Working Paper

Reverse Innovation for the New Mobility

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Reverse Innovation for the New Mobility

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Summary

The confluence of increasing urbanization with climate change, and the associated need to decarbonize the economy, is driving urgency for the global adoption and diffusion of sustainable scalable solutions. IT-enabled, multi-modal transportation, often referred to as the "new mobility", is making inroads in developed and emerging economies alike. Local emerging market entrepreneurs as well as multinationals, seeking transformative innovation strategies to open up new markets are engaging in this rapidly growing industry. This has created an opportunity for innovative indigenous firms in emerging economies to either scale internationally on their own or partner with (often Western) multinationals to define frugal products, services, and business models that address recession-constrained Western markets. Part and parcel to this shift in global engagement is the emergence of a new product development strategy, referred to as reverse innovation (RI). Here, we seek to explore the nexus of RI and the new mobility opportunity, by explicitly recognizing the spillover effects of knowledge transfer and economic development through local firms and, more broadly, the supply chains that internationalize. In fact, some Western companies are outsourcing RI to emerging economy partner firms, thus shifting historical cost-based relationships to value-based engagements. At the core, lies a radical shift in how products and processes are designed, to include: stripping out complexity without sacrificing customer experience; a high degree of customization not through features but by re-using underlying platforms; and customization at the latest stage of the value chain so as to not disrupt materials, components, and subsystems. The potential implications of RI designs and business models on the adoption of frugal innovations in the West are explored, and paths to engaging entrepreneurs in emerging economies are highlighted.

Introduction

We intend to examine how reverse innovation (RI), as applied to the new mobility industry, benefits and integrates the developed and emerging economies involved through sharing of innovations that migrate from south to north regions rather than in the other direction. Rather than attempting to distribute costly new innovations to poorer destinations, instead, frugal innovations are distributed to wealthier well-developed markets, possibly after some adaptation of those innovations. Either type of innovation migration is beneficial, but each offers a different set of impacts, serving different types of markets and resulting in different disruptions to current practices resulting from legacy infrastructure. Aside from transforming and raising the standard of living in emerging economies through the development of new firms, supply chains and employment opportunities, we expect that RI will result in mobility innovations that can be rapidly scaled to mass markets via new market segments previously not addressed (Govindarajan et al., 2009).

The main question is addressed in the context of the new mobility industry, encompassing the products, services and business models that will enable the next generation of transportation that addresses emerging urbanization and mobility needs in ways that are cleaner, greener, safer, healthier, more equitable, connected, inclusive, innovative, technology-enabled, and flexible. In response to rapid urbanization, shifting demographics and other pressing social, economic, and environmental factors, cities and regions are shifting investment dollars from single mode infrastructure to multi-mode, multi-service, IT-enabled door-to-door systems. Moreover, car companies are rebranding themselves as transportation companies. Fundamentally, innovations are driven by the physical and economic realities of transportation inefficiencies, the emergence of new technologies, services and business models, the pressure to mitigate climate change by decreasing carbon emissions, and shifts in demographic behaviors away from car ownership in developed countries and towards car ownership in emerging economies. Enter new mobility, where innovations and opportunities go beyond the sectoral bounds of the traditional transportation industries. The new mobility is being accelerated by the emergence of new fuel and vehicle technologies, new information technologies, flexible and differentiated transportation modes, services, and products, innovative land use and urban design, and new business models. Entrepreneurs, together with the investment community, have responded with electric cars and bikes, car-sharing platforms, fleet tracking software, multi-modal traffic management systems, vehicle-to-grid systems integration, regional goods movement, tele-solutions, and smart city designs where transportation, real estate, energy, IT, and financial and service solutions meet. New mobility grids have started to appear from Bremen, Germany to Cape Town, South Africa, to Cochin, India, and Rio de Janeiro (Brazil). Each region's new mobility grid is exploring customized solutions to fit local needs, resources, and aspirations of industrialized and emerging economies. It is expected that socio-economic and demographic drivers, as well as the state of existing infrastructure systems will result in a spectrum of frugal and more capital-intensive solutions balanced by energy efficiency initiatives, especially in developed countries.

To develop this viewpoint, we begin by providing an explanation of reverse innovation, including lessons from business experience, and implications for the innovation cycle and design, as well as economic and knowledge spillover effects. We then probe the emergent new mobility industry and the necessary engagement of industry sectors that enable it. Lastly, we explore examples of business models, products and services that are indicative of reverse innovation, including economic opportunities for emerging economies to initiate and become engaged in global new mobility value chains.

1. Reverse (or Frugal or Cost-) Innovation

a. Context and Definitions. The process of reverse innovation, as currently practiced in business, begins by focusing on needs and requirements for low-cost products in lesser-developed countries. In a recent paper, "Winning and Losing Bets on Green Technologies", Prof. Christensen argues that: "In contrast to wealthy nations where consumption of electricity and gasoline is ubiquitous, developing nations are an ideal place to commercialize green energy technologies. In these countries, there is so much non-consumption that green technologies need only be better than the alternative: nothing". This may appear counterintuitive, but redefining green technology market needs in the absence of legacy infrastructure fits the emergence of disruptive innovations, as the conditions may be better to scale up new technologies in poorer countries than in wealthier nations. This does not necessarily mean that the products from the former types of countries are of low quality, rather, they are designed to

different price-performance characteristics or the manufacturing process was redesigned to drive down cost (e.g. Pisano and Shih, 2012).

