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Economic Sustainability of Inner City Streets: A Collaborative Sustainable Asset Management Transportation System Model

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Abstract
The research team developed and created a sustainable asset management transportation system model, focusing on inner-city road conditions related to municipal asset allocation within three St. Louis, Missouri wards. To facilitate the research objectives, the team collaborated with Missouri constituents including the Missouri Department of Transportation (MoDOT), the City of St. Louis Street Department, local government officials, universities, and stakeholders. Selection criteria for roadways included roads, traffic, location, safety, utility, and demographics. A 45-block area was divided into six sections and roads were surveyed, photographed, and evaluated using The Transportation Engineers Association of Missouri's Pavement Surface Evaluation and Rating (PASER). Necessary street repairs and costs of each repair were calculated using global mapping technology and historical cost data. Since aldermen decide street asset allocations, costs were allocated to each city ward district. These assessments, which were based on a technology-driven model, should assist in the construction of future financial models based on a need projection to dollars spent ratio per fiscal year. It is expected that this economic model will be implemented in the St. Louis Metropolitan Region and replicated by similar municipalities.

Keywords
asset management; economic development; mapping; resource allocation; sustainable development; texture; Saint Louis (Missouri); city streets; economic model; rating system; road repair; St. Louis streets; transportation system model

Disciplines
Civil Engineering

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Final Report
July 2015

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Midwest Transportation Center
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These assessments, which were based on a technology-driven model, should assist in the construction of future financial models based on a need projection to dollars spent ratio per fiscal year. It is expected that this economic model will be implemented in the St. Louis Metropolitan Region and replicated by similar municipalities.

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ECONOMIC SUSTAINABILITY OF INNER CITY STREETS: A COLLABORATIVE SUSTAINABLE ASSET MANAGEMENT TRANSPORTATION SYSTEM MODEL

Final Report
July 2015

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EXECUTIVE SUMMARY

Harris-Stowe State University (HSSU) faculty and students succeeded in the development and completion of a research project to create a sustainable asset management transportation system model. Since HSSU is a historically black university, the team focused on inner-city road conditions related to municipal asset allocation within three St. Louis city wards.

To facilitate research objectives, the team collaborated with Missouri constituents including the Missouri Department of Transportation (MoDOT), the St. Louis City Street Department, local government officials, universities, and related stakeholders. Led by a group of HSSU Anheuser-Busch School of Business (ABSB) students, faculty, and staff, this project has outreach activities engaging the various constituents, including MoDOT, local government officials, aldermen, businesses, families, and other stakeholders affected by the project.

The team identified roadways for assessment using selection criteria that included roads, traffic, location, safety, utility, and demographics in residential and commercial areas. The selected 45-block area was divided into six sections.

The designated roads were surveyed, photographed, and evaluated using the Transportation Engineers Association of Missouri's Pavement Surface Evaluation and Rating (PASER). The number of necessary street repairs and costs of each repair were forecast using global mapping technology and historical cost data.

This research led to the completion of a relevant sustainable asset management transportation system model. The effort will assist in the construction of future financial models based on a need-projection-per-dollars-spent ratio. It is expected that this economic development model may be implemented in the St. Louis metropolitan region and replicated by similar municipalities.

PROJECT GOAL AND DESCRIPTION

The goal of this project was to develop a sustainable asset management system model for a local community in St. Louis, Missouri. Upon completion of the project, the team was expected to develop a technology-driven model to provide solutions to community road transportation conditions and related preventive maintenance issues that could have significant impact on future expenditures.

METHODOLOGY

Managed by a group of students, faculty, and staff of the Harris-Stowe State University (HSSU) Anheuser-Busch School of Business, the project had outreach activities engaging the various constituents: the Missouri Department of Transportation (MoDOT), local government officials, aldermen, businesses, families, and other stakeholders affected by the project.

Meeting with the Missouri Department of Transportation

The research team met with MoDOT in St. Louis on June 11, 2014. The meeting yielded many possible goals and actionable insights for the project as follows:

- Of the St. Louis roadways selected for the study, MoDOT is only responsible for the surfaces of Compton and Jefferson.

- Phil Rufus was identified as the MoDOT pavement specialist. Discussion included the possibility of an exchange of information with Rufus on the proper use of their roadway condition evaluation tools.

