1 with Trimble's GeoXT GPS receiver, this application clearly illustrated how the use of ArcPad, GPS and mobile technology can be customized for asset management project or other project that requires field data

collection activities and GIS integration (Kimberly Maynard Roden and Fleming, 2001).

Three distinctive types of mobile inspection's suitability criteria were found in the literature review (Jonson B. 1998):

- *Fundamental techniques of mobile inspection:* simple evaluation criteria base on using ArcPad application to create a shapefile, layer, Edit form for input and edit attributes data.
- *Roadway inventory and condition index/suitability-base:* The variables most common to all criteria were static factors, predictive factors, and dynamic factors such as: road geometry, street and road network, location, pavement, road type classifications, including road surface condition, road construction and maintenance.
- *Road inventory system configuration:* the component of roadway inventory system consists of handheld computer inspection which handles the communication between the users and other data bases, the input or output interface, as well as the database management system of both the road network and attributes data base.

The majority of suitability criteria in the literature review were to evaluate the roadway by using mobile inspection at remote field location. In addition, many criteria contain input variables that require additional data beyond the ones that commonly found in the transportation database. This research study concentrates on improving the performance of mobile inspection data collection for road inventory system in Lao PDR by applying specifications of national road characteristics related to the road management system based on Ministry of Communication Transportation Post and Construction (MCTPC) in Lao PDR.