Figure 1, based on a recent project on Reverse Innovation for Acceleration of Clean Technologies (RIACT), which explored value chain, financing, and design impacts of reverse innovation in water technologies, illustrates the evolution of a product going through RI. The RIACT cycle is inclusive of design in mature markets for emerging markets, to reproductization of designs in emerging markets for mature markets. An example is the evolution of an organic waste digester used in emerging markets to an in-sink food digester for Western markets (Ramaswami et al., 2007; Mihelcic et al., 2007).

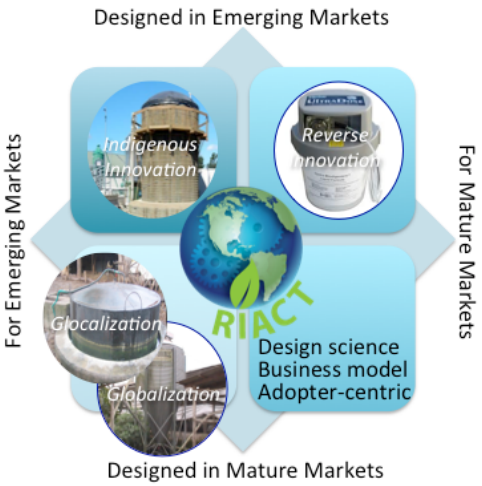

Figure 1: RIACT Conceptual Diagram

The premise of reverse innovation is that lessons from lesser-developed nations are transferrable to new products and markets in the developed world, from technology and financing, to business models. This premise raises compelling fundamental and applied research questions, such as: What kinds of innovation are emerging economies likely to spawn, why and how such innovations might diffuse to rich countries, and what advantages for climate technology diffusion are afforded by focusing on decentralized, local markets (Govindarajan and Ramamurti, 2010). The transfer of knowledge and products from the lesser-developed to the developed world has been recognized in the academic, policy, and business arenas, and has transcended various investment domains.

The implicit hypothesis of reverse innovation is that lessons from market-driven development programs and outsourced manufacturing, as well as from indigenous innovation case studies in lesser-developed countries, will result in different design and product outcomes that can accelerate technologies, processes and products with climate impact (such as multi-modal IT enabled transportation) for deployment in the North.

b. Lessons from Business Experience. The concept of reverse innovation is not new, since many companies have struggled with reinventing themselves through bottom-up innovation by being exposed to, and learning from, culturally- and demographically-divergent consumers. However, in recent years the trend has become more prevalent as companies have been faced with increasingly frugal and discriminating customers in their value chains as well as end-consumers as a result of the recent recession. Indeed, competition in the global marketplace, driven by cost innovation, is shifting the ways companies innovate and capture value. Importantly, this shift is impacting the North-South relationship dynamic and is broadly starting to engage lesser-developed economies in global value chains at a scale not seen before.

A recent article in Long Range Planning by Peter Williamson (2010) stated: *"Imagine a world where high technology, variety and customization - along with specialist products - are available to customers at dramatically lower prices, and where the value-for-money equation offered to global consumers has been transformed by the appearance of new players with new kinds of business models. Could even the best-entrenched incumbents ignore this kind of dramatic change in the competitive climate? This new era of global competition is not far-fetched: it is precisely the disruption to existing business models that the new multinationals from emerging markets, led by the Chinese dragons, are even now starting to unleash."*

To understand the emergence of this trend, we need to understand the impact of Western company outsourcing of cost centers to emerging economies, which started almost three decades ago. Starting with China, but now rapidly moving west and southwards, the availability of cheap labor in emerging economies was the impetus to reduce the cost of doing business (mainly manufacturing) in the West, thus increasing shareholder value. As has been noted in several industries, including semiconductors, energy, and automotive, the outsourcing process resulted in the transfer of know-how (more on this issue in section d) relevant to local economic development and the emergence of local value chains. In other words, the outsourcing of manufacturing processes to Asian hubs, in combination with supplier cost pressures from the West, resulted in the emergence of manufacturing innovation centers with intellectual property around efficiencies and economies of scale. Best practices developed in emerging economies, learned from outsourcing, were replicated to address local or regional frugal consumers looking for reliable products and to be manufactured on a mass scale.