- Identification of the international roughness index (IRI) was the most commonly used worldwide benchmark to evaluate new pavement construction and repair.

- The research possibly could provide the city with assistance in the appropriation of federally matched funds that have been earmarked for roadway repair and maintenance.

- The incorporation of a practical element to the roadway asset management system model would potentially address the subject of financing future efforts to improve roadway conditions.

- An open invitation was extended to MoDOT representatives to visit the HSSUcampus. This visit would further future collaborative efforts.

- Todd Waelterman of the St. Louis City Street Department was identified as the research team's next resource for repair and maintenance data on downtown roadways. Waelterman

could provide information needed to continue the research into the creation of a sustainable asset management system model for a local community that incorporates a feasibility study on road conditions, needed repairs, and associated costs with future projection of asset allocation.

Meetings with the City of St. Louis Street Department

The research team met with members of the City of St. Louis Street Department on several occasions. Items discussed on July 1, 2014 included the following:

- Right of way–distance curb to curb

- Public-pedestrian safety
  St. Louis is attempting to attract smart, young people who walk and bike.

- Safety street crossing devices
  Devices are $1,200 each and eight are needed per intersection. The total budget cost to plan per intersection is $5,000. The HSSU study area may need approximately 150 devices if the wires are underground. (The number will need to be determined.)

- White light-emitting diode (LED) lighting for added safety

- Materials to use on designated walking paths

Findings from the meeting included the following:

- The city's information is a few years old. The city has had students drive streets and make subjective measurements from 1 to 10 with 10 being the best.

- Road issues are presented to aldermen, who make decisions on which improvements to make. They usually use funds for residential city streets.

- Ward 5 has one block in the HSSU district, and its alderwoman is waiting to approve street improvements due to major planned construction projects in the ward.

- Use the Transportation Engineers Association of Missouri's Pavement Surface Evaluation and Rating (PASER) model for roads, but the Wisconsin model for non-asphalt surfaces.

Pavement Rating and Evaluation

As a result of meetings with MoDOT and the St. Louis Street Department, the research team identified urban roadways surrounding the university as target areas for assessment.

A 45-block area (approximately) within the borders of Kingshighway, Martin Luther King, Jr. Drive, Jefferson Avenue, and Market Street was selected. The criteria for selection were traffic, location, and utility that supports the research team's selected demographic.

The area was then divided into six sections. The assessment teams were identified and all roads within each section were evaluated and photographed by the team.

The Transportation Engineers Association of Missouri's Pavement Surface Evaluation and Rating (PASER) was used as a benchmark to develop the pavement condition parameters by which the streets were assessed. Table 1 summarizes the rating system that was used.

Researchers collected data on the metropolitan St. Louis Central Corridor target areas using the following criteria:

- Ward designation
- Distance surveyed
- Number of necessary repairs
- Missouri PASER evaluation of roadway conditions
- Cost associated with each repair

The number of necessary street repairs and costs of each repair were forecast using global mapping technology and historical cost data. Since aldermen decide street asset allocations, costs were also allocated to each city ward district.

RESULTS

Table 2 presents the results for the entire research area. Tables 3, 4, and 5 show the results, including the cost calculations, for the research areas in Wards 5, 6, and 19, respectively.

Table 1. Research rating system

Surface Rating	Visible Distress	General Condition/ Treatment Measures
10 Excellent	None	New construction
9 Excellent	None	Recent overlay. Like new.
8 Very Good	No longitudinal cracks except reflection of paving joints. Occasional transverse cracks, widely spaced (40 ft or greater). All cracks sealed or light (open less than 1/4 in.).	Recent sealcoat or new cold mix. Little or no maintenance required.
7 Good	Very slight or no raveling, surface shows some traffic wear. Longitudinal cracks (open 1/4 in.) due to reflection or paving joints. Transverse cracks (open 1/4 in.) spaced 10 ft or more apart, little or slight crack raveling. No patching or very few patches in excellent condition.	First signs of aging. Maintain with routine crack filling.
6 Good	Slight raveling (loss of fines) and traffic wear. Longitudinal cracks (open 1/4 to 1/2 in.), some spaced less than 10 ft. First signs of block cracking. Slight to moderate flushing or polishing. Occasional patching in good condition.	Shows signs of aging. Sound structural condition. Could extend life with sealcoat.
5 Fair	Moderate to severe raveling (loss of fine and coarse aggregate). Longitudinal and transverse cracks (open 1/2 in.) show first signs of slight raveling and secondary cracks. First signs of longitudinal cracks near pavement edge. Block cracking up to 50 percent of surface. Extensive to severe flushing or polishing. Some patching or edge wedging in good condition.	Surface aging. Sound structural condition. Needs sealcoat or thin nonstructural overlay (less than 2 in.).
4 Fair	Severe surface raveling. Multiple longitudinal and transverse cracking with slight raveling. Longitudinal cracking in wheel path. Block cracking (over 50 percent of surface). Patching in fair condition. Slight rutting or distortions (1/2 in. deep or less).	Significant aging and first signs of need for strengthening. Would benefit from a structural overlay (2 in. or more).

