



►► Under the patronage of **H.E. Dr. Abdullah Belhaif Al Nuaimi** - Minister of Infrastructure Development



►► 17th Edition

—
International Operations & Maintenance Conference in the Arab Countries

19, 20, 21 NOV 2019

Le Meridien Dubai Hotel
& Conference Centre
United Arab Emirates

Under the Theme:

**Enhancing Maintenance
Through Big Data Management**

►► **PERSPECTIVES ON BIG DATA
ANALYTICS for
INFRASTRUCTURE'S
ENGINEERING,
CONSTRUCTION, &
MAINTENANCE**

Dr. Moustafa Kassab



►► **Agenda**

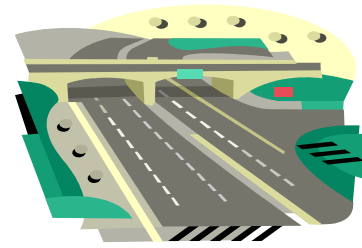


- **Infrastructure Assets /Challenges/ Opportunities**
- **Information / Communication Technology**
- **Big Data and Big Data Analytics**
- **Big Data Technology for Infrastructure**
- **BD in Infrastructure's Engineering Construction & Maintenance**
- **Conclusion**



►► Infrastructure Challenges

- Importance to economy and social developments
- Ageing infrastructure
- Increasing population ⇒ Massive users
- Budgets cut toward health and education
- Spread of digital economy
- Massive information: Critical analysis
- Smart cities: Smart-Infrastructure assets
- Sustainability
- Making right decisions



Build New facilities
Maintain & Expand Existing
Rehabilitate Old facilities



►► Digital Age and 4th Industrial Revaluation

- Gigantic : in Volume
- Varied in type
- Fast in production velocity
- Super exponential in its generation
- Real -Time advantage
- Easy to use: Collect, Storage, Analysis
- Appropriate: - Handling
 - Utilization
 - Socio-Economy Benefits
- In-Expensive

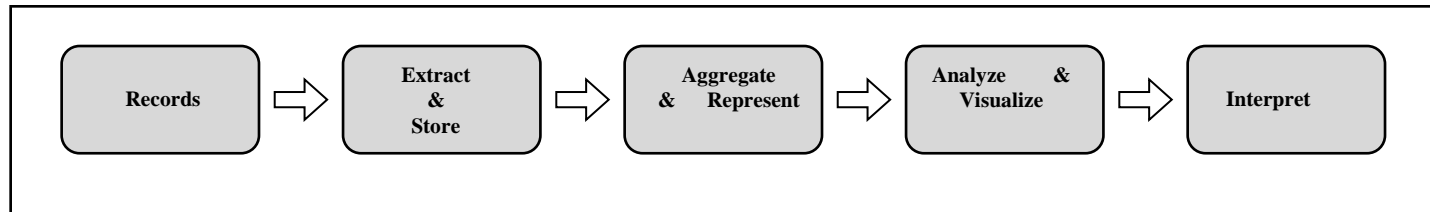


- CCTV
- Sensors
- Cameras
- Smart Phones
- GPS
- Mega Servers
- Smart computers

►► Big Data for Infrastructure

Big Data : Refers to datasets whose size is beyond the ability of typical database software tools to capture, store, manage, and analyze:

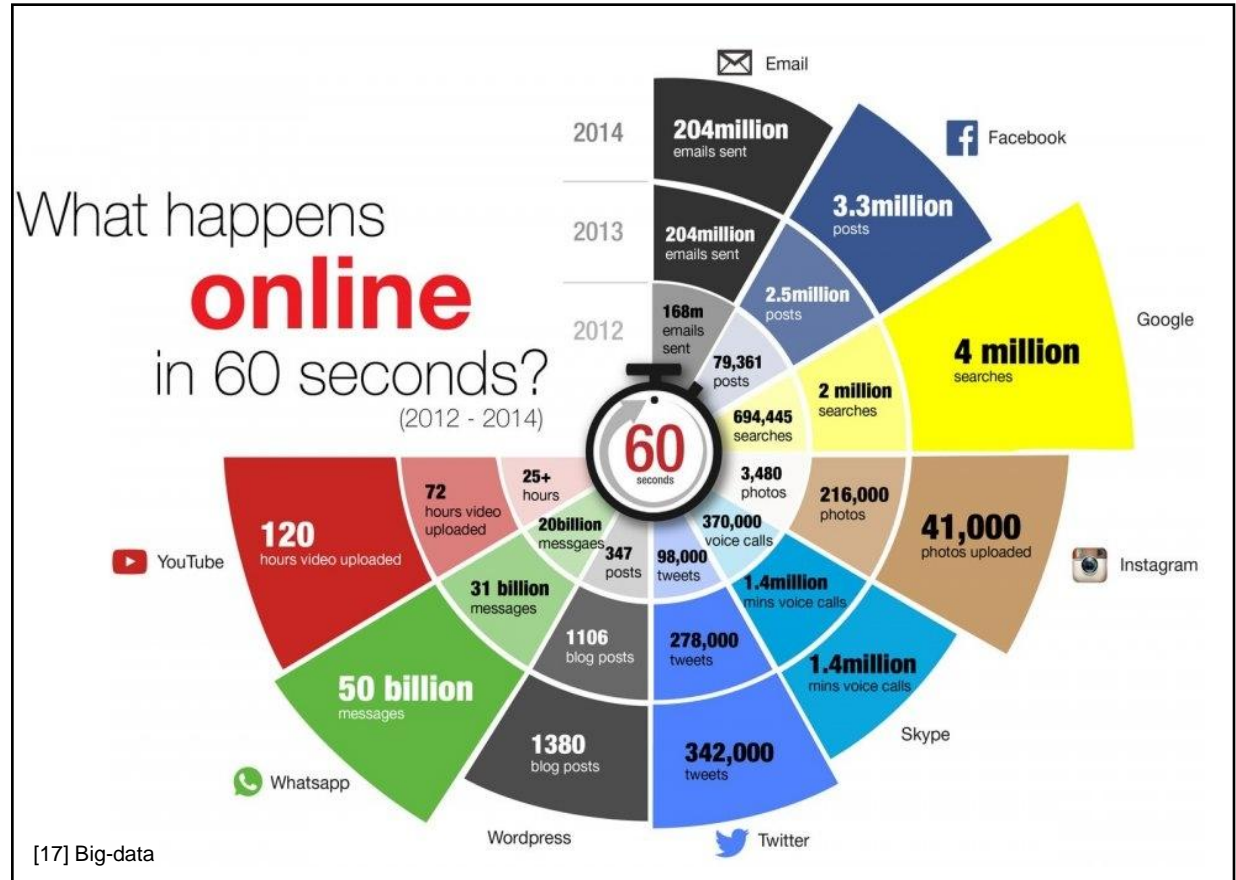
- Has many characteristics
- Invent big data platform technology: Hadoop.
- Hadoop: widely used in business and large Internet companies (Amazon)
- Big data analytics can process economic and environmental data
- Can make in-depth useful analysis to make the right decisions and forecast close to accurate expectations and lay down precautions and risks



►► Big Data for Infrastructure

► Examples of Big Data

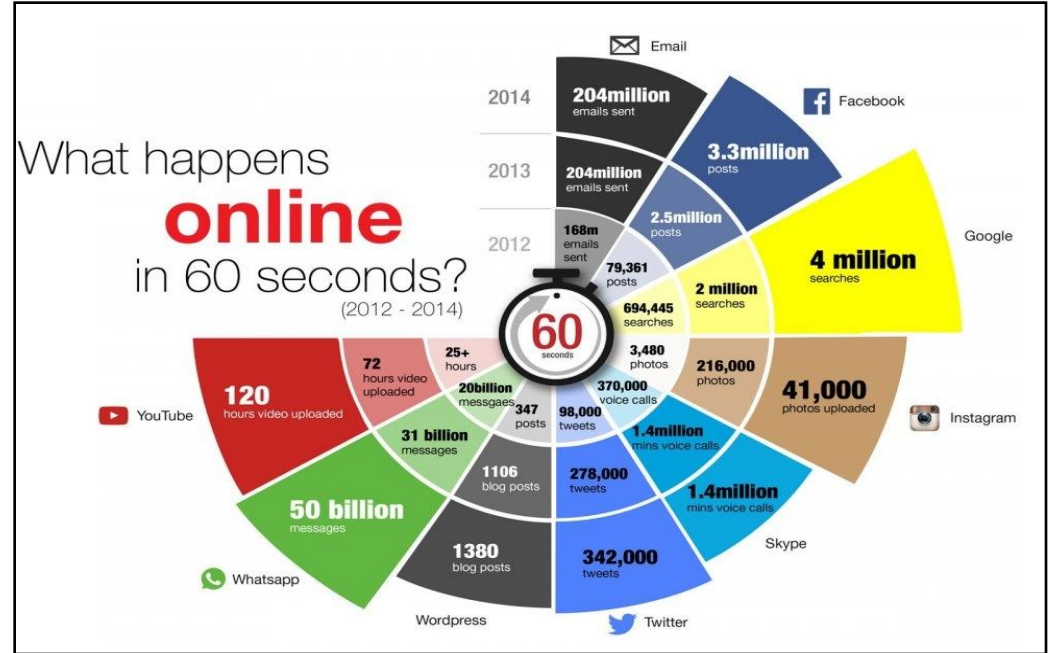
- Twitters
- LinkedIn
- Face Book
- Website
- Wikipedia
- Machine generated data
- Sensors data
- Call data records
- Smart Meters
- Manufacturing sensors
- Data Acquisition tools
- Traffic data
- Air data
- Weather data
- Traduis systems