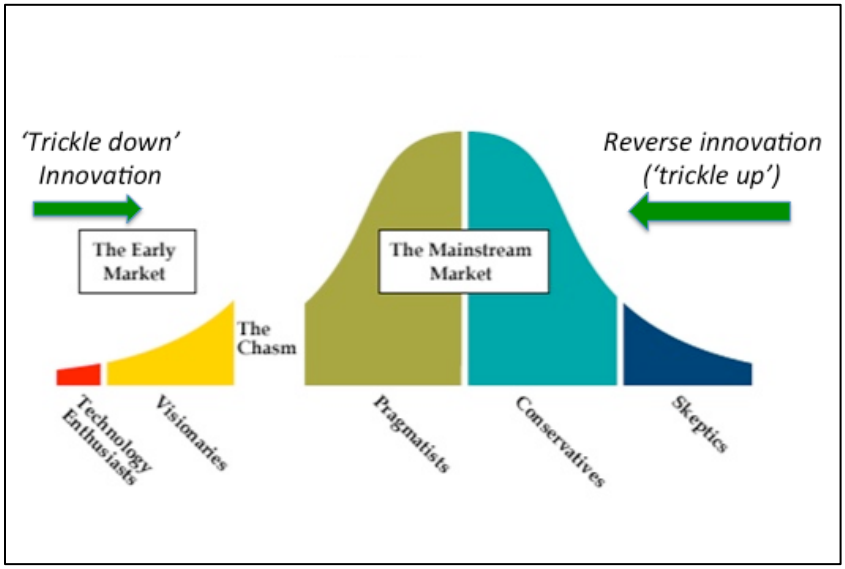

Figure 2: Two Directions of Innovation from a Technology Adoption View

In other words, what has happened over thirty years of outsourcing is that cost centers became value centers that learned how to shift the product adoption curve (See Figure 2) from trickle down innovation to trickle up innovation. The adoption curve, popularized by Geoffrey Moore in his book, "*Crossing the Chasm"*, groups innovators and early adopters as the adventurous (and cost-insensitive) customer willing to try 'good enough' products or services, whereas the majority and laggards of product adoption are those that need the assurance and price point of a mature and commoditized offering. Traditionally, innovation, as is being practiced in the West, starts with niche market offerings that help to de-risk the product or service, before user endorsements and improved products support the transition to mainstream markets.

Examples in new mobility abound. Relatively expensive electric vehicles such as the Tesla (the Tesla Model S is the 2013 Motor Trend Car of the Year), Volt and Nissan Leaf are being bought for reasons, alongside the benefits of reducing emissions affecting climate change, that they are cool and exclusive, by affluent buyers as a second or third car. To cross the chasm to mass markets, the charging infrastructure has to be in place and the value proposition has to shift to a utilitarian one that displaces existing transportation solutions. In contrast, fractional use business models such as car sharing, for example, offer a more thrifty and thereby, compelling alternative to car ownership for urban travelers, thus tackling a problem that is experienced by youth and other more risk-averse consumers. It is a frugal innovation that leverages existing automotive, real estate and information and communications technology (ICT) infrastructure, and does not require new distribution and service systems, except for information technology

(IT) platforms. The electric vehicle is a trickle down innovation, and fractional ownership a trickle up innovation.

It turns out that firms in lesser-developed economies, satisfying largely frugal consumers, have developed a competitive advantage over Western firms when it comes to efficiency and cost innovation because of their historical exposure to Western manufacturing technologies and designs from the outsourcing process. As we will explain, this know-how has allowed these economies to capture value from their innovations and develop scale, thus capturing value in local (and later international) markets, while at the same time lifting populations out of poverty. At a recent International Finance Corporation (IFC) conference on CleanTech investing in emerging and developing economies, it was indicated that intellectual property and economic value creation is on the rise. That said, startups in those countries use a different approach to innovation and design than that used in Western countries. Understanding the difference, and articulating how this can be incorporated in new business models for RI and new mobility is key to identifying new opportunities and scaling solutions beyond the prototype stage.

c. Designing for RI. Reverse innovation is founded on three premises - cost-innovation, application innovation, and business model innovation - deployed in emerging economies that learned to innovate in a resource- and consumer buying power- constrained environment. At the core, lies a radical shift in how products and services are designed. Design science describes a systematic approach to designing a product or service (See Figure 3), whereby a cycle is followed including idea sourcing, design concept development, design implementation realization, analytics and iterations on working prototypes, real-world product realizations and refinement. These more traditional engineering 'bottom up' designs tend to work well for trickle down innovations, and often focus on features of a product or service for a specific market. They also tend to be constrained to a specific segment of the value chain (or value system), rather than taking a holistic system perspective. The challenge with design science, as laid out for trickle down innovation, is that it depends on testable hypotheses and sufficient data to go through the various iterations of the design process.

Figure 3: A Process Model of Decision Science

This is often not possible in the design for reverse innovation, which requires engagement with or initiation by the innovation communities that start off with working prototypes, and experience an often chaotic process to evolve into the designs that diffuse and are adopted in emerging economies first before being reproductized for Western requirements. The design innovation theory around reverse innovation has not been developed yet, but since it starts from a systems perspective, rather than a product market perspective. Research recognizes that design science needs to be strengthened by empirical observations and knowledge, through case studies and by engaging with global entrepreneurs in the new mobility area.

For example, in their HBR article, "*Value for Money Strategies for Recessionary Times*" (2009), Peter Williamson and Ming Zeng articulated lessons to be learned by Western companies from emerging markets:

- Customize products and services at the latest stage in the value chain so as to not disrupt materials, components, and subsystems design activities;
- Strip out complexity without sacrificing the customer experience;
- Focus on a high degree of customization, not through features but by re-using underlying platforms;
- Incorporate lateral thinking and invest in capability adjacencies;
- Provide global partners in emerging and developing markets the autonomy to experiment and develop product designs while leveraging the brand, reach, systems and experience of the industry leaders.