Surface Rating	Visible Distress	General Condition/ Treatment Measures
3 Poor	Closely spaced longitudinal and transverse cracks often showing raveling and crack erosion. Severe block cracking. Some alligator cracking (less than 25 percent of surface). Patches in fair to poor condition. Moderate rutting or distortion (1 to 2 in. deep). Occasional potholes.	Needs patching and repair prior to major overlay. Milling and removal of deterioration extends the life of overlay.
2 Very Poor	Alligator cracking (over 25 percent of surface). Severe distortion (over 2 in. deep). Extensive patching in poor condition. Potholes.	Severe deterioration. Needs reconstruction with extensive base repair. Pulverization of old pavement is effective.
1 Failed	Severe distress with extreme loss of surface integrity.	Failed. Needs total reconstruction.

Table 2. Cost calculation of the repairs for the entire research area

Major Streets	Sub-Streets	Ward	Measured Distance	Missouri PASER Evaluation	Length	Width	Yards	Cost Associated with Repair
Martin Luther King Jr. (MLK) Dr.	N. Jefferson Ave. to Beaumont St.	5	.14 miles	8-9	570	48	3040	$54,720.00
MLK Dr.	Beaumont St. to Compton Ave.	6	.07 miles	7-8	3300	57	20,900	$376,200.00
Bell Ave.	Cardinal Ave. to N. Garrison Ave.	19	.12 miles	8	480	36	1920	$34,560.00
School St.	Compton Ave. to Cardinal Ave.	19	.13 miles	8-9	670	24	1790	$32,220.00
Franklin Ave.	N. Leffingwell Ave. to T.E. Huntley Ave.	19	.37 miles	7	520	36	2080	$37,440.00
Franklin Ave.	T.E. Huntley Ave. to Compton Ave.	19	.32 miles	6	1580	36	6320	$113,760.00
Delmar Blvd.	N. Jefferson Ave. to Beaumont St.	5	.17miles	8-9	670	58	4320	$77,760.00
Delmar Blvd.	Beaumont St. to Compton Ave.	19	.52 miles	7	2670	40	11,870	$213,660.00
Samuel Shepard Dr.	N. Jefferson Ave. to N. Leffingwell Ave.	6	.25 miles	3	1270	36	5080	$91,440.00
Samuel Shepard Dr.	N. Leffingwell Ave. to Compton Ave.	6	.38 miles	7	2150	36	8600	$154,800.00
Washington Ave.	N. Jefferson Ave. to Compton Ave.	6	.67 miles	9	3300	60	22,000	$396,000.00
Locust St.	N. Jefferson Ave. to Compton Ave.	6	.61 miles	7	3350	44	16,380	$294,840.00
Olive St.	N. Jefferson Ave. to Compton Ave.	6	.63 miles	7	3420	76	2880	$51,840.00
Pine St.	N. Leffingwell Ave. to Beaumont St.	6	.11 miles	8	510	40	2270	$40,860.00
Laclede Ave.	N. Ewing Ave. to N. Garrison Ave.	19	.13 miles	7	775	42	3620	$65,160.00
N. Market St.	N. Jefferson Ave. to N. Garrison Ave.	6	.43 miles	8	2200	80	19,560	$352,080.00
N. Market St.	N. Garrison Ave. to Compton Ave.	6	.20 miles	7	1150	80	10,230	$184,140.00
N. Jefferson Ave.	MLK Dr. to Market St.	19/5	0.7 miles	6	2260	80	23,650	$425,700.00
Beaumont St.	MLK Dr. to Locust St.	5	.16 miles	3	1350	30	4500	$81,000.00
Beaumont St.	Locust St. to Olive St.	19	.13 miles	6	620	24	1660	$29,880.00
Beaumont St.	Olive St. to N. Market St.	19	.15 miles	8	830	32	2960	$53,280.00
N. Leffingwell Ave.	MLK Dr. to Pine St.	19	.38 miles	8-9	2160	36	8640	$155,520.00
N. Ewing Ave.	Olive St. to N. Market St.	19	.22 miles	7	1100	42	5140	$92,520.00
T.E. Huntley Ave.	MLK Dr. to Delmar Blvd.	19	.12 miles	4	640	36	2560	$46,080.00