Big Data for Infrastructure: Characteristics

►► Volume

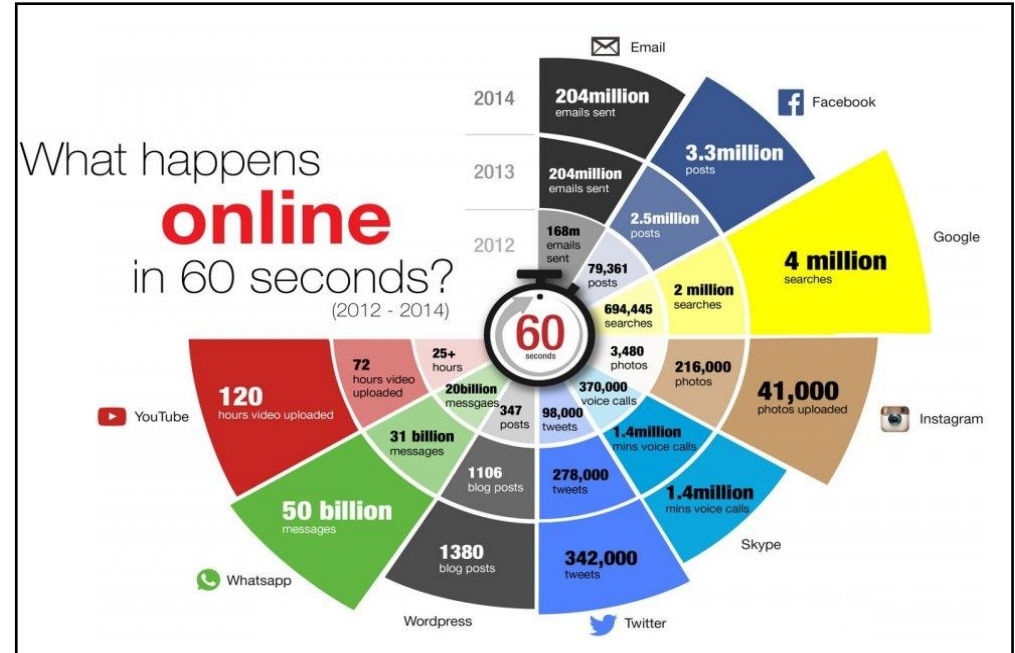
- Every single day, "Over 2.5 quintillion bytes of data are created
- 2020 on earth: it's estimated that 1.7MB of data will be created/ Second/ person
- Exponentially increase: > 90% of the world's data has been created in the last two years.



Big Data for Infrastructure: Characteristics

►► Velocity

- The speed at which the data is being generated
- streamed data from various smart devices: social media, sensors, camera...etc
- Big data grows very rapidly, generating quantities need to be stored, transmitted, & quickly processed.



