Assessing the Economic Impact of the 2024 Baltimore Bridge Collapse using RDF/OWL to Crosswalk the NAICS, SICS and GICS Industry Classification Systems

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1. Introduction

In the early morning of March 26, 2024, the Francis Scott Key Bridge in the Port of Baltimore collapsed after having one of its piers struck by the container ship DALI. Six members of a maintenance crew working on the bridge at the time of the collapse lost their lives. In the days and weeks that followed, the city of Baltimore suffered subsequent economic impacts, estimated at $15 million per day [1]. The port re-opened to full maritime operations on June 10, 2024. This industry track paper presents a model of the various impacts mentioned in media articles that covered the bridge collapse. The W3C Web Ontology Language (OWL) is used to identify key industry classes of the port's cargo traffic and use features of OWL to cross-walk various industry classification systems.

2. Methods

The various impacts of the bridge collapse are modeled at high level in Figure 1. This OWL model is based on the ECLAC 2003 [2] system of measuring disaster related damages including human impacts and economic impacts. This paper focuses specifically on the economic impact caused by the loss of imports and exports of commodities and roll on/off cargo and is intended to assist industry analysts and data scientists using differing classification systems in their research. The full economic impact is broken down by the impact from bridge collapse and the impact from the Port of Baltimore being restricted for shipping. Impacts related to the bridge collapse are more relevant to the local community whereas impacts from the port closure may have a national and even a global impact. The time-frame also differs significantly as the Bridge collapse is expected to be rebuilt by 2028 (4 years) whereas the Port closure lasted for 76 days.

A classification system is by its own name, a system of classes and OWL provides a formalized class model. OWL features an Annotation property "owl:equivalentClass" for equivalent OWL Classes and uses the Data property "owl:sameAs" for identical OWL Individuals. It is important to note that in OWL, equivalent does not necessarily mean identical. Equivalence applies to two separate things that share the same extension of properties and subclasses. Identity applies to a single individual that has been represented more than once. Since we have modeled each of the four Industry
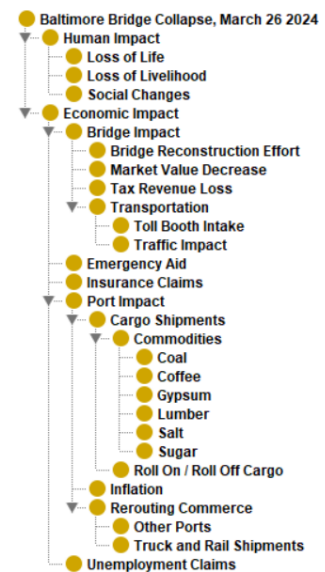

Figure 1: Impact Taxonomy

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Classification Systems using classes, we will cross-walk the systems using equivalence as opposed to identity.

	Level 1	Level 2	Level 3	Level 4	Level 5	Total
SICS (2007)	Division	Major Group	Industry Group	Industry		
	10	83	415	882		1390
NAICS (2017)	Sector	Sub-Sector	Industry Group	Industry	Sub-Industry	
	24	99	311	709	1057	2200
GICS (2008)	Sector	Industry Group	Industry	Sub-Industry		
	11	25	71	165		272
ISIC (rev4)	Section	Division	Group	Class		
	21	88	238	419		766

Figure 2: Industry Classification System Comparison

The first step performed in this study was to model each of the four industry classification systems into an OWL model. Figure 2 shows a high level comparison of the four systems obtained by summarizing their respective OWL model. The second step was apply the owl:equivalentClass Annotation property to the equivalent classes across each model. We obtained a set of 2270 cross-references between NAICS and SICS [3], and a set of 1655 cross-references between NAICS and ISICS [4]. NAICS is the only of the four systems to provide internal cross-references to identify class equivalence within its own set of classes [5]. After performing these two steps, the resulting crosswalk shown in Figure 3 was generated for the commodities most affected by the Baltimore Bridge Collapse.