Major Streets	Sub-Streets	Ward	Measured Distance	Missouri PASER Evaluation	Length	Width	Yards	Cost Associated with Repair
T.E. Huntley Ave.	Delmar Blvd. to Washington Ave.	19	.14 miles	6	630	36	2520	$45,360.00
T.E. Huntley Ave.	Washington Ave. to Olive St.	19	.13 miles	7	640	36	2560	$46,080.00
Cardinal Ave.	MLK Dr. to Bell Ave.	19	.09 miles	5-6	450	36	1800	$32,400.00
Cardinal Ave.	Bell Ave. to Olive St.	19	.36 miles	7	2010	36	8040	$144,720.00
N. Garrison Ave.	MLK Dr. to Delmar Blvd.	19	.22 miles	6	890	34	3370	$60,660.00
N. Garrison Ave.	Delmar Blvd. to Washington Ave.	19	.12 miles	5	660	34	2500	$45,000.00
N. Garrison Ave.	Washington Ave. to Olive St.	19	.15 miles	5	620	34	2350	$42,300.00
N. Garrison Ave.	Laclede Ave. to N. Market St.	19	.08 miles	8	390	40	1740	$31,320.00
Compton Ave.	MLK Dr. to Washington Ave.	19	.19 miles	4-5	2250	62	15,500	$279,000.00
Total Cost of Repair for the Whole Research Area								**$4,182,300.00**

The cost associated with the repairs is derived from the number of yards multiplied by the current cost on paving roads at $18 per yard (Source: St. Louis City Street Department)

Table 3. Cost calculation for Ward 5 research area

Major Streets	Sub-Streets	Ward	Measured Distance	Missouri PASER Evaluation	Length	Width	Yards	Cost Associated with Repair
Martin Luther King Jr. (MLK) Dr.	N. Jefferson Ave. to Beaumont St.	5	.14 miles	8-9	570	48	3040	$54,720.00
Delmar Blvd.	N. Jefferson Ave. to Beaumont St.	5	.17 miles	8-9	670	58	4320	$77,760.00
Beaumont St.	MLK Dr. to Locust St.	5	.16 miles	3	1350	30	4500	$81,000.00
Total Cost of Repair for the Ward 5 Research Area								**$213,480.00**

The cost associated with the repairs is derived from the number of yards multiplied by the current cost on paving roads at $18 per yard (Source: St. Louis City Street Department)

Table 4. Cost calculation of the repairs for Ward 6 research area

Major Streets	Sub-Streets	Ward	Measured Distance	Missouri PASER Evaluation	Length	Width	Yards	Cost Associated with Repair
Martin Luther King Dr. (MLK)	Beaumont St. to Compton Ave.	6	.07 miles	7-8	3300	57	20,900	$376,200.00
Samuel Shepard Dr.	N. Jefferson Ave. to N. Leffingwell Ave.	6	.25 miles	3	1270	36	5080	$91,440.00
Samuel Shepard Dr.	N. Leffingwell Ave. to Compton Ave.	6	.38 miles	7	2150	36	8600	$154,800.00
Washington Ave.	N. Jefferson Ave. to Compton Ave.	6	.67 miles	9	3300	60	22,000	$396,000.00
Locust St.	N. Jefferson Ave. to Compton Ave.	6	.61 miles	7	3350	44	16,380	$294,840.00
Olive St.	N. Jefferson Ave. to Compton Ave.	6	.63 miles	7	3420	76	2880	$51,840.00
Pine St.	N. Leffingwell Ave. to Beaumont St.	6	.11 miles	8	510	40	2270	$40,860.00
N. Market	N. Jefferson Ave. to N. Garrison Ave.	6	.43 miles	8	2200	80	19,560	$352,080.00
N. Market	N. Garrison Ave. to Compton Ave.	6	.20 miles	7	1150	80	10,230	$184,140.00
Total Cost of Repair for the Ward 6 Research Area								**$1,996,920.00**

