Mississippi's Transportation Infrastructure: Paving Everyone's Road to Success

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Executive Summary

The ability to move goods, services, and people throughout Mississippi is integral to the overall survival of the state. Mississippi (MS) has an extensive system of highways, bridges, rails, airports, and ports that are a significant financial asset. This paper investigates the value of MS transportation infrastructure, deterioration trends, economic implications from existing funding levels, and survey results of hundreds in the transportation industry to assess factors including the satisfaction of the MS transportation infrastructure workforce. The survey revealed that 93% of surveyed employees were either satisfied or very satisfied with their job. The cumulative efforts of this paper highlight the challenges and opportunities of adequately valuing transportation infrastructure in a way that paves Mississippi's way to short and long term economic prosperity.

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Introduction

Transportation infrastructure plays an integral role in the overall well-being of all MS residents. When valued appropriately it is an economic development engine fueling rewarding careers in numerous professions. Mississippi has developed a strong, diverse intermodal infrastructure system defined by an extensive network of highways, bridges, rails, water ports, and commercial airports which facilitates movement of people, goods, and services. Some of these assets were developed from the "1987 Highway Program"; a $1.6 billion long-range bill calling for the construction of over 1,000 miles of four-lane highways.

Fast-forward 30 years and MS is at a crossroads with a large portion of roadway infrastructure rapidly deteriorating. These critical assets are at an increasing risk of complete failure while construction costs have increased, and funding levels have remained stagnant. Aging infrastructure causes concern for reliability, safety, and security for all Mississippians. Damaged roads cost MS drivers time and vehicle wear (e.g. bent alignments, flat tires) and ultimately could lead to accidents from poor infrastructure conditions. Closed roads or bridges could also delay emergency response activities. The inability to maintain infrastructure affects labor forces, future economic development, and the ability to entice students to pursue careers in the transportation industry. Mississippians are faced with the challenge of protecting the massive aging infrastructure to meet the demands of future generations.

This paper aims to draw attention to the individual and interconnected importance of transportation infrastructure and the workforce that makes infrastructure possible. To achieve this objective, data concerning the condition of roads and bridges and the economic impact of delaying maintenance and preservation treatments are analyzed considering the state government perspective (Mississippi Department of Transportation, or MDOT), industry perspectives (roadway contractors, material suppliers, consultants), and the state chamber of commerce advocacy group (Mississippi Economic Council, or MEC). This paper also includes work by the Construction Materials Research Center (CMRC) to generate transportation infrastructure interest in elementary and high school students (K12). A survey was administered to a group of MS infrastructure workers to understand their perspective and to relate that perspective to K12 (the next possible generation of workers). The ultimate goal of this paper is to show how vital "Mississippi's Transportation Infrastructure" is to "Paving Everyone's Road to Success".

Overview of National and State Infrastructure

Since 1998, the American Society of Civil Engineers (ASCE) has published a national infrastructure report card (IRC) every four years for reference by decision makers and everyday American citizens (ASCE 2017) using a letter grade format to evaluate the condition of America's infrastructure. With each publication, the report card has grown in depth and sophistication. The two most recent reports (i.e. 2013 and 2017) evaluated 16 infrastructure components. Table 1 summarizes national infrastructure letter grades from 2013 and 2017 and the financial need (defined as the investment required to raise the infrastructure component in question to a B grade). As seen in Table 1, the nation was assigned an overall grade of D+ with roads being assigned a D and bridges a C+. The total needed investment has grown from $3.6 trillion in 2013 to $4.6 trillion in 2017.

Table 1. National Infrastructure Letter Grades from 2013 and 2017.

Infrastructure Component	2013 Grade	2017 Grade	2016-2025 Funding (billions)		
			Expected	Needed	Gap
Bridges	C+	C+	$941	$2,042	$1,101
Roads	D	D			
Transit	D	D-			
Drinking Water	D	D	$45	$150	$105
Wastewater	D	D+			
Energy	D+	D+	$757	$934	$177
Aviation	D	D	$115	$157	$42
Inland Waterways	D-	D	$22	$37	$15
Ports	C	C+			
Dams	D	D	$5.6	$45	$39.4
Hazardous Waste	D	D+	$4	$7	$3
Solid Waste	B-	C+			
Levees	D-	D	$10	$80	$70
Parks and Recreation	C-	D+	$12.1	$114.4	$102.3
Rail	C+	B	$124.7	$154.1	$29.4
Schools	D	D+	$490	$870	$380
Overall	**D+**	**D+**	**$2,526**	**$4,590***	**$2,064**

*Estimated needed funding in 2013 was $3,600 billion

To address the national infrastructure funding gap, the Fixing America's Surface Transportation (FAST) act of 2015 was initiated, which was a $305 billion federal initiative with the possibility of up to $500 billion dollars being invested into infrastructure projects in the near future (Shuster 2017). Shuster (2017) quoted a former ASCE President who noted that "it requires leadership on the part of our elected officials to make that [infrastructure improvements] happen and to frankly not kick the can down the road for the next group of elected officials. Because the longer we wait to make these improvements on our infrastructure, the more costly it is going to be." Shuster (2017) also discussed one of ASCE's three initiatives known as the Grand Challenge which is to "significantly enhance the performance and value of infrastructure projects over their life cycles by 2025". Landers (2018) also discusses federal government priorities relative to infrastructure, especially those concerning life cycle cost analysis. As previously mentioned, in 1987 MS initiated the construction of over 1,000 miles of four-lane highway; however, no economic tools were put in place for maintenance of such a system. Landers (2018) considers the possibility of conducting 20-year life cycle analyses for significant projects assessing future costs associated with operation and maintenance. This approach could help prevent the maintenance funding gap currently faced by MS.

