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Socio-Technical Transition in the Commercial Road Transport Sector: The Case of Motorcycle-Tricycle Transition in Maiduguri Metropolis

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Abstract: Socio-technical transition is a gradual but continuous process of a holistic shift in the social and technical components of a regime. Socio-technical transitions have defined pathways along which transition processes occur. This paper offers a descriptive analysis of the transition process that occurred in the commercial road transport sector in Maiduguri city, the capital of Borno state, Nigeria. The motorcycle mode of passenger transport used to be the dominant means of local travels since year 2000 up till 2011, when the machine was finally banned by the government for security reasons. At the same period, the tricycle technology was fully developed in niches and subsequently grew to occupy the space created by the absence of the motorcycle and eventually became the dominant vehicle in the mass transport regime. The transition dynamics involved was analysed using socio-technical transition pathway theory (the multi-level perspective) and a wide range of data on historical population of commercial passenger transport vehicles in Maiduguri, collected from field survey study. It was found that the motorcycle-tricycle transition pathway involved a complete de-alignment of the regime in the absence of a significant re-alignment dynamics. Thus, the technological change was a radical one whose pathway involved partial characteristics of de-alignment/re-alignment scenario.

Keywords: Multi-level Perspective, Road Vehicles, Security Issues, Transition Pathways

1. Introduction

Transitions are a result of the interplay of multi-level developments in different domains; this implies that they are multi-dimensional with different dynamic layers. For a transition to occur, several developments must come together in different domains. This causes a path of development based on new practices, knowledge, social organisation and different guiding principles. It is can be described as a set of connected changes, which reinforce each other but take place in several different areas, such as technology, the economy, institutions, behavior, culture, ecology and belief systems. They emerge over time as fundamental change of large-scale socio-technical systems. The goals of a transition are chosen by society and/or governments. Although government policy can influence the direction, scale and speed of development paths, it will never assume entire control over them [1-3].

This paper attempts to describe the emergence of the tricycle transport infrastructure in the commercial transport system for the movement of people (and light goods) in Maiduguri metropolis. The transition started in 2011 as a result of the high level of insecurity prevalent in the city during that period. It was a rapid transition which resulted from a regulation by the government of placing a ban on the use of motorbikes for commercial transport in Maiduguri, triggered by the high insecurity level [4]. Before the year 2011, the tricycle infrastructure was used in a number of technological niches due to the entrenchment of the motorcycle transport technology in the regime. Currently, the high traffic density of the tricycle used in the transport industry is obviously evident

on Maiduguri roads. A close observation of the transition scenario will reveal that the pathway followed seemed to involve part of de-alignment/re-alignment pathway.

The aims of the paper are therefore:

1. To use the concept of the sociotechnical transition theory; multi-level perspective and transition pathways to describe the emergence and adoption of the tricycle mode of commercial transport in Maiduguri city.
2. To identify the transition scenario involved in the transition process and to find the best way to describe the pathway for further researches.

The paper uses quantitative (primary) data to estimate the historical population of vehicles in the commercial transport sector in Maiduguri to identify the dominant technology (means of transport) in the regime at any given time. The data were collected from records and by direct interviews of the relevant vehicle operators who have enough knowledge and experience on the historical quantity of vehicles in their areas. Statistical methods were used to analyse the data and determine the most reliable results which are ultimately used for examining the transition process. The paper is structured into five sections. Section 1 provides introduction about the meaning of socio-technical transitions, transition pathways and introduces the research questions of the paper. Section 2 deals with the literature on system transitions pathways, elaborating the scenarios of the four main transition pathways. Section 3 dwells on the approach to the research, section 4 provides extensive discussion on the results obtained while 5 focused on conclusion and outlook of the research.

2. Transition Pathways

Transitions are long-term transformation processes in which society changes in a fundamental way over decades or generations [5]. They are a result of a co-evolution of technological, institutional, cultural, ecological and economic developments on various scale levels [6]. The emergence of transitions has been conceptualised in several approaches which include the multi-level perspective (MLP), which distinguishes three analytical and heuristic levels, namely, the socio-technical regime, the socio-technical landscape and niche levels.

The socio-technical landscape is the upper most level on the MLP framework. The landscape comprises a heterogonous set of contextual factors (such as technical and material that sustains society, but also includes soft factors of economic conditions, political ideologies and societal trends) at the macro level. It forms an exogenous environment and a broader context in which regimes and niches are situated which is beyond the direct influence of niche and regime actors, has a deep structuring influence on niches and regimes as well as their interaction but itself cannot be changed directly by actors. Changes at the landscape level usually take place slowly (usually decades) and are the key philosophy behind policy making [7-11].