The cost associated with the repairs is derived from the number of yards multiplied by the current cost on paving roads at $18 per yard (Source: St. Louis City Street Department)

Table 5. Cost calculation of the repairs for Ward 19 research area

Major Streets	Sub-Streets	Ward	Measured Distance	Missouri PASER Evaluation	Length	Width	Yards	Cost Associated with Repair
Bell Ave.	Cardinal Ave. to N. Garrison Ave.	19	.12 miles	8	480	36	1920	$34,560.00
School Street	Compton Ave. to Cardinal Ave.	19	.13 miles	8-9	670	24	1790	$32,220.00
Franklin Ave.	N. Leffingwell Ave. to T.E. Huntley Ave.	19	.37 miles	7	520	36	2080	$37,440.00
Franklin Ave.	T.E Huntley Ave. to Compton Ave.	19	.32 miles	6	1580	36	6320	$113,760.00
Delmar Blvd.	N. Jefferson Ave. to Beaumont St.	19	.17miles	8-9	670	58	4320	$77,760.00
Laclede Ave.	N. Ewing Ave. to N. Garrison Ave.	19	.13 miles	7	775	42	3620	$65,160.00
Beaumont St.	Locust Ave. to Olive St.	19	.13 miles	6	620	24	1660	$29,880.00
Beaumont St.	Olive St. to N. Market St.	19	.15 miles	8	830	32	2960	$53,280.00
North Leffingwell Ave.	Martin Luther King Jr. (MLK) Dr. to Pine St.	19	.38 miles	8-9	2160	36	8640	$155,520.00
North Ewing	Olive St. to N. Market St.	19	.22 miles	7	1100	42	5140	$92,520.00
T.E. Huntley Ave.	MLK Dr. to Delmar Blvd.	19	.12 miles	4	640	36	2560	$46,080.00
T.E. Huntley Ave.	Delmar Blvd. to Washington Ave.	19	.14 miles	6	630	36	2520	$45,360.00
T.E. Huntley Ave.	Washington Ave. to Olive St.	19	.13 miles	7	640	36	2560	$46,080.00
Cardinal Ave.	MLK Dr. to Bell Ave.	19	.09 miles	5-6	450	36	1800	$32,400.00
Cardinal Ave.	Bell Ave. to Olive St.	19	.36 miles	7	2010	36	8040	$144,720.00
North Garrison	MLK Dr. to Delmar Blvd.	19	.22 miles	6	890	34	3370	$60,660.00
North Garrison	Delmar Blvd. to Washington Ave.	19	.12 miles	5	660	34	2500	$45,000.00
North Garrison	Washington Ave. to Olive St.	19	.15 miles	5	620	34	2350	$42,300.00
North Garrison	Laclede Ave. to N. Market St..	19	.08 miles	8	390	40	1740	$31,320.00
Compton Ave.	MLK Dr. to Washington Ave.	19	.19 miles	4-5	2250	62	15,500	$279,000.00
Total Cost of Repair for the Ward 19 Research Area								**$2,185,380.00**

The cost associated with the repairs is derived from the number of yards multiplied by the current cost on paving roads at $18 per yard (Source: St. Louis City Street Department)

CONCLUSIONS

This research led to the completion of a relevant sustainable asset management transportation system model.

As a result of meetings with MoDOT and the St. Louis Street Department, the research team identified urban roadways surrounding the university as target areas for assessment. These assessments will assist in the construction of a financial model based on a need-projection-to-dollars-spent per fiscal year. This tool will aid local agencies with the identification and estimation of repair and maintenance of local roadways.

The project team collaborated with other research institutions in utilizing best practices to develop a sustainable, result-oriented solution model of transportation asset management. This technology-driven database model could potentially be used for a designated St. Louis community and could be replicated in other similar localities.