The 2017 ASCE-IRC gave MS infrastructure an overall rating of C-. Data extracted from the report card for MS and its surrounding states (ASCE 2017) are presented in Table 2 which shows that MS has similar infrastructure deterioration as a large part of the Southeast United States. While the National Report Card is a vital tool of reference for national lawmakers, certain aspects of the report card may not be of extreme importance or relevance within each state. As such, many state sections of ASCE produce a version of the report card for their specific state.

Table 2. Regional Infrastructure Report Card Data (ASCE 2013).

Category	Bridges		Roads				
STATE	Total	Structurally Deficient	Public Roads (miles)	Major Roads (miles)	Poor[1] Condition (%)	Total Cost to Motorists Billion ($)	Cost/ motorist/yr ($)
Mississippi	17,044	2,274	75,181	8,327	8	0.9	464
Alabama	16,078	1,405	101,811	10,401	6	1.2	321
Louisiana	13,050	1,827	61,326	6,559	19	1.3	464
Tennessee	20,058	1,157	95,523	10,401	6	1.0	225
Arkansas	12,748	880	100,123	8,044	14	1.1	497

[1]Note individual state's definition of "poor" condition may vary.

The last MS state report card was released in 2012 and included sections on dams, drinking water, roads and bridges (as a single section), and wastewater with corresponding letter grades of D, C-, C, and C, respectively (MS-ASCE 2012). The 2018 report card, which is planned for release in October, is expected to be expanded from the 2012 report card. Infrastructure components expected to be of interest for 2018 are aviation, bridges, dams, drinking water, energy, inland waterways, levees, ports, rails, roads, solid waste, and wastewater. While the focus of this article is roads and bridges in MS, there are other infrastructure components (e.g. rails systems and ports and waterways) within the state which face the same threat of deterioration exacerbated by stagnant funding. For example, the importance of rails, ports, and waterways to the MS economy is described below.

Rails. Rail transportation in MS is important to sustaining trade, manufacturing, and commerce. The railroad system is comprised of five Class I railroads (i.e. annual gross freight revenue of $250 million or more) and 23 local railroads for a total of 2,841 miles of track. This rail system transported an estimated 1.7 million tons of freight in 2006; approximately 20% of which was either inbound or outbound with outbound goods overvaluing inbound goods by $3.5 billion. Also, the rail system in MS provides jobs to approximately 2,200 Mississippians (MEC 2012). Based on the 2017 national ASCE-IRC, the rail system in MS improved from the 2013 grade of C+ to a B.

Ports and Waterways. Mississippi's 15 ports and 870 miles of inland waterways contribute greatly to the state economy. According to MEC (2012), 5 MS ports ranked in the top 150 in the country in 2000, considering tonnage. The Port of Gulfport and the Port of Pascagoula are two of the major deep-water Ports in the country. Considering containerized ports across the country, The Port of Gulfport is the 23rd busiest in the U.S. and the 3rd busiest in the Gulf of Mexico. The Port of Pascagoula is in the Top 20 U.S. ports in annual tonnage of foreign cargo, supporting 19,730 jobs, and generating $902 million in employee income and $50 million in state tax revenue, annually. Considering all ports in MS, they provide a $1.4 billion economic impact and account for 3 percent of the State's gross domestic product (GDP). MEC (2012) estimates that ports provide 34,000 jobs, which result in a total of $765 million in employee compensation. In 2008, MS ports transported approximately 52 million tons of freight, 19 million tons of which were outbound and 33 million tons of which were inbound (MEC 2012).

Mississippi Road Conditions

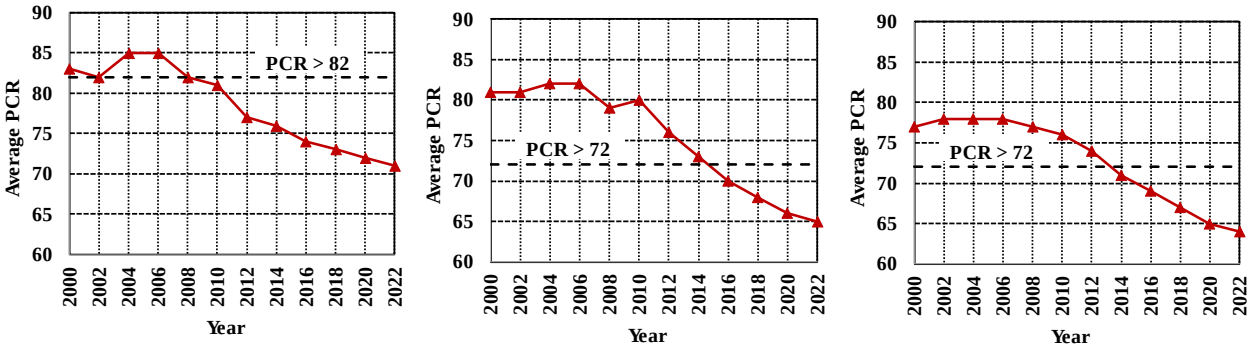
In 1987, the MS legislature enacted a funding bill calling for the construction of over 1,000 miles of four-lane highways. At the time, it was one of the most comprehensive highway funding bills in the country. Since 1988, the number of lane miles maintained by MDOT has increased 3,800 miles from 24,278 to 28,078 miles. In the mid-1990s, MDOT began maintaining some rural roads, creating a network of farm to market routes, vital to the agricultural industry. In order to maintain a database of the road system and monitor road condition, MDOT established a pavement management system (PMS) with the first condition survey conducted in 1991. A PMS consists of a standard, repeatable, and comprehensive method of measuring pavement distresses, such as rutting, potholes, and cracking, to calculate a numerical rating on a scale of 0 (worst) to 100 (best) referred to as a Pavement Condition Rating (PCR). Descriptions of the various conditions for interstate, four-lane, and two-lane highway systems are presented in Table 3.