Big Data for Infrastructure: Characteristics

►► Variety

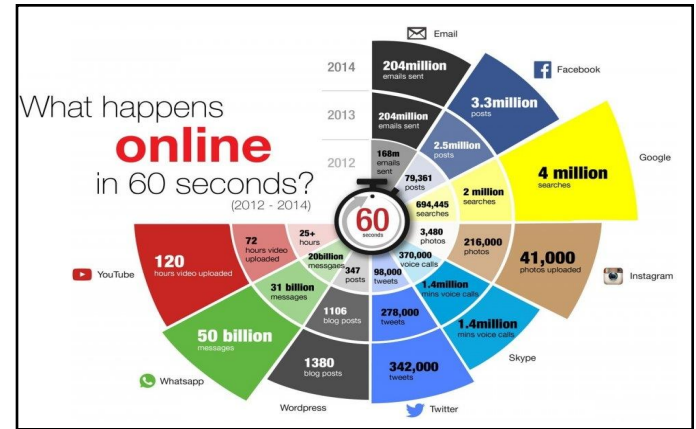
➤ Big data comes from:

1- Structured data: inserts a data warehouse already tagged and easily sorted.

2- Unstructured data: random and difficult to analyze. Comes in the form of text documents, email, video, audio.

3- Semi structured data: not conform to fixed fields, but contains tags to separate data elements.

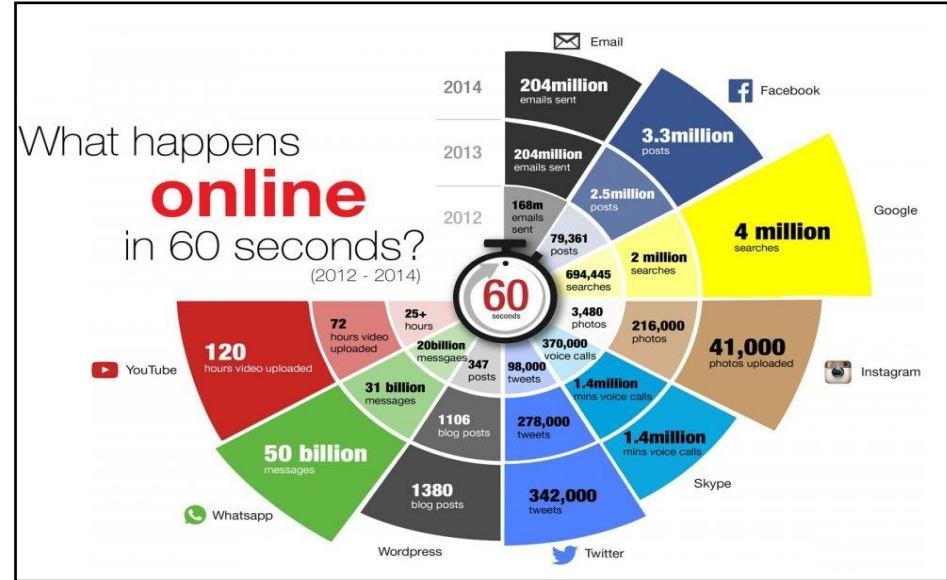
➤ Merging and managing such different forms is one of the aspects of Big Data



Big Data for Infrastructure: Characteristics

►► Veracity

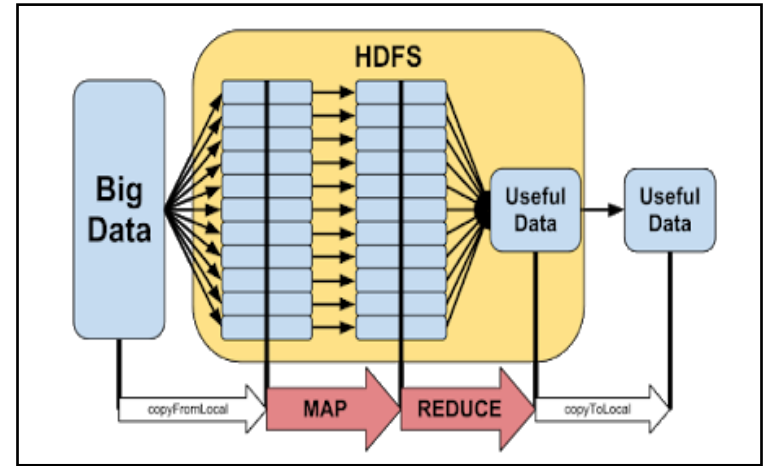
- Refers to the biases, noise and abnormality in data.
- Biggest challenge compare to volume and velocity.
- In particular if the data that is being stored and mined is meaningful to the problem being analyzed.