One of the implications of these lessons on product design is that, in order to approach the product adoption curve from the right side (product development for risk-averse consumers on a large scale), the materials, production, integration, sales and distribution channels have to be well-understood, leverage existing infrastructure, and not require a lot of education to engage the consumer. This type of innovation and product design is such unfamiliar terrain to most Western firms that they have now outsourced frugal innovation to their global partners in emerging economies. This opens the door to new innovation and entrepreneurship on an unprecedented scale. The outsourced cost centers of the past are well on their way to becoming full partners in the global innovation ecosystem, creating spillover effects in development models towards empowerment, value creation, and the design of new policy frameworks to enable economic growth.

d. Spillover Effects: Economic Development and Knowledge Transfer. Innovations occurring in emerging economies tend not to involve technological breakthroughs of the kind that drive innovation in developed countries. Rather, they involve novel and innovative combinations of existing knowledge and technologies to solve pressing local problems and the use of new processes and business models (The Economist, 2010a; 2010b). How then, can reverse innovation be made effective and new mobility case studies mined and analyzed to drive scale in technology adoption? First, the whole innovation system, including the role of supply- and demand-side actors, institutions, pricing strategies and business models, and the technology itself need to be considered and analyzed. Second, adopter-centric (i.e., end-users and communities) decisions need to be incorporated in the design process (Dieperink et al., 2004; Rogers, 2003).

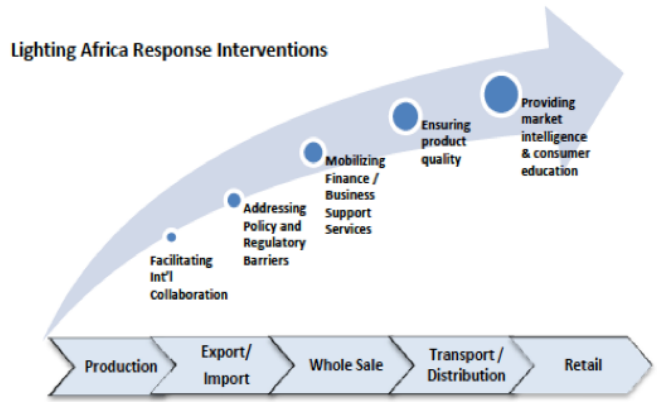

Figure 4: Lighting Africa RI Example

Let's consider the systems approach and its impact on economic development and knowledge transfer. Central to overcoming the market scale-up challenge of emerging technologies is the development of microenterprises and entrepreneurial business development along the value chain that enables value creation for all stakeholders in emerging economies (Blackman, 1999). For example, renewable energy for income generation is an exportable economic development model that has enabled other countries and regions to make leapfrog technology

choices, and allowed companies to innovate (Perkins, 2003; Hart and Christensen, 2002). The IFC-funded Lighting Africa program, that used a systems approach, is an example of a public-private market acceleration plan to advance climate technology programs, with 1.5 million households reached to date in two countries. By tapping distributed knowledge, market barriers were overcome, entrepreneurship and innovation were catalyzed, and products were designed and commercialized. Specifically, the program included: value chain analysis of the industry; technology diffusion gap analysis; financing, pricing and business model strategies; development of product specifications; local capacity for product testing; entrepreneurial business development support; and policy and regulatory design (Morey et al. 2010, 2011). As a result of this initiative, and other foreign direct investments, 'reverse spillover effects', where foreign firms learn from local firms about new business models, management practices, or technologies in emerging markets, are helping to identify new markets and opportunities in the developed world (Govindarajan and Ramamurty, 2011; Morey et al, 2010). The Lighting Africa project has led to millions of people having newly produced, low cost, solar off-grid LED lighting in place of more expensive, dirty fuel sources. This was achieved without subsidies, and through local value creation and access to export markets by way of a global industrial leader (Phillips Lighting).

A central challenge to reverse innovation and spillover opportunities for wider economic development in emerging markets is the availability of skilled people to support industrial growth and encourage a culture of market-driven innovation. Because entrepreneurial talent is highly distributed, crowd-sourced open innovation platforms such as the Mobi Prize are a key-enabler to identify, for example, new mobility opportunities and the talent to support it.

2. New Mobility.

Much like our personalized telecommunications portfolios have evolved to connect iPod, laptop, desktop, search function, GIS, cell phone, and more, the next generation of urban transportation (new mobility) is about seamlessly linking different modes of transportation, services, IT technologies, and designs and infrastructures to provide integrated "open source" urban transportation portfolios. To our knowledge, reverse innovation for multi-modal IT-enabled transportation solutions has not been harnessed or explicitly explored. Even in other areas of innovation, there is no systematic approach to channel entrepreneurial business opportunities, even if examples such as the Lighting Africa exist that are currently being analyzed as case studies to extract characteristics of the RI approach. Some characteristics or lessons learned from these previous case studies can be grouped along value chain, product and business model elements. These will be briefly described here with respect to their applicability to the new mobility reverse innovation opportunity.

a. Urban Mobility Infrastructure Value Systems. In a general sense, an industry value system captures all the relevant segments ('activities') in an industry sector (e.g. transportation) that are transactionally-related. This implies that a map of the value system is organized to capture all monetary, information and material flows among the segments, often starting from raw material segments all the way through to the end-consumer. The value system, if properly constructed provides an overview of how economic value capture is distributed across the industry, for example represented by EBITDA (earnings before interest, taxes, depreciation and amortization) margins of public companies that are pure plays (i.e., focused on one set of activities). Alternative or complementary metrics are used for private companies because financial information is not often publicly available. These may include valuations of startups based on public proxy companies. A simple five-segment value system for the electric vehicle

industry is shown below, indicating that most of the value is captured by raw materials providers, particularly for lithium and other rare earth materials sourcing.