Figure 1 shows pavements in varying conditions ranging from relatively new construction with little to no damage (Figure 1a), to a pavement with significant structural distress, rutting, and extensive cracking (Figure 1d). Figure 2 summarizes measured PCR data provided by MDOT from 2000 to 2014 and projected PCR data up to 2022. Figure 2a displays PCR trends for the MS interstate system, Figure 2b shows PCR changes for the four-lane state-maintained system, and Figure 2c displays PCR data for the two-lane state-maintained system.

Table 3. Pavement condition ranges for highway system.

Type	Description	Interstate PCR Range	4-lane & 2-lane PCR Range
Very Good	New or almost new, will not require improvement for some time	≤ 89	≤ 82
Good	Will not require improvement in near future	$82 \leq x < 89$	$72 \leq x < 82$
Fair	Will likely need improvement in the near future	$73 \leq x < 82$	$62 \leq x < 72$
Poor	Needs improvement in the near future, to preserve usability	$63 \leq x < 73$	$52 \leq x < 62$
Very Poor	Needs immediate improvement to restore serviceability	< 63	< 52

Figure 1. Pavement Conditions: (a) very good, (b) fair, (c) poor, and (d) very poor.



a) Interstate System b) Four-Lane System c) Two-Lane System

Figure 2. Decline in MDOT pavement network condition – Data from 2000 to 2014 is measured and data from 2014 to 2022 is forecasted

The average interstate PCR fell below the desired score of 82 in 2008 (Figure 2a) with a continuous decline thereafter. As of 2012, 37% of interstate lane miles were in good to very good condition (PCR > 82) while approximately 1,798 of 2,882 (62%) interstate lane miles needed some form of repair. The four-lane highway system average PCR fell below the desired value of 72 around 2014 (Figure 2b) and approximately 2,244 miles required repair. Similarly, around 2014 the average PCR for state-maintained two-lane road system fell below 72 (Figure 2c). Pavement condition data from 2012 indicated that 54% of the two-lane roads had a PCR>72; approximately 7,534 miles out of 16,420 miles needed repair even a few years ago. The data clearly show that Mississippi's highway network is deteriorating.

Maintaining a pavement system above a threshold condition depends on the timing of preventative maintenance and rehabilitation. Shahin (2006) determined that pavements which are rehabilitated while still in fair or better condition can cost 4 to 5 times less to repair than pavement which have deteriorated to very poor or worse. These numbers are not exact and would be expected to vary from source to source. For example, MDOT collected data on the cost of delaying roadway repairs. Figure 3 shows that delaying improvements could increase repair costs by 6 to 14 times as pavement condition worsens.

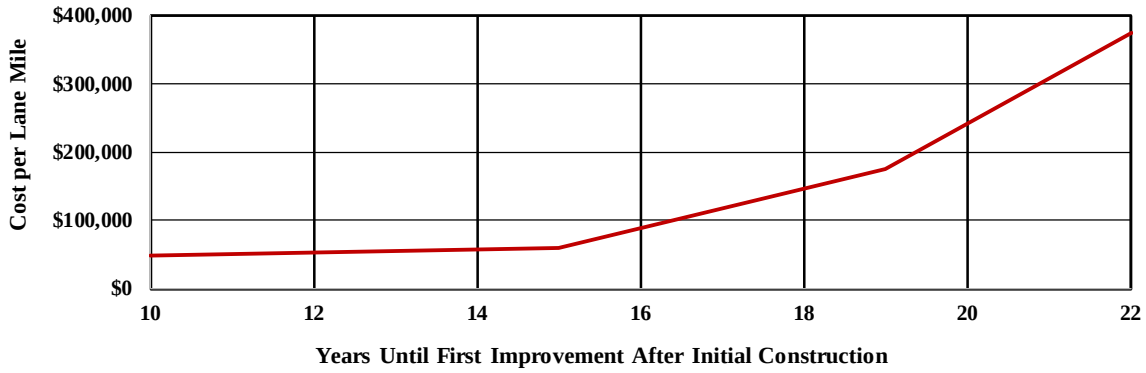
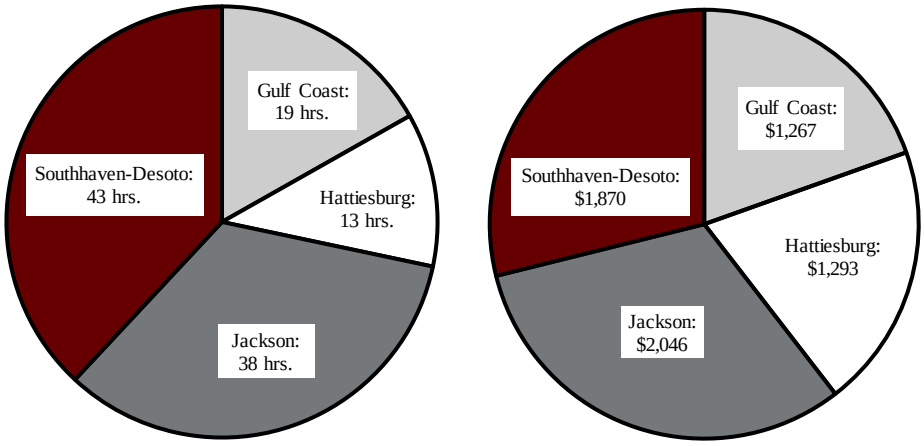