Commodity	System	Level 1	Level 2	Level 3	Level 4	Level 5	Label
Coal	GICS (2008)	10	1010	101020	10102050		Coal & Consumable Fuels
	ISIC (rev4)	B	05	051	0510		Mining of hard coal
	NAICS (2017)	21	212	2121	21211	212111	Bituminous Coal and Lignite Surface Mining
	NAICS (2017)	21	212	2121	21211	212112	Bituminous Coal Underground Mining
	NAICS (2017)	32	324	3241	32419	324199	All Other Petroleum and Coal Products Manufacturing
	NAICS (2017)	42	423	4235	42352	423520	Coal and Other Mineral and Ore Merchant Wholesalers
	SICS (2007)	B	12	122	1221		Bituminous Coal and Lignite Surface Mining
	SICS (2007)	B	12	122	1222		Bituminous Coal Underground Mining
	SICS (2007)	B	12	124	1241		Support Activities for Coal Mining
	SICS (2007)	D	29	299	2999		All Other Petroleum and Coal Products Mfg
	SICS (2007)	F	50	505	5052		Coal and Other Mineral and Ore Merchant Wholesalers
Coffee	GICS (2008)	N/A					
	ISIC (rev4)	A	01	012	0127		Growing of beverage crops
	NAICS (2017)	31	311	3119	31192	311920	Coffee and Tea Manufacturing
	SICS (2007)	D	20	209	2095		Coffee and Tea Mfg.
Gypsum	GICS (2008)	15	1510	151020	15102010		Construction Materials
	ISIC (rev4)	C	23	239	2395		Manufacture of articles of concrete, cement and plaster
	NAICS (2017)	32	327	3274	32742	327420	Gypsum Product Manufacturing
	SICS (2007)	D	32	329	3299		Gypsum Product Mfg.
Lumber	GICS (2008)	20	2010	201020	20102010		Building Products
	ISIC (rev4)	C	16	162	1629		Manufacture of other products of wood
	NAICS (2017)	32	321	3219	32191	321912	Cut Stock, Resawing Lumber, and Planing
	NAICS (2017)	42	423	4233	42331	423310	Lumber, Plywood, Millwork, and Wood Panel Merchant Wholesalers
	SICS (2007)	D	24				Lumber And Wood Products, Except Furniture
	SICS (2007)	F	50	503			Lumber And Other Construction Materials
Salt	GICS (2008)	15	1510	151040	15104020		Diversified Metals & Mining
	ISIC (rev4)	B	09	098	0983		Extraction of salt
	NAICS (2017)	31	311	3119	31194	311942	Spice and Extract Manufacturing
	SICS (2007)	N/A					
Sugar	GICS (2008)	N/A					
	ISIC (rev4)	C	10	107	1072		Manufacture of sugar
	NAICS (2017)	11	111	1119	11193	111930	Sugarcane Farming
	NAICS (2017)	11	111	1119	11199	111991	Sugar Beet Farming
	NAICS (2017)	31	311	3113	31131	311313	Beet Sugar Manufacturing
	NAICS (2017)	31	311	3113	31131	311314	Cane Sugar Manufacturing
	SICS (2007)	D	20	206	2061		Cane Sugar Mfg.
	SICS (2007)	D	20	206	2062		Cane Sugar Mfg.
	SICS (2007)	D	20	206	2063		Beet Sugar Mfg.
Vehicles	GICS (2008)	25	2510	251020	25102010		Automobile Manufacturers
	ISIC (rev4)	C	29	291	2910		Manufacture of motor vehicles
	NAICS (2017)	33	336	3361	33611	336111	Automobile Manufacturing
	NAICS (2017)	33	336	3361	33611	336112	Light Truck and Utility Vehicle Manufacturing
	NAICS (2017)	33	336	3361	33612	336120	Heavy Duty Truck Manufacturing
	NAICS (2017)	48	488	4883	48832	488320	Marine Cargo Handling
	SICS (2007)	D	37	371	3711		Motor Vehicle Body Mfg.
	SICS (2007)	D	37	371	3714		Motor Vehicle Gasoline Engine and Engine Parts Mfg.
	SICS (2007)	F	50	501			Motor Vehicles And Motor Vehicle Parts And Supplies