A key-challenge with emergent consumer products such as electric vehicles (which are part of the emergent new mobility is that they knit together pre-existing value systems, and disrupt the value distribution across these pre-existing industry chains. Consider how electric vehicles, which threaten to displace the internal combustion engine, not only engage the automotive value chain (as shown in the value system figure), but also link up with the energy and telecommunications industries, which have entirely different value systems (all within the emerging new mobility industry). Given the interaction of communication standards internal (automotive) and external (telecommunications) to the car, and a new fuel supply chain (electricity, charging infrastructure), the new vehicle OEMs not only need to manage their own automotive industry tiered supply chain, but also must negotiate new relationships with strong incumbents in industries previously not involved in automotive (but now in new mobility). Value is shifting towards industry segments that operate outside of the automotive industry, including data and services segments around new communication standards (ICT).

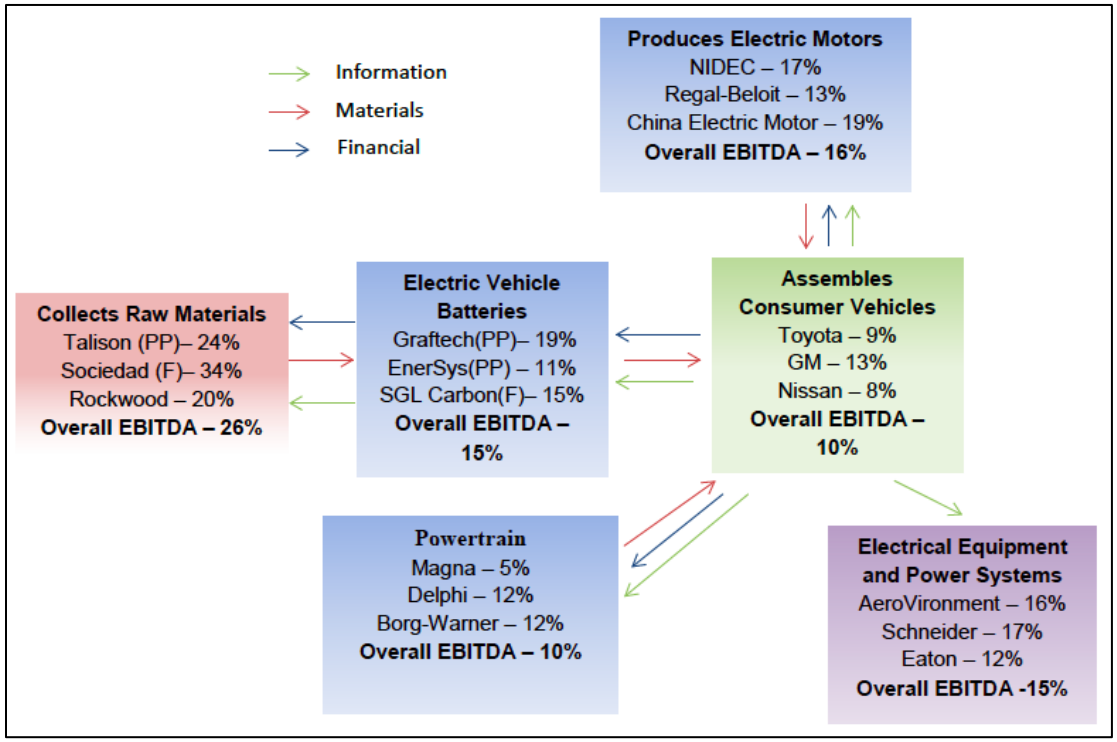

Figure 5: Value Chain Example for Electric Vehicles

The value system becomes even more complex in IT-enabled multi-modal transportation, as compared to when only the electric vehicle is considered. Which industry segment and players will capture the most value? Where are the bottlenecks in the system and how do new products, services and business models scale? Where are the companies that create and capture this value, and where will the entrepreneurs come from to enable this system? A recent Ernst & Young report on the integrated mobility ecosystem focused on: (i) the mobility services for end-users, (ii) the infrastructure that enables integration, and (iii) the stakeholders that deliver these services. The implications of the shift in focus from vehicle ownership to mobility access ('new mobility') are shown below (See Table 1). The table illustrates how the increasing complexity of consumer requirements (from data and planning to payment platforms and transport options)

impacts the required deployment of infrastructure and engagement of variable industries to enable the emergent new mobility industry.

Research on these emerging value systems will be required to understand the value distribution, dependencies and leveragability of market position, and decision-making by actors across the value chains. There is a further need to analyze the industry segments that are prone to disruption by new products, services and business models, and to assess the policy interventions necessary to overcome adoption barriers and drive behavior change.