Figure 3. Cost of Delayed Maintenance Based on MDOT Data

When pavement rehabilitation is performed before extreme deterioration, relatively low-cost treatments, such as crack sealing and thin overlays are effective options, and are on the order of tens of thousands of dollars per lane mile. As maintenance activities are delayed, pavement

condition continues to decline requiring more extensive repairs, such as removal and replacement, at a much higher cost (on the order of hundreds of thousands of dollars per lane mile).

In addition to increased maintenance and preservation costs, continued deterioration costs MS drivers time and money as well as jeopardizing their safety. In 2017, The Road Improvement Program (TRIP) report identified four main urban areas which have significant congestion: 1) MS Gulf Coast consisting of the Gulfport-Biloxi-Pascagoula area, 2) Hattiesburg area, 3) Jackson area, and 4) Southaven-Desoto area. Road conditions and congestion in these areas were reported in TRIP (2017) to cause loss of time and money due to traffic delays, crashes, extra vehicle operating costs, and others (see Figure 4).



a) Annual Delay Per Driver b) Annual Cost Per Driver

Figure 4. Time and Monetary Costs of Poor Road Condition and Congestion in MS

In total, MS drivers lose approximately $2.9 billion dollars annually due to roadway condition and congestion-related issues (TRIP 2017). Improving roadway conditions could save MS drivers up to $534 annually in vehicle operating costs (VOC) over 10 years (MEC 2015). Traffic crashes believed to result from poor roadway conditions cost MS drivers a total of $1 billion annually in lost productivity, insurance, and other costs (TRIP 2017). Concerning public safety, fatality rates on MS roads have been slightly increasing since 2012, with the majority of fatalities occurring on rural roadways (FHWA 2012-2016). Zeng et al. (2014) found that pavements in good condition can reduce fatality and injury-causing crashes by 26% when compared to deficient pavements.

Mississippi Bridge Conditions

In ASCE's 2017 IRC, 2,098 bridges (12.3%) were reported structurally deficient in Mississippi (ASCE 2017). A bridge is structurally deficient if there is significant deterioration of the bridge deck, supports or other major components. Structurally deficient bridges are often posted for lower weight or closed to traffic, restricting or redirecting large vehicles, including commercial trucks and emergency service vehicles. TRIP (2016) stated that one-fifth of locally and state-maintained bridges 20 feet or longer show significant deterioration. Additionally, seven percent of MS bridges are functionally obsolete, meaning they no longer meet current highway design standards, often

because of narrow lanes, inadequate clearances or poor alignment. Figure 5 has more bridge condition information.