►► Big Data for Infrastructure

a) HADOOP

- New way to store, Retrieve, and process massive amount of data.
- Enables distributed computing of huge amount of data across inexpensive servers
- store and process data with enormous processing power =► ability to handle virtually limitless concurrent tasks or jobs.



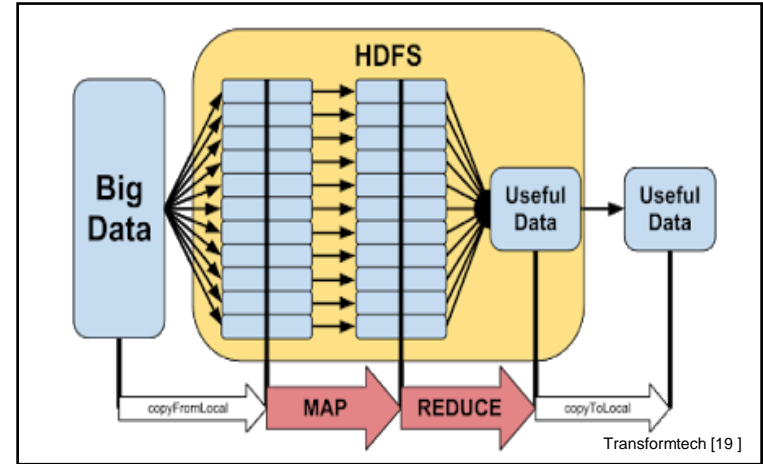
Big-Data Platform

- 1-The storage part of Hadoop: called **HDFS**
- 2- The processing part: called **Map Reduce**.

►► Big Data for Infrastructure

b) MAP REDUCE

- The programming paradigm that allows for massive scalability across hundreds or thousands of servers in the Hadoop cluster.
- The heart of Hadoop where the processing is carried out by assigning the tasks to various clusters.
- simultaneously, process multiple files:
=► Processed minimizing the computation time