The next level on the MLP framework is the socio-technical regime forming the meso-level [12]. A regime represents the dominant way (established practices and associated rules) by which a particular societal function is delivered [13, 14]. Socio-technical regime consists of "a set of technologies embedded in a social, political and institutional context with its associated regime-specific set of rules, procedures, habits and practices" [11]. The lowest level on the multi-level perspective is the technological niche which forms the micro-level where fundamental innovations exist. It is a system level that exists below the regime and forms the locus where novelties emerge [15].

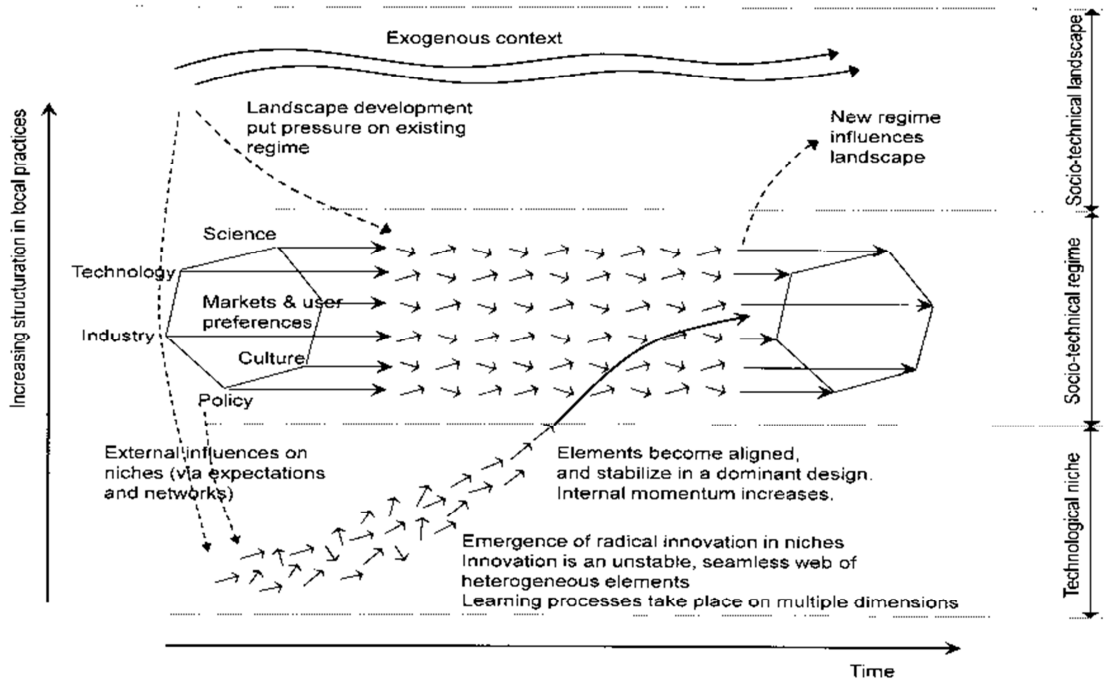

Figure 1. *The multi-level perspective framework of system transition [9].*

Figure 1 below shows an ideal-typical representation of how the three levels interact dynamically in the process of socio-technical transitions. Generally, transitions result from the interaction between processes at these levels thus: (a) niche-innovations build up internal momentum, (b) changes at the landscape level create pressure on the regime, and (c) destabilisation of the regime creates windows of opportunity for niche innovations [9]. Similarly, transition pathways result from interaction of dynamics among two or more of the three distinct levels on the MLP as shown on Figure 1 below. [9, 7] Suggested different typologies based on the levels of the landscape pressure and maturity of niche innovations, and the timing of landscape pressure action with respect to maturity level of niche innovations. The regime is the main level where transitions occur while the landscape and niche are considered as derived concepts [8]. The four transition pathways are discussed as follows.

2.1. Transformation Pathway

Transformation occurs as a result of interactions between the regime and the landscape without a substantial involvement of the niche level. The regime experiences a moderate landscape pressure at a time when niche innovations are not sufficiently developed. These pressures are usually translated by societal pressure groups and social movements. In response to the pressure, regime actors modify the direction of development paths and innovation activities by using the innovations as add-ons to solve local problem. These modifications occur without changing the basic architecture of the existing regime. In this pathway, regime actors survive as new regimes emerge from the old regime through cumulative adjustments and gradual trajectory realignments. The new regime emerges out of the old one through cumulative adjustments and reorientations. In this pathway, government intervention can be used to focus and encourage the pace of change [11, 16, 17].