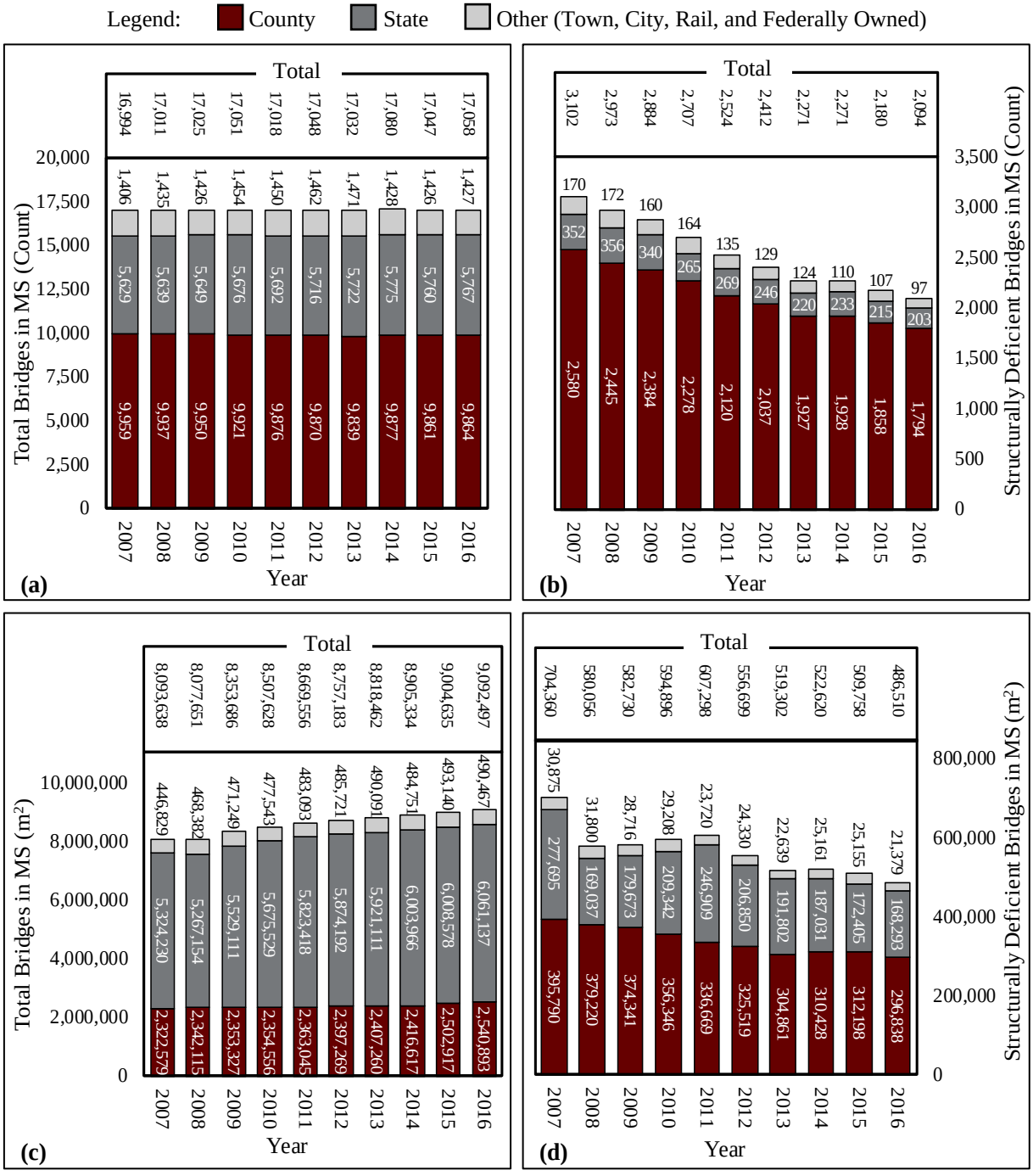


Figure 5. MS Bridge Data from NBI: (a) total number, (b) number structurally deficient, (c) total bridge area, and (d) area of structurally deficient bridges.

Each year, every state is required to submit their bridge inspection information to the Federal Highway Administration (FHWA) as part of the national bridge inventory (NBI). Data pertaining to MS bridges for the years 2007 to 2016 were obtained with assistance from MDOT and are displayed in Figure 5. Bridge count data are displayed as the number of total bridges in the state based on ownership (Figure 5a) and as the number of structurally deficient bridges in the state based on ownership (Figure 5b). Figures 5c and 5d display the same data based on square meters (instead of number) of bridges.

Figure 5a shows that total bridge inventory (based on number of bridges) has increased slightly from 16,994 in 2007 to 17,058 in 2016 (less than 0.5% increase). In the same time frame, Figure 5b shows the number of structurally deficient bridges consistently decreased annually from 3,102 to 2,094 (32.5%). Total area of bridges (Figure 5c) increased by nearly 1 million square meters (12%) from 2007 to 2016, which is a more noticeable change than seen in the number of bridges. While Figure 5d also shows an overall decrease in the area of structurally deficient bridges over the most recent decade, the trend is not as pronounced as when considering the number of bridges. Overall, there was a 31% decrease in square meters of structurally deficient bridges, similar to the 32.5% seen when considering the number of bridges.

Trends in Figure 5 show that MS bridge conditions appear to be moving in the right direction (i.e. increase in inventory and decrease in number/area of structurally deficient bridges); however, this should not be taken to mean that bridge conditions in MS are not a major issue. According to data in Figure 5, 12.3% of the total number of bridges in MS (5.4% based on bridge area) are structurally deficient. In the most recent showing of failing infrastructure in MS, Governor Phil Bryant declared a state of emergency in April 2018 and ordered roughly 100 county bridges closed (Pender 2018).

With these statistics in mind, progress towards bridge replacement and rehabilitation has been pushed by transportation leadership in Mississippi. One of MDOT's top priorities has been to replace Mississippi's deficient bridges. Bridge inspections are conducted at least every 2 years. Repairs are generally considered if the cost is 20% or less than replacement and if the repair extends the service life at least 7-10 years. Bridge replacements are prioritized based on factors including foundation type, bridge deck condition, environmental impact, freight or vehicle traffic, economic impact, and detour length while the bridge is closed.

Funding Mississippi Roads and Bridges

As of 2012, over 40% of the state-maintained roads were in need of some form of repair, and MDOT estimates that based on current trends in pavement management data, approximately 60% of the state-maintained system will require minor or major rehabilitation to raise the PCR to a good condition. Documents from an August 2017 MS Senate Highway and Transportation Committee meeting noted MDOT typically repairs around 1,600 miles per year while around 400 more miles deteriorate to a poor PCR. The MEC found that since the start of the 1987 four-lane highway program, inflation has increased 108%, construction costs have more than tripled, and there has only been a 1.8% gas tax revenue growth (MEC 2015). All factors considered, current highway funding in MS does not seem adequate based on the data presented. MDOT operates on a total annual budget of around $1 billion. Table 4 summarizes the sources of revenue for MDOT's fiscal year 2017 (FY2017) as found in their most recent annual report.