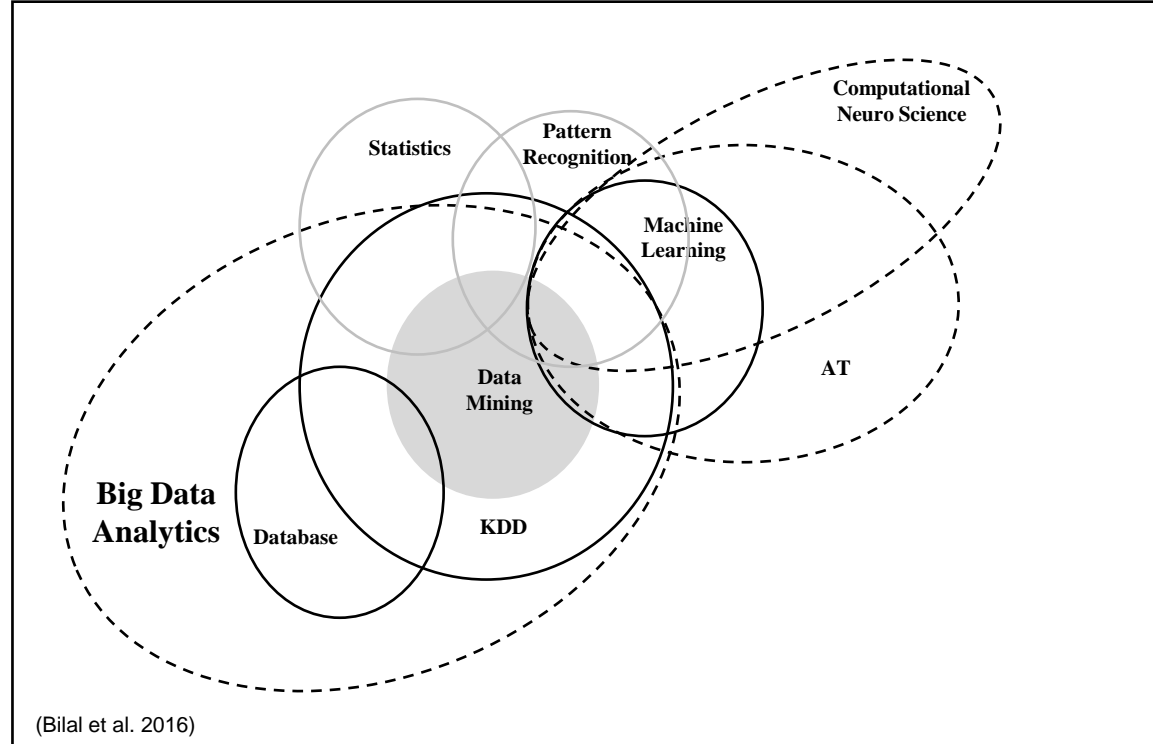


Big-Data Platform

►► Big Data for Infrastructure

➤ Big Data Analytics and Artificial Intelligence

- Big Data Analytics:
Rich intellectual tradition
- Borrows from a wide variety of fields.
- Statistics, Data Mining, Predictive Analytics, Business Analytics, and Knowledge Discovery from Data (KDD), Data Analytics, Data Science and now Big Data.



►► ➤ Big Data Analytics and Artificial Intelligence (AI)

- Artificial Intelligence (AI): 5th incoming industrial revolution
- AI techniques: Neural Networks, Expert system, Machine leanings, Image processing, Pattern recognitions, Voice recognitions, and Fuzzy-logic...etc.
- AI tools + Big-Data Mining =► Provide proper analysis and accurate engineering design, prediction, and decision making
- AI tools + Big-Data Mining =► Help engineers in improving project performance (reducing delivery times, environmental impact, expenses)
- AI tools + Big-Data Mining =► makes use of terabytes of information stored on the cloud by big-time service providers (Google, Oracle, IBM...)
- AI tools + Big-Data Mining =► Make sure that confidence engineers & decision makers don't miss out on an opportunity for improvement.

►► Sample Potential usage of Big Data in Infrastructure

- Big data technology helps engineers design massive infrastructures, while avoiding normally unforeseen Problems
- Design of Construction, and maintenance Management Systems
- Estimation and teams Management for the proposed projects
- In depth analysis for monitoring the Utilities health
- Analytics Big Data in Environmental Engineering
- Prediction of users capacities for Design, construction, and maintenance of Highway, Transportation, Water and Waste water networks

►► Sample Potential usage of Big Data in Infrastructure

- Geo-Technical Engineering applications
- Earthquake, and floods severity Prediction to avoid risk and potential project setbacks
- Coastal, Harbor prediction Engineering design, and construction
- Big-Data analytics in Geo- spatial engineering and Surveying
- Many applications for Data analytics in the field of Geographical Information System (GIS)
- Advanced Transportation: evaluate and analyze massive amounts of data generated by transportation and traffic systems.

Sample Potential usage of Big Data in Infrastructure



►► Design, Construction, & Maintenance Systems

- Construction and maintenance Industry of infrastructure sector generate huge amounts of information.
- Big data storage and analytics information are not properly benefiting from this data.
- Most of infrastructure stakeholders are using traditional computers & software for structure design computer aided drafting (CAD), and project details.
- Majority of engineers and decision makers in infrastructure sector are not aware of Big-Data technology & trends in storage and processing in Europe and Arab countries.

Sample Potential usage of Big Data in Infrastructure



►► Design, Construction, & Maintenance Systems

- Construction data will be gathered and stored for the future projects
- Applying big data analytics: the large amounts of data collected from various resources will be stored in the HDFS and then processed through Map Reduce to obtain the better results.
- Significant opportunities to scientists and practitioners: identifying useful insights & knowledge.
- BIM is envisioned to capture multi-dimensional CAD information systematically for supporting multidisciplinary collaboration.