2.2. Reconfiguration Pathway

This pathway is a result of interactions among all the three levels and occurs when a system changes through cumulative component changes and new combinations through the adoption of niche-innovations. Reconfiguration take place when innovations developed in niches trigger further adjustments at the regime level [16]. This pathway involves the replacement of a set of interlocking technologies by an alternative array of inter-related technologies which fulfill the same, or similar, functions. The alignments of alternative interlocking technologies in response to huge and continually emerging landscape pressure result in new regime architecture and broader changes in the system. The reconfiguration pathway can best be described under the context of a distributed socio-technical system with multiple interrelated technologies such as agriculture, hospital, etc. [9, 11, 18-20].

2.3. Substitution Pathway

Substitution occurs as a result of interactions among all the three levels on the MLP. The regime experiences enormous pressure from the landscape at a time when a niche innovation is fully matured and is ready to break through. Before this pressure, the innovation remains stuck in the niche because the regime is strongly entrenched, unwilling to give up to an alternative technology. But with the development of the intense pressure on the regime, windows of opportunity for the new technology are created, allowing it to compete favourably with the incumbent dominant technology. The niche innovation will break through and ultimately replace the existing regime. Therefore this pathway has a 'technology push' character whereby the existing dominant regime is gradually displaced by the emerging niche technology, resulting to radical transformation of the incumbent regime. Technological substitution is a direct replacement of one dominant technology within the socio-technical regime by another [11, 20].

2.4. De-alignment/De-alignment Pathway

De-alignment/de-alignment occurs through the interplay among all the three levels on the MLP. It is characterised by a divergent, sudden and huge disruptive landscape pressure on a regime at a time when a number of immature niche innovations exist. The pressure is so enormous to cause regime destabilisation, and subsequent erosion or de-alignment of existing regimes because actors lose faith in the usual incremental solutions. This creates space for competition between the dominant technology within the regime and a number of other competing options which have different performance characteristics. This leads to uncertainties in choice and adoption, causing the exploration of different possible trajectories. In this pathway, there is no clear substitute for the eroded regime and this leaves space for the emergence and co-existence of multiple innovations that compete for attention and resources. This is eventually resolved through the emergence of one niche-innovation (after a prolonged period of competition) which becomes dominant, forming the core for re-alignment of a new regime and re-institutionalisation. This pathway is characterised by a long period of experimentation, co-existence, competition and learning before the new regime emerges. The pathway results to a major restructuring of the system in terms of new guiding principles, beliefs and practices [11, 18, 19, 21, 22].

3. Methodology and Data

Data on various important parameters were collected using questionnaires at different locations and from different vehicle users in Maiduguri. The information collected include the number of commercial passenger vehicles used in the transport sector (i.e. buses, taxis, motorcycles and tricycles) at selected years between the period 2000-2017 and the percentage of each in relation to their total is determined.

To ensure a more accurate data that can have a true representation of historical changes in the number of the commercial vehicles, five critical motor parks were visited and data were collected from 22 respondents from each park. Each respondent was asked about the historical changes (2000-2017) in the number of all the vehicles. Therefore, a total of 132 results were collected for each category of the vehicles, among the five different data collection points in Maiduguri. To ensure a more reliable data, the respondents were chosen to include only those individuals have been are fully engaged in the business of commercial transport system right from the year 2000. The data obtained from field survey from the various parks in Maiduguri city are grouped in Table 1 below.

Table 1. *Field survey data on number of commercial-passenger vehicles and frequency of respondents.*