Table 4. MDOT FY2017 Revenues and Disbursements

Incoming Cashflow			**Outgoing Cashflow**		
Source	**Revenue**		**Source**	**Disbursement**	
Federal Funds	$514,426,182	(45.5%)	State-Maintained Roads and Bridges	$954,100,541	(82.7%)
Fuel Tax	$303,842,249	(26.9%)	Transfers for Local Systems	$122,839,612	(10.6%)
Interlocal Proceeds	$70,852,486	(6.3%)	Other Transfers	$41,600,115	(3.6%)
Truck and Bus Taxes/Fees	$68,630,971	(6.1%)	Business Support	$35,250,774	(3.1%)
Other Receipts	$129,903,116	(11.5%)			
Tag Fees	$14,244,786	(1.3%)			
Interest	$5,918,004	(0.5%)			
Contractor's Tax	$16,255,527	(1.4%)			
Commercial Vehicle Fees	$4,579,413	(0.4%)			
Lubricating Oil Tax	$856,423	(0.1%)			
Total Revenue	$1,129,509,157		**Total Disbursement**	$1,153,791,042	
Remaining from FY2016	$105,774,145		**Budget Reduction**	$2,953,121	
Total FY2017 Funds	**$1,235,283,302**		**Remaining at end of FY2017**	$78,539,139	

The vast majority of MDOT's outgoing cash flow observed in Table 4 are allocated to state and local roads and bridges. Only 3.1% of MDOT's annual budget is allocated to business support which includes areas such as employee compensation and benefits, and other operating costs. This compares favorably with the surrounding states of Alabama, Arkansas, Louisiana, and Tennessee where the lowest administrative and operating cost found was 4% (ASL 2016; AlDOT 2016; LaDOTD 2016; TDOT 2017). Comparatively, MDOT does well with its use of available funds to improve roadways within the state.

Federal funds and fuel tax revenue account for a majority of MDOT's annual incoming cash flow. MS gas tax was last raised in 1987 at the start of the four-lane highway program, to 18.79 cents/gallon. Figure 6 compares gas taxes in surrounding states as well as the national average (data obtained from 2040 Multiplan and Drenkard 2017). Numbers displayed in parenthesis after each states' name indicate the national rank of their gas tax (not including the District of Columbia) where a rank of 50 indicates the lowest gas tax (Alaska at 12.25 cents/gal.) and 1 indicates the highest gas tax in the nation (Pennsylvania at 58.20 cents/gallon). It should be noted that Alabama's gas tax is currently 22.91 cents/gal.

Figure 6 shows that MS has not only one of the lowest gas taxes in the southeast (only South Carolina was lower in Figure 6), but also in the nation with a rank of 46. In other words, there are only four other states in the U.S. with a lower gas tax than MS. Since 2012, 23 states have increased revenue for road and bridge repair and maintenance through various means. While several states have increased fuel taxes, increased vehicle fuel efficiency has resulted in less fuel tax revenue, forcing many states to turn to other means of funding, such as increasing license plate registration and other fees (MEC 2015).

The Mississippi Unified Long-Range Transportation Infrastructure Plan (MULTIPLAN) is a document compiled by MDOT in compliance with the federal Long-Range Transportation Plan (LRTP). The 2040 MULTIPLAN was released in January 2016 and is an updated version of the 2035 MULTIPLAN which was released in 2011. The 2040 MULTIPLAN discusses financial needs, constraints, and future plans relative to MS transportation infrastructure for three different funding scenarios: expected funding situation, funding needed to maintain infrastructure system as is, and funding needed to meet minimum performance goals.

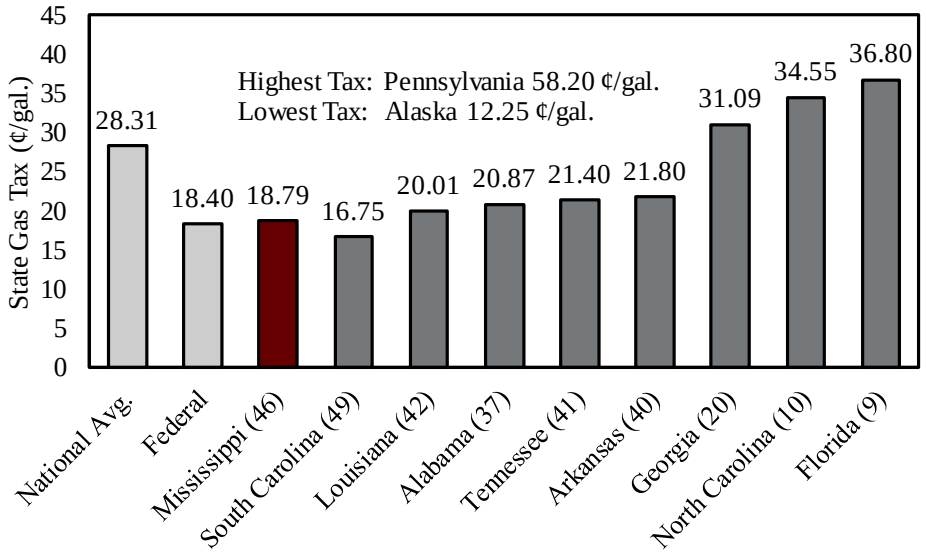


Figure 6. National and Southeast State Gas Taxes

Table 5 summarizes 2040 Multiplan data relative to pavement conditions, roadway capacity, public safety, and modernization within the state-maintained roadway system. Bold-underlined text represents the current funding gap based on either funding needed to maintain the system, or funding needed to meet the minimum goals in the far-right column.