Table 1: Vehicle-to-New Mobility Paradigm Transformation Implications

Impact of Consumer Needs on Infrastructure and New Mobility Stakeholders			
Consumer Needs	**Real-Time Information And Planning**	**Payment Platforms**	**Multi-Modal Transport**
Infrastructure	Connectivity e-Commerce (payment and account management)	Data, information, analytics and insight Transit stations, parking lots	Technology platform integration Personal and public transport modes
New Mobility Stakeholders	*Infrastructure providers*: ▪ Telematics, ▪ Telecom, ▪ IT & payment systems, ▪ Parking operators	*Administration*: ▪ Transport authorities, ▪ Urban development boards	*Transportation product and service providers*: ▪ Car/bike sharing companies, ▪ Public transport systems, ▪ Automotive OEMs

b. Business models, Products and Services. Transportation in Western societies has a long tradition of various modes of public and automotive products and services that generally follow the mature manufacturing and sales/lease/rental model, procured either by individual consumers, governments, or public-private partnerships. Traffic management systems, navigation and location-based services, and integration services such as smart cards are also of relative maturity. Over the last decade, the fractional ownership model, pay-as-you-go, or fee-for-service model of shared transport systems has started to disrupt legacy industries as well as the markets they serve. Despite these shifts, a recent Arthur D. Little report (The Future of Urban Mobility) concluded that *"…current urban mobility systems adapt poorly to changing demands, are weak in combining the single steps of the travel chain in a single integrated offering, and find it difficult to learn from other systems and shun an open, competitive environment."*

Already, some changes are occurring, particularly in shifting perception and demographic changes around mobility, as well as by increasing emphasis on service models. For example, car companies are increasingly labeling themselves as mobility service providers, integrating new business models such as car sharing and providing on-demand solutions. Fleet companies are launching more corporate mobility services. Rail operators pioneer to set up first examples of mobility integrators by providing integrated solutions offering flexible door-to-door travel with a single card. At the same time, technological advancements lead to increasingly smart, integrated, intelligent transport networks, aimed at reducing emissions, accidents, and congestion, in particular, while the automotive industry witnesses considerable growth regarding the connectivity of cars.

Hence, the future will necessitate extending the scope of new business models, products and services to address the new mobility paradigm, and the need for diffusion and adoption of technologies and services at scale (See Figure 5). This will be the case whether the models address infrastructure, transport systems, traffic management, information and payment services, or integration systems. Many solutions and technologies (both at the vehicle and transportation network scale) already exist, but remain unexploited, or are not integrated or optimized. Many corporate and institutional efforts are underway, and roadmaps are being developed at the city- and country- scale with focus on leveraging (capital-intensive) infrastructure systems in advanced societies.

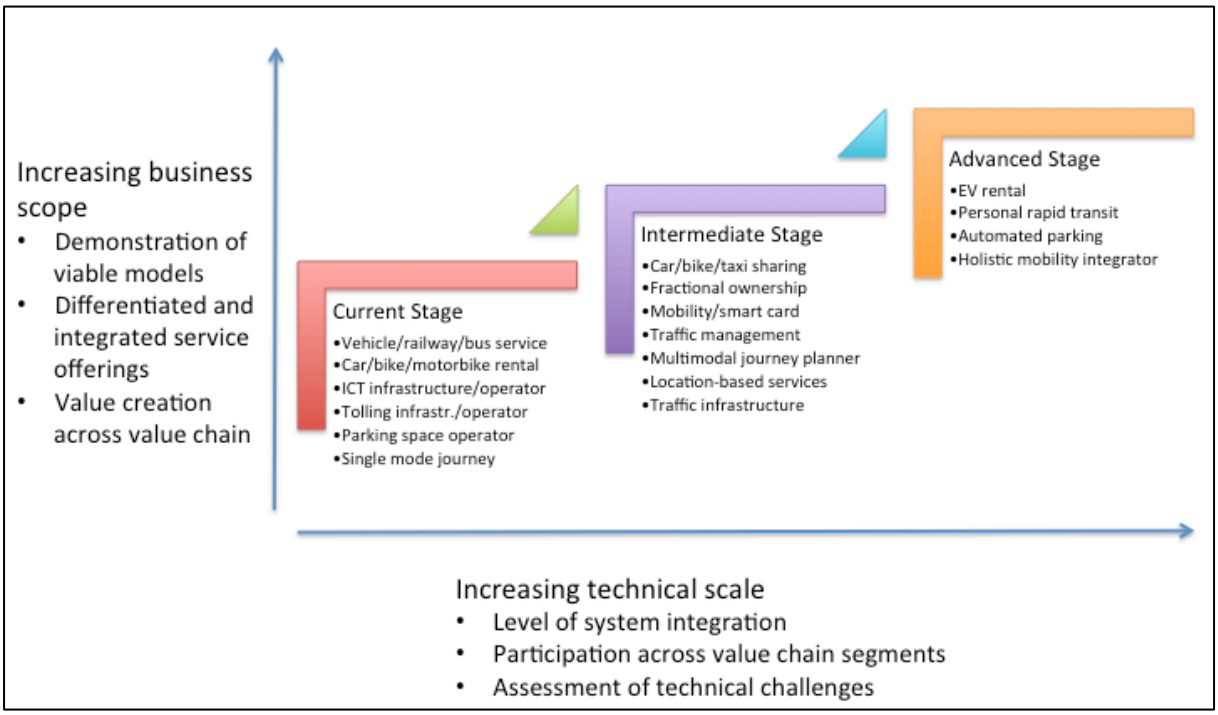

Figure 5: The Increasing Scale and Scope of the New Mobility Technological and Business Transformation

Yet, the challenge of scale brings us to a potential role for reverse innovation in the design of new mobility solutions, given that it addresses the adopter majority.

c. New Mobility Solutions and Reverse Innovation. As noted earlier, frugal innovation that evolves into RI incorporates design strategies that are inherently different from 'Western innovation' models. To our knowledge, urban mobility and reverse innovation have not been systematically integrated. As an example, one could argue that SideCar, a ride-matching app that connects people who need rides with local, vetted drivers who are available and willing to give rides for a donation, is a Western reproductization of a common practice in urban centers in emerging economies where transportation infrastructure is lacking. What is missing from the SideCar example is the lack of economic spillover effects and transfer of know-how within the emerging economies where the ideas originated. Perhaps, lessons learned from RI strategies in other industries can be deployed to scale the new mobility opportunities from emerging economies to the West and to leave economic development benefits behind at both ends.