Sample Potential usage of Big Data in Infrastructure



►► Floods, Users volume, Earthquake severity prediction

- Natural disaster: Hard to predict - uncertainty
- Cause painful losses in lives and property.
- Minimization and mitigation its risks : Main concerns for Engs. & DMs.
- Big data: Geographical, weather data, soil, buildings performance history...etc
- HDFS storage and MapReduce process =► Early Prediction.
- Avoid risks: Taking proper engineering and construction process for protection and mitigation

►► **Conclusions**

- Infrastructure challenges / Opportunities
- Construction of New Utilities, Maintenance of Existing ones
- Lack of Big data utilization in most Europe and the Arab countries.
- Big-data emersions: Endless world of Opportunities and benefits
- Big-data intergradations with infrastructure engineering, construction and maintenance
- Sample applications of Big-data with Infrastructure sector
- Big-data advantages in creating sustainable infrastructure
- Potential Benefits: Users, national economy, and environment

References

- [1] Dan Benta, Lucia Rusu, Marius Podean, Raluca Arba. (2012). "Web Based pavement maintenance and monitoring system". *2nd World Conference on Innovation and Computer Sciences*, 2012, Romania.
- [2] Manyika, J., Chui, M., Brown, B., Bughin, J., Dobbs, R., Roxburgh, C. & Byers, A. (2011). "Big data: The next frontier for innovation, competition, and productivity". McKinsey Global Institute.
- [3] Tien, J. (2013). "Big Data: Unleashing information". *J. Systems Sc. and Systems Eng.* 22, 127-151.
- [4] Waller. & Fawcetts. (2013). "Data science, predictive analytics, and big data: A revolution that will transform supply chain design and management". *Journal of Business Logistics*, 34, 77-84.
- [5] Robert P. Biuk-Aghai and Simon Fong. (2016). "Big data analytics for transportation: Problems and prospects for its application in China". *IEEE Region 10 Symposium*, Bali, Indonesia
- [6] Youseok Kang, JiayanYu, Jiarui Chang. (2017). "Big Data Analytics in Civil Engineering: The Case of China". *SSRG International Journal of Civil Engineering*. (SSRG – IJCE), Volume 4 Issue 10 – October 2017.
- [7] Hore, A. (2006). "Use of IT in Managing Information and Data on Construction Projects - A Perspective for the IRISH Construction Industry". *Information Technology in Construction Project Management*.
- [8] Sai On Cheung, H. C. (2004). "PPMS: A Web-based Construction Project Performance Monitoring System". *Automation in Construction*, 361-376.
- [9] Leu, Y.-M. C.-S. (2011). "Integrating data mining with KJ method to classify bridge construction defects". *Expert Systems with Applications*, 7143-7150.
- [10] Kunz J. and Fischer M. (2005). "Virtual Design and Construction: Themes, Case Studies and Implementation Suggestions". CIFE Working Paper #097, *Center For Integrated Facility Engineering*, Stanford University, USA
- [11] Jae-Gil Lee, M. K. (2015). "Geospatial Big Data: Challenges and Opportunities". *Big Data Research*, 74-81.
- [12] Muhammad Bilal, Lukumon O. Oyedele, Junaid Qadir, Maruf Pasha. (2016). "Big Data in the construction industry: A review of present status, opportunities, and future trends". *Journal of Advanced Engineering Informatics* .30(3):500-521
- [13] <https://www.zdnet.com/article/what-is-big-data> : (Accessed on August 10, 2019)
- [14] S.R Kim, M.M Kang (2014). "Today and the Future of Big Data analytics technology", *The Korean Institute of Information Scientists and Engineering*, vol. 1, pp. 8-17, 2014
- [15] Basics of Big Data: <http://www.sliceofbi.com/2015/09/basics-of-big-data.html> : (Accessed on August 10, 2019)
- [16] How Much Data Is Generated Every Minute? <https://www.socialmediatoday.com/news/how-much-data-is-generated-every-minute-infographic-1/525692/> (Accessed on August 10, 2019)
- [17] Big data : <http://www.anishsneh.com/2014/07/big-data-volume-velocity-and-variety.html> (Accessed on August 10, 2019)
- [18] Understanding-basics-of-HDFS: <https://community.cloudera.com/t5/Community-Articles/Understanding-basics-of-HDFS-and-YARN/ta-p/248860> (Accessed on August 10, 2019)
- [19] Transfortech.com: <http://user-manual-guide.blogspot.com/2016/03/hadoop-mapreduce-architecture.html> (Accessed on August 10, 2019)
- [20] Abdelkarim Ben Ayed, Mohamed Ben Halima, Adel M. Alimi. (2015). "Big Data Analytics for Logistics and Transportation". *The 4th IEEE International Conference on Advanced Logistics and Transport* (IEEE ICALT'2015).



Thank You