Table 5. Future Funding Needs and Goals from the 2040 Multiplan

Factor	Funding Scenario	Annual Spending	Summary of Goals
Condition	Expected	$372.0	• 75% of interstate in good or better condition. • 75% of NHS* non-interstate in fair or better condition. • 75% of non-NHS 4-lane in fair or better condition. • 75% of non-NHS 2-lane in fair or better condition.
	Maintain System	$551.0	
	Gap	**$179.0**	
	Meet Min. Goals	$694.0	
	Gap	**$322.0**	
Capacity, Safety, & Modernization	Expected	$36.4	• Increase capacity to adequate level for entire state-owned system. • Towards no deaths on MS roadways: 100 fewer annual fatalities. • Reduce total daily driver delay by 12,500 hours.
	Maintain System	$97.1	
	Gap	**$60.7**	
	Meet Min. Goals	$203.0	
	Gap	**$166.6**	
Overall	Expected	$408.4	
	Maintain System	$648.1	
	Gap	**$239.7**	
	Meet Min. Goals	$897.0	
	Gap	**$488.6**	

*NHS= National Highway System

Data in Table 5 only considers state-maintained roadways. MEC (2015) estimated that an additional $75 million is needed annually by municipalities and counties to address 13,192 miles of road rated in "Very Poor Condition" which are expected to require significant rehabilitation. This estimate does not include approximately 16,531 miles which are rated as "Poor" and likely require minor rehabilitation.

Effects of Deteriorating Infrastructure

Local Construction Industry: APAC-MS is an asphalt paving contractor and aggregate producer headquartered in Richland, MS. APAC-MS operates thirteen asphalt production plants and four aggregate pits in locations ranging from north to central MS. Dwayne Boyd, president of APAC-MS stated that since the 1990's, the road building industry has lost approximately 4,000 jobs. The labor force was scaled back to meet a reduced workload caused by stagnant MDOT funding. As a result, companies purchased less new equipment, less raw materials, and less maintenance parts (tires, wear parts, etc.). Additionally, it was stated that less expansion of current facilities or construction of new facilities has occurred.

It was stated that as a result of scaling back the workforce, the ability to find qualified operators has become increasingly difficult. Experienced employees such as paver, roller, and motor grader operators, have since learned new skills and sought other jobs which may be outside the transportation industry. Considering administrative/management staff, such as estimators, project managers, and accountants, this has not been as much of an issue. Mr. Boyd made the following analogy regarding his opinion on roadway maintenance and repair: "Every person that owns a home probably has some wood on the exterior of the home. In order to maintain the wood, periodic washing and repainting is necessary. If a homeowner waits until the wood is rotten to repaint, the paint does no good. The homeowner is still left with rotten wood".

MMC Materials is a supplier of ready mixed concrete and related construction products from locations in the southeastern United States with a long history of serving customers in commercial, industrial, residential and transportation markets. Ben Hardy, Quality Assurance (QA) Director of the Central MS Area, reports that aging infrastructure has recently impacted their operations. He illustrated a consequence of infrastructure failure by telling of an instance when one of their concrete trucks fell through a wooden bridge that could not support its weight. He emphasized their number one priority of safety is jeopardized by poor infrastructure conditions. In addition, excessive repair and operation costs ultimately produce higher customer costs and create challenges for recruiting new businesses to the state.

It is obvious, based on comments received, that the ability to maintain or repair a deteriorating infrastructure affects all industries that play a supporting role in transportation infrastructure construction and that the transportation infrastructure industry supports proper funding of the transportation system.

***Economic Development*:** The MEC, comprised of a coalition of more than 11,000 members from 1,100 member firms, has been the voice of Mississippi business since 1949. MEC deals with broad issues related to businesses through advocacy, research, resources and leadership. One message MEC advocates is development of a plan to repair crumbling roads and bridges. The interactive website, *www.msroadsmatter.com*, looks at safety, economic development, and the impact on jobs. The MEC Blueprint Mississippi Transportation Infrastructure Task Force was formed in June, 2014 and is comprised of business leaders and community resource members from across MS. According to a recent report (TRIP 2016) an investment of an additional $375 million annually is needed to address the most vital road and bridge needs in Mississippi. Of that, $300 million should be dedicated to state-owned bridge and road needs and the remaining $75 million should be split between counties and municipalities. This $375 million annually, would address road and bridge conditions as well as provide a return to transportation users through reduced drive-time and vehicle maintenance. Further deterioration could also lead to loss of new economic development opportunities (MSMEC, ND).

Workforce and Education Initiatives

Up to this point in the paper, focus has been on the infrastructure elements themselves, rather than the workforce responsible for designing, building, and maintaining transportation infrastructure. This section discusses the workforce in terms of the value to transportation infrastructure (i.e. their value to Mississippi), and the value of gainful employment to the workforce (i.e. the value transportation infrastructure can bring to employees/citizens of Mississippi). This section highlights some workforce challenges approaching transportation infrastructure, example workforce development activities, and survey results where a representative sample of Mississippi's workforce provided answers to standard questions. This section is intended to show the interconnected importance of transportation infrastructure to the lives of all Mississippians, and how those that choose transportation infrastructure as a career are positively impactful.

Literature Review and Examples of Workforce Development: The current transportation industry workforce is aging, and workforce numbers are expected to decrease by half by 2022 (Amekudzi-Kennedy et al. 2015). The dwindling working transportation population must be replaced to maintain the status quo, and for transportation infrastructure to grow, the workforce needs to grow. Programs like the American Association of State Highway and Transportation Officials (AASHTO) TRAC™ and RIDES educational initiative are helping to encourage K12 science, technology, engineering, and mathematics (STEM) growth, but additional tools have potential to further prepare a transportation workforce. The transportation industry needs civil engineers, human resource workers, truck drivers, technical writers, heavy equipment operators, material suppliers, and many other diverse careers. To this end, the video *Interstate 269 and the People Who Made it Possible* was recently produced to show everyone the vast career opportunities in transportation infrastructure. This video is numbered CMRC V18-1, and is free for use (https://vimeo.com/255776766) or (https://www.youtube.com/watch?v=_PENqVZ82_o).