The rapid and often unplanned and uncoordinated growth of cities has seriously compromised existing transportation systems and significantly increased the challenge of creating future transportation systems everywhere. The same problems of decrepit Western transportation systems are spreading rapidly within emerging economies. Many of these countries have seen

the greatest growth in motor vehicles in recent years and this is expected to continue into the future, primarily in urban areas. However, the levels of physical infrastructure and institutional capacity are not rising adequately to meet and manage the pace of motorization. Motorization, urban sprawl, and declining modal share of public transport constitute a vicious cycle and, as a result, mobility and equitable accessibility are declining rapidly particularly in big cities of emerging economies.

It has been argued that sustainable urban mobility in lesser-developed countries is a political, rather than a technical issue. Local decision makers and urban and transportation planners need to formulate and implement appropriate policies that contribute to sustainability in urban transport. Defining the opportunity involves an analysis of the important issues of urban transport including demand management, improved public, shared, and non-motorized transport, information and mobile technology, environmental protection, road safety, and gender in transport and more. In order to achieve sustainability, an understanding of economic and financial instruments, institutional improvements, capacity building, regulation of markets and environmental standards is required. Hence, the focus of the opportunity identification scope tends to be on land use planning, mobility management and conventional public transport

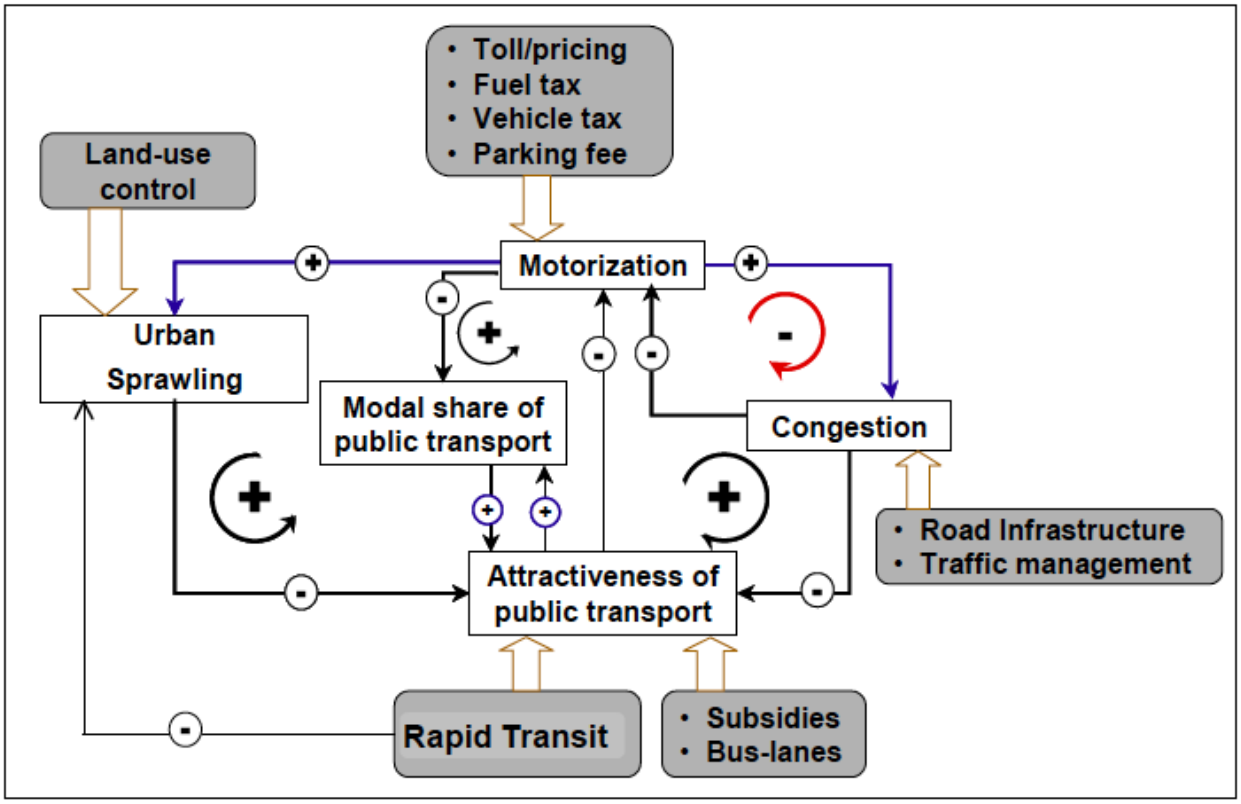

Figure 6: The Interrelationships Between Land-use, Motorization, Public Transport and Policy (Acharya, 2005)

services. The interrelationships between land-use, car ownership, public transport, and policy options are shown in Figure 6.

This framework indicates feedback loops that need to be considered in strategizing multi-modal mobility targets so as to develop a roadmap for technology and service integration using scalable business models in developing countries. The shaded boxes in the Figure show different policy measures that direct overall system behavior toward desirable ends. Traditionally, those areas impacted by policies tend to become opportunity spaces for

entrepreneurial endeavor because the incentives and policy structures provide a degree of certainty for business development.