Park	Vehicle type	2000		2005		2011		2013		2015		2017	
		Range	Frq	Range	Frq	Range	Frq	Range	Frq	Range	Frq	Range	Frq
Unimaid	Tricycle	0-50	0	400-450	4	10000-12500	1	20000-22500	4	25000-27500	12	20000-30000	1
		51-100	8	451-500	4	12501-15000	7	22501-25000	13	27501-30000	8	30001-40000	0
		101-150	13	501-550	12	15001-17500	10	25001-27500	4	30001-32500	1	40001-50000	19
		151-200	1	551-600	2	17501-20000	4	27501-30000	1	32501-35000	1	50001-60000	2
	Taxi	500-1000	2	1000-2000	6	1000-1500	10	1000-1500	3	500-1000	7	1000-1500	5
		1001-1500	16	2001-3000	7	1501-2000	2	1501-2000	10	1001-1500	15	1501-2000	15
		1501-2000	4	3001-4000	9	2001-2500	8	2001-2500	6	1500-2000	0	2001-2500	1
		2001-2500	0	4001-5000	0	2501-3000	2	2501-3000	3	2001-2500	0	2501-3000	1
	Bus	1000-1250	4	0-500	1	1000-1250	3	1000-1250	5	1000-1250	4	0-1000	2
		1251-1500	11	501-1000	0	1251-1500	11	1251-1500	13	1251-1500	8	1001-2000	9
		1501-1750	2	1001-1500	21	1501-1750	6	1501-1750	3	1501-1750	8	2001-2500	9
		1751-3500	4	1501-2000	0	1751-2000	2	1751-2000	1	1751-2000	2	2501-3000	2
	Motor-cycle	500-2000	12	500-2000	4	500-2000	18	-	-	-	-	-	-
		2001-3000	1	2001-4000	2	2001-4000	0	-	-	-	-	-	-
		3001-4000	1	4001-6000	2	4001-6000	1	-	-	-	-	-	-
		4001-5000	8	6001-8000	14	6001-8000	3	-	-	-	-	-	-
Muna	Tricycle	0-1000	4	1000-2000	1	1000-20000	7	10000-30000	3	30000-40000	5	20000-40000	5
		1001-2000	11	2001-3000	8	20001-30000	0	30001-40000	10	40001-50000	3	40001-50000	10
		2001-3000	7	3001-4000	12	30001-40000	14	40001-50000	7	50001-60000	14	50001-60000	5
		3001-4000	0	4001-5000	1	40001-50000	1	50001-60000	2	60001-70000	0	60001-70000	2
	Taxi	2000-4000	7	2000-3000	9	1000-1250	2	0-2000	2	0-2000	11	1000-2000	7
		4001-5000	8	3001-4000	9	1251-1500	9	2001-4000	14	2001-4000	8	2001-3000	4
		5001-6000	4	4001-5000	3	1501-1750	6	4001-6000	5	4001-6000	2	3001-4000	3
		6001-7000	3	5001-6000	1	1751-2000	5	6001-8000	1	6001-8000	1	4001-5000	8
	Bus	0-5000	6	0-5000	2	0-5000	3	0-5000	1	0-10000	3	0-10000	10
		5001-10000	10	5001-10000	9	5001-10000	15	5001-10000	12	10001-20000	17	10001-20000	11
		10001-15000	4	10001-15000	10	10001-15000	4	10001-15000	9	20001-30000	2	20001-30000	1
		15001-25000	2	15001-20000	1	15001-20000	0	15001-20000	0	30001-40000	0	30001-40000	0
	Motor-cycle	0-20000	9	0-20000	11	0-10000	2	-	-	-	-	-	-
		20001-30000	4	20001-30000	4	10001-20000	10	-	-	-	-	-	-
		30001-40000	7	30001-40000	5	20001-30000	4	-	-	-	-	-	-
		40001-50000	2	40001-50000	2	30001-40000	6	-	-	-	-	-	-

Park	Veh type	2000		2005		2011		2013		2015		2017	
		Range	Frq	Range	Frq	Range	Frq	Range	Frq	Range	Frq	Range	Frq
Baga	Tricy-cle	0	22	0	22	0-1000	10	0-5000	14	10000-20000	15	10000-20000	3
		-	-	-	-	1001-2000	9	5001-10000	5	20001-30000	5	20001-30000	13
		-	-	-	-	2001-3000	3	10001-15000	3	30001-40000	2	30001-40000	3
		-	-	-	-	3001-4000	0	15001-20000	0	40001-50000	0	40001-50000	3
	Taxi	0-2000	7	1000-2000	9	1000-2000	14	1000-2000	16	0-1000	13	0-1000	12
		2001-4000	9	2001-3000	8	2001-3000	5	2001-3000	4	1001-2000	8	1001-2000	9
		4001-6000	6	3001-4000	4	3001-4000	2	3001-4000	2	2001-3000	1	2001-3000	1
		6001-8000	0	4001-5000	1	4001-5000	1	4001-5000	0	3001-4000	0	3001-4000	0
	Bus	1001-2000	6	0-1000	3	0-1000	15	0-100	4	0-100	7	50-100	12
		2001-3000	4	1001-2000	10	1001-2000	3	101-200	13	101-200	12	101-150	0
		3001-4000	7	2001-3000	5	2001-3000	4	201-300	5	201-300	3	151-200	9
		4001-5000	5	3001-4000	4	3001-4000	0	301-400	0	301-400	0	201-250	1
	Motor-cycle	0-5000	6	0-10000	14	0-10000	10	-	-	-	-	-	-
		5001-10000	8	10001-20000	3	10001-20000	3	-	-	-	-	-	-
		10001-15000	8	20001-30000	2	20001-30000	6	-	-	-	-	-	-
		15001-20000	0	30001-50000	3	30001-50000	3	-	-	-	-	-	-
Bulum kutu	Tricy-cle	10-20	15	0-10	3	0-250	3	0-5000	0	0-10000	1	20000-30000	7
		21-30	3	11-20	7	251-500	8	5001-10000	7	10001-20000	12	30001-40000	5
		31-40	3	21-30	9	501-750	8	10001-15000	12	20001-30000	8	40001-50000	6
		41-50	1	31-50	3	751-1000	3	15001-20000	3	30001-40000	1	50001-60000	4