Construction industry workforce development initiatives are occurring worldwide. One example, a Japanese government developed business model, called i-Construction, was developed to boost industry image via a culture of salary, holiday, and hope (NAPA 2018). Another example is the Virginia Education Center for Asphalt Technology (VECAT) described by Iseman (2018). VECAT is a vocational program that was deployed just over one year ago to attract talented individuals from other fields (automotive and restaurant were used as examples). VECAT opportunities were reported to have starting salaries of around $40,000 that can approach $100,000 with complete training and proper certifications.

Mangum (2018) discusses the need to retain top talent at engineering or construction firms, especially with a significant volume of skilled labor leaving the industry. Employee retention is beyond this effort's scope, but Mangum (2018) highlights the need to bring talent into the industry through programs like VECAT. The authors believe that the construction industry needs more positive public exposure, and in particular to STEM and non-STEM minded young individuals so that after high school or college they will consider joining the transportation workforce.

Transportation Infrastructure Survey: As one step to understanding the current transportation infrastructure workforce, and to better understand prospects for potential future workforce currently in K12, an optional survey was administered in February and March of 2017 where 467 total responses were collected from adults (209 of these responses were from Mississippians, defined in this survey as the state where the majority of their work occurs, and are the only data reported herein). This survey was first handed out at the Mississippi Quality Asphalt Conference

in Starkville, MS and was later handed out at the 44th Annual Rocky Mountain Asphalt Conference & Equipment Show in Denver, CO. All other distribution originated from emails sent to several dozen colleagues. These emails asked colleagues to consider completing the survey themselves and to send it to others inside and outside their organizations. Survey answers were anonymous and assigned a PIN number to de-identify them from the sender. Tables 6 and 7 summarize survey responses pertinent to this paper. The survey was composed of four demographic questions (Gender, Job Type, Age Range, Home State/Country, and Experience), four questions related to job description and satisfaction, and an optional comments field. As seen in Table 6, 93% of respondents were satisfied or very satisfied with their job, but less than 3% of respondents believed the vast number of career paths in transportation infrastructure were clear and as available as they would have liked while in high school. This points to the need to better inform K12 students about transportation infrastructure.

Table 6. Mississippi Transportation Infrastructure Survey Results (209 Responses) 1 of 2

Category	Responses
Gender	Male [85%], Female [11%], Did Not Identify [4%]
Job Type	Consultant [8%], Supplier [16%], Contractor [28%], Agency [41%], Other [10%]
Age Range	<25 [2%], 25-45 [48%], 45-65 [46%], >65 [4%]
Experience	0-10 years [25%], 10-20 years [29%], 20-30 years [28%], >30 years [18%]
Job Satisfaction	Not Satisfied [<2%], Somewhat Satisfied [5%], Satisfied [45%], Very Satisfied [48%]
High School[1]	No-Not at All [28%], No-Not Really [56%], Yes-Somewhat [14%], Yes-Very Available [<3%]

1: *When you were in high school, was the vast number of career paths available in transportation infrastructure clear and as available as you would have liked?*

SPSS Regression was used to see if variables such as gender, age, experience, or exposure could predict job satisfaction. There were no exclusion factors involved and no reason to use a manipulation check or to check for ceiling or floor effects. No correlation was found between any of the variables and job satisfaction in Mississippi at a 5% significance level. However the extremely high satisfaction rate from Table 6 should be a key point when promoting transportation infrastructure to K12 students.

Another survey point that should be highlighted was the diverse number of reasons for entering the transportation workforce. The most common responses given by over half of the respondents were working outside, job stability, and seeing projects built. The next most common responses were location, salary, working with people, and work/life balance; all of these responses were given by at least one-third but less than one-half of respondents.

Table 7. Mississippi Transportation Infrastructure Survey Results (209 Responses) 2 of 2

What Describes Your Duties?		**What Interested You Enough to Enter the Transportation Infrastructure Workforce?**	
Category	**Percentage Who Marked**	**Category**	**Percentage Who Marked**
Engineering	55 %	Seeing Projects Built	57 %
Project Management	48 %	Job Stability	53 %
Administration	23 %	Working Outside	52 %
Other	22 %	Work/Life Balance	38 %
Safety	17 %	Salary	36 %
Financial/accounting	16 %	Working with People	34 %
General Construction	15 %	Location	33 %
Surveying	11 %	Personal Fulfillment	25 %
Marketing	11 %	Coordinating Projects	24 %
Environmental	10 %	Public Service	19 %
Drafting/CAD	8 %	Operating Heavy Equipment	11 %
Human Resources	6 %	Other	2 %
Equipment Operator	4 %		
Trades	3 %		

--Respondents were instructed to check all that applied in both categories.

Summary and Conclusions

Imagine life in Mississippi if food in stores, oil to and from refineries, travel to popular entertainment events, and so forth were crippled because society didn't value infrastructure by way of adequate funding or if those retiring from the transportation infrastructure workforce were not replaced. Transportation infrastructure plays a vital role in connecting people, places, and goods throughout our great state, but the data in this paper clearly shows that investments are needed if our state is to continue to benefit fully from its infrastructure. Now is a good time for all Mississippians to ask themselves if we are collectively treating our infrastructure as well as it has treated us. It is understood that deteriorating infrastructure is a national issue and is not limited to Mississippi, but the state has been an infrastructure leader before (e.g. 1987 Highway Program) – why not again?

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