Figure 3: Crosswalk of Selected Commodities

3. Notes

Listing of all Classification Systems reviewed during this study:

- Standard Industrial Classification (SIC) 1938, OMB
- International Standard Industrial Classification (ISIC) 1948, United Nations
- North American Industry Classification System (NAICS) 1997 - OMB / ECPC
- Global Industry Classification Standard (GICS) 1999 - Standard & Poor's (S&P)
- Harmonized System (HS) 1988 - World Customs Organization (WCO)
- Standard International Trade Classification (SITC) 1950 - United Nations
- End-Use Commodity Category - Bureau of Economic Analysis
- Advanced Technology Products (ATP) - USCB

References

[1] Zina Hutton (April 18, 2024) *Economic Fallout from Baltimore's Bridge Collapse Hits Home* (https://www.governing.com/finance/economic-fallout-from-baltimores-bridge-collapse-hits-home)

[2] Economic Commission for Latin America and the Caribbean (https://www.weforum.org/agenda/2015/03/how-can-we-measure-the-impact-of-natural-disasters)

[3] (https://www.naics.com/naics-to-sic-sic-to-naics-crosswalks/)

[4] (https://econweb.ucsd.edu/~mmuendler/teach/22x/101/conc/census/ISIC_4_to_2017_NAICS.xlsx)

[5] (https://www.census.gov/naics/reference_files_tools/2017_NAICS_Manual.pdf)

[6] Sales and Inventories (May 2024) (https://www.census.gov/wholesale/pdf/mwts/currentwhl.pdf)

[7] Chloe Demrovsky (Mar 27, 2024) *The Economic Impact Of The Baltimore Bridge Collapse Will Linger, Contributing To Inflation* (https://www.forbes.com/sites/chloedemrovsky/2024/03/26/the-economic-impact-of-the-baltimore-bridge-collapse-will-linger-contributing-to-inflation/)

[8] Joseph W. Kane, Fred Dews (March 28, 2024) *Economic cost of the Baltimore bridge collapse* (https://www.brookings.edu/articles/economic-impact-of-the-baltimore-bridge-collapse/)

[9] Sean Hackbarth (April 02, 2024) *How the Baltimore Bridge Collapse Affects Business and the Economy* (https://www.uschamber.com/infrastructure/how-the-baltimore-bridge-collapse-affects-business-and-the-economy)

[10] Camila Domonoske, Laurel Wamsley (April 2, 2024) *The economic impact of the Baltimore bridge collapse* (https://www.npr.org/2024/04/02/1242327964/the-economic-impact-of-the-baltimore-bridge-collapse)

[11] Information about the Port of Baltimore (April 5th, 2024) (https://www.bts.gov/current-transportation-statistics/information-about-port-baltimore)

[12] Sen. Cardin, Benjamin L. *S.4114 - Baltimore BRIDGE Relief Act* (https://www.congress.gov/bill/118th-congress/senate-bill/4114)

[13] Julie Strupp (5/6/2024) *Baltimore bridge rebuild expected to cost up to $1.9B* (https://www.constructiondive.com/news/baltimore-bridge-rebuild-cost-timeline/715169/)

[14] Avi Salzman (June 26, 2024) *Shipping Rates Are Soaring. Will They Refuel Inflation?* (https://www.barrons.com/articles/shipping-container-rates-inflation-c3358751)

[15] Reuters (07/10/2024) *US wholesale inventories rise in May (07/10/2024)* (https://www.investing.com/news/economic-indicators/us-wholesale-inventories-rise-in-may-3513883)

[16] Maryland at a Glance (https://msa.maryland.gov/msa/mdmanual/01glance/html/port.html)