Park	Veh type	2000		2005		2011		2013		2015		2017	
		Range	Frq	Range	Frq	Range	Frq	Range	Frq	Range	Frq	Range	Frq
	Taxi	0-10000	4	0-5000	6	0-2500	1	0-2500	5	0-5000	9	0-2500	0
		10001-20000	16	5001-10000	3	2501-5000	19	2501-5000	9	5001-10000	5	2501-5000	6
		20001-30000	2	10001-15000	13	5001-7500	2	5001-7500	7	10001-15000	8	5001-7500	15
		30001-40000	0	15001-20000	0	7501-10000	0	7501-10000	1	15001-20000	0	7501-10000	2
	Bus	0-2500	0	0-2500	0	0-10000	2	0-5000	2	0-5000	0	0-10000	10
		2501-5000	11	2501-5000	12	10001-20000	6	5001-10000	14	5001-10000	3	10001-20000	11
		5001-7500	10	5001-7500	10	20001-30000	8	10001-15000	6	10001-15000	18	20001-30000	1
		7501-10000	1	7501-10000	0	30001-40000	6	15001-20000	0	15001-20000	1	30001-40000	0
	Motor-cycle	5000-10000	1	10000-12500	9	0-5000	1	-	-	-	-	-	-
		10001-15000	13	12501-15000	10	5001-10000	3	-	-	-	-	-	-
		15001-20000	7	15001-17500	3	10001-15000	12	-	-	-	-	-	-
		20001-25000	1	17501-20000	0	15001-20000	6	-	-	-	-	-	-

Park	Veh type	2000		2005		2011		2013		2015		2017	
		Range	Frq	Range	Frq	Range	Frq	Range	Frq	Range	Frq	Range	Frq
Molai	Tricycle	0	22	0	22	0-100	9	0-10000	2	0-20000	6	0-10000	8
		-	-	-	-	101-200	9	10001-20000	7	20001-40000	10	10001-20000	4
		-	-	-	-	201-300	2	20001-30000	8	40001-60000	4	20001-30000	7
		-	-	-	-	301-500	2	30001-50000	5	60001-80000	2	30001-40000	3
	Taxi	0-2500	0	0-2500	1	1000-2000	1	0-1000	1	0-1000	2	0-1000	5
		2501-5000	10	2501-5000	17	2001-3000	6	1001-2000	17	1001-2000	15	1001-2000	15
		5001-7500	8	5001-7500	3	3001-4000	7	2001-3000	4	2001-3000	5	2001-3000	2
		7501-10000	4	7501-10000	1	4001-5000	8	3001-4000	0	3001-4000	0	3001-4000	0
	Bus	0-2500	4	0-2000	1	0-2000	10	0-1000	10	50-100	3	50-100	11
		2501-5000	5	2001-4000	5	2001-4000	7	1001-2000	7	101-150	5	101-150	7
		5001-7500	7	4001-6000	15	4001-6000	5	2001-3000	5	151-200	11	151-200	3
		7501-12000	6	6001-8000	1	6001-8000	0	3001-4000	0	201-250	3	201-250	1
	Motor-cycle	20000-30000	8	20000-30000	8	20000-30000	7	-	-	-	-	-	-
		30001-40000	6	30001-40000	5	30001-40000	9	-	-	-	-	-	-
		40001-50000	8	40001-50000	8	40001-50000	5	-	-	-	-	-	-
		50001-60000	0	50001-80000	1	50001-60000	1	-	-	-	-	-	-
Post office	Tricycle	0	22	0	22	0-2500	20	10000-15000	16	0-20000	0	0-20000	2
		-	-	-	-	2501-5000	1	15001-20000	4	20001-40000	15	20001-40000	13
		-	-	-	-	5001-7500	0	20001-25000	1	40001-60000	5	40001-60000	6
		-	-	-	-	7501-10000	1	25001-30000	1	60001-80000	2	60001-80000	1
	Taxi	0-5000	4	0-5000	8	0-2500	5	0-1000	11	0-200	1	100-200	5
		5001-10000	17	5001-10000	12	2501-5000	13	1001-2000	6	201-400	8	201-300	5
		10001-15000	1	10001-15000	0	5001-7500	2	2001-3000	3	401-600	9	301-400	6
		15001-20000	0	15001-50000	2	7501-10000	2	3001-4000	2	601-800	4	401-500	6
	Bus	5000-7500	4	0-2500	1	0-1000	9	0-250	10	100-200	12	100-150	13
		7501-10000	15	2501-5000	17	1001-2000	7	251-500	8	201-300	5	151-200	7
		10001-12500	2	5001-7500	1	2001-3000	4	501-750	3	301-400	1	201-250	0
		12501-15000	1	7501-10000	3	3001-4000	2	751-1000	1	401-500	4	251-300	2
	Motor-cycle	0-20000	4	0-20000	2	0-20000	2	-	-	-	-	-	-
		20001-30000	6	20001-40000	10	20001-40000	13	-	-	-	-	-	-
		30001-40000	4	40001-60000	9	40001-60000	7	-	-	-	-	-	-
		40001-50000	8	60001-80000	1	60001-80000	0	-	-	-	-	-	-