Where do solutions originate from for reverse innovation? Sometimes, emerging market entrepreneurs initiate their own RI (e.g. Bajaj Auto, Mahindra Reva Electric Vehicles Private Limited, Iochpe-Maxion S.A., Wanxiang Group) and some of them scale to become multi-nationals. Alternatively, as indicated earlier, RI may result from engagement of a global industry leader (e.g. Ford) with local partners and entrepreneurs in emerging economies. Often, the partner is part of the industry leader's global value chain (e.g. General Electric EKG technology), or part of a global crowd-sourced open innovation system (e.g. Phillips LED technology in Africa; Veolia water hubs in Latin America). Hence, in this second type of scenario where typically a large multinational initiates the RI, there needs to be a two-pronged approach to uncover and source global innovations: structured value chain partnerships, and a crowd-sourcing platform. The concept is illustrated below in the RI design paradigm, which starts with local immersion to identify needs, followed by solution discovery using crowd-sourcing platforms such as the Mobi Prize and SMART exchange, validation with local decision-makers, and local piloting/diffusion, before reproductization for global markets.

Figure 7: Integration of Design Science with Reverse Innovation

Central to this system is the understanding and integration of solutions in a multi-sector value system. As noted earlier, the new mobility opportunity is complex in terms of stakeholders and industry segments. For a crowd-sourced solution to work, a system needs to be in place to 'filter' solutions such that the technologies, services or business models can either be integrated into the relevant segment of the value chain or such that they disrupt the value system altogether. Reverse innovation business experience has shown that scale of adoption and cost can be achieved by focusing on innovations in the later stages of the value chain so as to allow product and service differentiation on common underlying platforms. Existing examples in new mobility are car sharing and fractional ownership services which leverage existing physical infrastructure by embedding ICT, such as that devised by the 2012 Mobi Prize winner

(Caronetas, Brazil). This company, Caronetas, provides a service that is an exchange market for carpooling. Carpooling passengers pay drivers a mileage fee through a website and it is paid out as a virtual credit that can be redeemed for products and services at local stores. Technological solutions may include those from companies like Zambikes, a social business that manufactures from off-the-shelf materials, assembles and distributes high quality bicycles, bicycle ambulances and cargo bicycle trailers to the underprivileged. We see some of these reverse innovations turn up in niche electric bike and motorbike companies in Europe and the US (e.g. Brammo) that assemble imported subsystems (e.g. from China or India) into high performance electric vehicles. Where a large multinational initiates the process, it may decide to legalize its intellectual property rights and distribute the product through its well established channels. On the other hand, smaller entrepreneurial emerging market firms, such as those listed earlier along with others, have also been able to scale so as to widely internationally distribute, thus creating indigenous industries spurring local economic development. Examples of RI across many sectors, aside from the Lighting Africa project discussed earlier, are provided below.

Table 2: Examples of Reverse Innovation

Company	**Technology or Business Model**		**Market of Origin**		**Reverse Innovation (Western Markets)**	
Nokia	Classified ad model	Phone sharing app	Kenya	Ghana	New models for ads	Features in US phones
Microsoft	Phone app for web access using 'dumb' phones		India and South Africa		Low cost cloud computing platform	
GE	Battery-operated portable EKG machine		India and China		Ultraportable EKG for first responders	
Tata Motors	Tata Nano	Tata Power	India	South Africa	Tata Europa	Municipal power (Europe)
Veolia	Photovoltaic/wind electric hub for water treatment		Latin America		Distributed water treatment (US/Europe)	
LG Electronics	Low cost air conditioners		India		Low cost air conditioners	

3. Conclusions and Future Steps

Although North-to-South technology transfers related to climate change mitigation continue to be important in many industries, South-to-North transfers increasingly make essential contributions. This is especially true in energy technologies such as biofuels that rely on agricultural feedstocks, but it is also true in manufacturing energy efficiency as well as a variety of services. In fact, emerging economies have become leading exporters of climate technologies, in part as the result of lessons learned from outsourced manufacturing programs. For example, India is one of the world's leading exporters of oil extraction machines for use in refining feedstocks for biofuels, and Mexico is a world leader in exports of solar hot water heaters. China is the leading exporter of heat pumps. The World Bank identified China as the leader in wind energy; China and Malaysia in solar energy; and China and Indonesia in compact fluorescent lamps. We may see this trend extend to new mobility in the future.

Reverse innovation, which emphasizes a decentralized, local-market focus, highlights how the sheer number of new production, distribution, and technology innovations and even business management strategies are already having an impact in shaping markets in emerging and industrialized markets. Global companies are starting to outsource frugal innovation to partners in emerging economies, entrepreneurs in emerging economies are scaling their businesses into

developed country markets, Western universities are setting up frugal innovation labs, and governments (e.g. Obama administration Office of Social Innovation and Civic Participation) are deploying frugal innovation principles in health care and energy. Even though the potential of RI in the new mobility area has not yet been realized, the experiences and trends highlighted here indicate that the potential for crowd-sourced new mobility innovation may be considerable, while at the same time driving entrepreneurial value creation in emerging market communities. Global trade policies as well as local transportation strategies will become major drivers to seeing this potential realized (Brewer, 2008).

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