Under each vehicle type in the grouped data above, each year has four ranges with different frequencies. The range with the highest frequency (shown in bold) is chosen for each particular year and the midpoint determined. The procedure is repeated for all vehicle types in each park and the result in summarised in Table 2 below.

Table 2. *Summary of survey data presenting the mean of ranges with the highest frequencies.*

Veh	Park	2000		2005		2011		2013		2015		2017	
		Range mid-point	Frq	Range mid-point	Frq	Range mid-point	Frq	Range mid-point	Frq	Range mid-point	Frq	Range mid-point	Frq
Tricycle	Unimaid	125	13	525	12	16250	10	23750	13	26250	12	45000	19
	Muna	1500	11	3500	12	35000	14	35000	10	55000	14	45000	10
	Baga	0	22	0	22	500	10	2500	14	15000	15	25000	13
	Bulumkutu	15	15	25	9	500	16	12500	12	15000	12	25000	7
	Molai	0	22	0	22	100	18	25000	8	30000	10	5000	8
	Post office	0	22	0	22	1250	20	12500	16	30000	15	30000	13
	Mean	175		490		7,867		17,038		28,718		31,929	
Taxi	Unimaid	1250	16	3500	9	1250	10	1750	10	1250	15	1750	15

Veh	Park	2000		2005		2011		2013		2015		2017	
		Range mid-point	Frq	Range mid-point	Frq	Range mid-point	Frq	Range mid-point	Frq	Range mid-point	Frq	Range mid-point	Frq
	Muna	4500	8	30000	18	1375	9	3000	14	1000	11	4500	8
	Baga	3000	9	1500	9	1500	14	1500	16	500	13	500	12
	Bulumkutu	15000	16	12500	13	3750	19	3750	9	2500	9	6250	15
	Molai	3750	10	3750	17	4500	8	1500	17	1500	15	1500	15
	Post office	7500	17	7500	12	3750	13	500	11	500	9	400	12
	Mean	6,421		11,555		2,765		1,925		1,191		2,458	
	Unimaid	1375	11	1250	21	1375	11	1375	13	1500	16	2000	18
	Muna	7500	10	12500	10	7500	15	7500	12	15000	17	15000	11
	Baga	3500	7	1500	10	500	15	150	13	150	12	75	12
Bus	Bulumkutu	3750	11	3750	12	25000	8	7500	14	12500	18	15000	11
	Molai	6250	7	5000	15	1000	10	500	10	175	11	75	11
	Post office	8750	15	3750	17	500	9	125	10	150	12	125	13
	Mean	5,424		4,118		5,142		3,071		5,925		4,860	
	Unimaid	1250	12	7000	14	1250	18	-	-	-	-	-	-
	Muna	10000	9	10000	11	15000	10	-	-	-	-	-	-
	Baga	10000	16	5000	14	5000	10	-	-	-	-	-	-
Motorcycle	Bulumkutu	12500	13	13750	10	12500	12	-	-	-	-	-	-
	Molai	35000	16	35000	16	35000	9	-	-	-	-	-	-
	Post office	45000	8	30000	10	30000	13	-	-	-	-	-	-
	Mean	18,210		17,007		14,965		0		0		0	
Total vehicles		30230		33170		30739		22,034		35834		39247	
Percents	Tricycle	0.58		1.48		25.59		77.33		80.14		81.35	
	Taxi	21.24		34.84		9.00		8.74		3.32		6.26	
	Bus	17.94		12.41		16.73		13.94		16.53		12.38	
	Motorcycle	60.24		51.27		48.68		0.00		0.00		0.00	

For each year, the midpoints of the ranges with their frequencies are used to evaluate the mean values of vehicle population for that year. These mean values are added up for each year to obtain the total commercial vehicles population for that year. The annual percentage for each vehicle type is then calculated to determine the relative historical changes in their numbers.

To check the reliability of the data, manual counts were done at five important road junctions in the city to estimate the actual existing percentages of each of the three categories of the transport vehicles (tricycles, buses and taxis) in relation to their total in Maiduguri. This is compared to same (current) year's results obtained through field survey to identify the level of mismatch that is likely to occur. The idea is to reveal how accurate and reliable the other results for the previous years (obtained through survey studies only) could be and the extent of their acceptability. In case of insignificant disparities in the two current year's results, i.e. figures from manual counts and those from interviews, then other results are deemed fairly accurate and shall be adopted. Otherwise interviews are conducted again and again until acceptable results are obtained.

Table 3. *Data on proportion of current commercial passenger vehicles in Maiduguri.*

Data collection point	Roads	Road side	Tricycle	Taxi	Bus
Lagos street-Bama road junction	First road	1st side	150	2	18
		2nd side	150	21	16
	Second road	1st side	150	14	18
		2nd side	150	30	34
	Third road	1st side	150	8	2
		2nd side	150	4	14
Custom roundabout	First road	1st side	150	8	3
		2nd side	150	12	16
	Second road	1st side	150	20	18
		2nd side	150	7	12
	Third road	1st side	150	22	11
		2nd side	150	1	27
Fire service roundabout	First road	1st side	150	24	13
		2nd side	150	8	14
	Second road	1st side	150	3	31
		2nd side	150	7	19
	Third road	1st side	150	2	17
		2nd side	150	9	13
	Fourth road	1st side	150	1	8
		2nd side	150	6	18
West end roundabout	First road	1st side	150	20	18
		2nd side	150	3	29

Data collection point	Roads	Road side	Tricycle	Taxi	Bus
Bolori roundabout	Second road	1st side	150	27	14
		2nd side	150	12	32
	Third road	1st side	150	9	19
		2nd side	150	3	10
	Fourth road	1st side	150	5	16
		2nd side	150	6	14
	First road	1st side	150	3	25
		2nd side	150	3	17
	Second road	1st side	150	2	19
		2nd side	150	8	8
	Third road	1st side	150	27	16
		2nd side	150	11	14
	Fourth road	1st side	150	6	7
		2nd side	150	8	15
Total			5400	362	595
Percentages			84.95	5.7	9.36

It can be seen that the 2017 percentages for tricycle, taxi and bus are 81.35%, 6.26% and 12.38% from the field survey while 84.95%, 5.7% and 9.36% from real counts. The results are similar and hence the field work data is considered valid for use. Graphic figures will be used for the analysis. Graphs of historical percentages of the categories of the commercial transport vehicles in relation to their total are plotted against time in years (from 2000 till 2017). The graph will reveal which commercial vehicle was dominant in the sector at any time over the given period. The motorcycle-tricycle transition will be analysed using the concept of socio-technical transition pathways developed by Geels [23], to identify which pathway (s) is/are involved in the transition process. Based on this, conclusion shall be drawn and viewpoints put forward.

4. Results and Discussion

Around the year 2010, the motorcycle mode of commercial transport was the dominant in the city of Maiduguri. During the same time, the tricycle transport mode was (the only) fully developed technology and was already active in small niches like the city university and other high institutions of learning, charter transport systems, etc. The tricycle was obviously more profitable to the riders than the motorcycle due to the higher number of passengers carried than the motorcycle. The tricycle also has lower risk of accident than motorcycles because of its better gravitational balance and stability. In addition, it has better privacy due to an overhead roof, rear cover and partial side covers. The roof and the covers provide shade that protects its passengers from the heat of the sun (which is very common in semi-arid regions like Maiduguri). And also in addition to the front glass, these covers provide reasonable protection in cases of dusty winds/rains. Despite these obviously numerous advantages, the tricycle could not break through the socio-technical regime because the commercial motorcycle mode was well entrenched in the regime. This is the result of stabilizing mechanisms of sunk investment, rules and vested interest, creating a lock-in.

From 2010, the Boko Haram insurgents in their plan of taking vengeance against the Nigerian security forces, largely caused by the anger of the 2009 execution of their leader and their subsequent defeat, used the motorcycle machines to launch attacks on security personnel, while rushing into the traffic crowd to use other innocent riders to take shelter. The deadly attack by the insurgents became very rampant around 2010-2011 due to the key advantages the insurgents enjoyed from motorcycles. The motorcycle is very fast in speed and can maneuver its ways between and out of vehicle congestion successfully. A significant number of security men lost their lives in this process in addition to those that were seriously injured on almost daily basis. This created a very high landscape pressure for a shift from this mode of commercial transport into other better security friendly alternatives. The intense landscape pressure (avalanche effect) created by the serious insecurity situation led to the formulation of a regulation by the government that banned the use of motorbikes in the city [4]. This led to a complete de-alignment of the dominant motorcycle commercial transport regime. This event gave way to other preexisting modes of passenger transport system in the regime, namely buses and taxis, in addition to the tricycle machine existing in niches.

A number of other features associated with the tricycle mode of transport system made it a good alternative worthy of consideration both by the government and the society after the motorcycle regime. The tricycle has a relatively low speed compared to the motorcycle and requires larger spaces between vehicles' congestions to escape. These features significantly reduced the success of attacks on security outfits by the insurgents and that made it more security friendly than the motorcycle. The tricycle also had a high suitability of transportation. It has a relatively wide view and free ventilation from the sides compared to bus and taxi and the absence of doors eliminates the task of open/close while embarking and disembarking the machine. Its smaller size and lower passenger capacity (maximum of 4) than bus and taxi gave it a high flexibility in terms of passenger pick and drop points. The low passenger capacity gave it the ability to easily cover different routes/drop points within geographically closely related areas. This quality made it possible for operators to combine customers not necessarily

with common travel destination but also near-common destination and also made it less costly for chatter arrangement with a single passenger. Unlike the bus and taxi with specific transport routes and loading/off-loading points, the passenger common/near-common destination interest associated with the tricycle removes such rigidities for the rider, making it easier for him to take/change decisions instantly as to where to travel according to customer desires. This quality made it possible for the rider to easily get regular customers and easily manage them accordingly.

The relatively small size gave it the ability to travel within small areas and corridors with less fuel consumption rate. These features made the tricycle easily obtainable for travels almost everywhere, even along minor roads or links. Consequently, it has a wider range of service coverage in the city than bus and taxi. Apart from human passengers, the machine was also used to carry low to medium size goods. On the technical side, maintenance and repair skills on the machine were multiplying, machine and spare parts suppliers were increasing, cost was low and profitability was high. This created a lot of jobs and job opportunities for the teaming youths, generated income and reduced poverty beyond the motorcycle regime. The high level of information and the available practical evidence about these numerous socio-economic advantages associated with the tricycle for local transportation needs has made the vehicle gain popularity and a wide acceptability in the society as the best mode of commercial mass transit in a relatively short period of time.

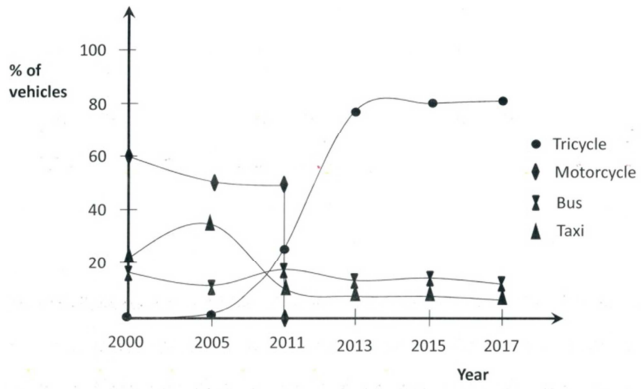

Figure 2. *Historical changes in percent populations of commercial passenger vehicles in Maiduguri metropolis.*

Between the period 2000-2010, the period during which the tricycle was operating within niches, its number was about less than 2000 in the whole of Maiduguri city. However, from 2011, the year of motorcycle ban, the tricycle began to grow geometrically in number until 2015, where it reached a figure close to 30000 in number and in 2017, the number is above 30,000 (Figure 2).

5. Conclusion

The socio-technical transition process of motorcycle to tricycle mode of commercial transport in the road sector in Maiduguri Metropolis has been analysed using the multi-level perspective framework. The scenario of the transition pathway has been critically looked into and certain conclusion can be deducted. The transition involved partial characteristics of de-alignment/re-alignment. It is similar to de-alignment/re-alignment pathway in that there was a complete de-alignment of the existing regime technology (dominant motorcycle machine) but yet different from it in that there were no more than one alternative at the niche level (only tricycle existed), and hence no competition among niche alternatives which usually leads to re-alignment, which is an essential feature of de-alignment/re-alignment pathway. As a consequence, the transition pathway may be best described as a de-alignment/re-alignment pathway that is free of niche competition.

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