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Achieving Smarter Buildings and More Efficient Facilities Management: The Implementation Of Big Data

Presented by Mary-Catherine Greene

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Presentation Overview

- Introduction and Context
- Background to Research
- Research Methodology
- Research Objectives
- Research Findings
- Research Conclusions, Implications for Industry and Further Research

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Achieving Smarter Buildings and More Efficient Facilities Management: The Implementation Of Big Data

Section 1: Introduction, Context, Background, Research Methodology

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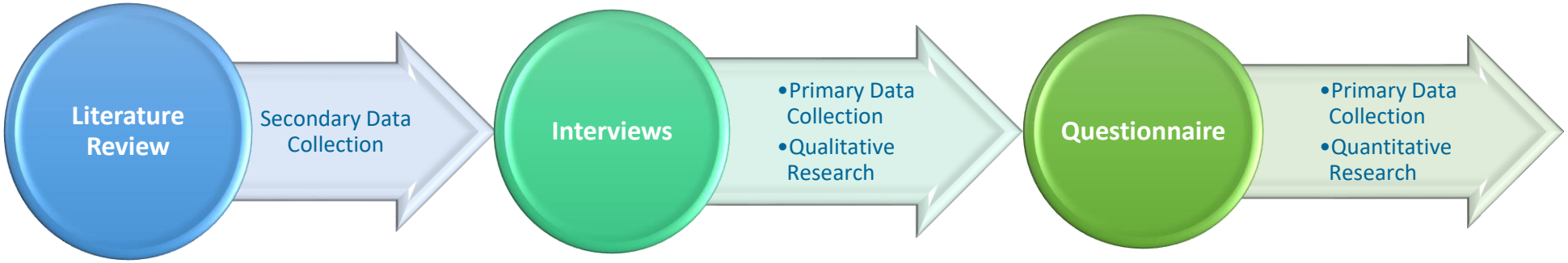
Introduction and Context

- Big Data – What is it? Where does it come from?
- Does it exist in the construction industry?
- How can we use it?
- Can it help to achieve smarter buildings?
- Can it bring efficiencies to facilities management?

Background to Research

- Spurred by multi-industry buzz relating to Big Data
- Determination of the most common concepts of Big Data
- Where Big Data fits within the Architectural, Engineering and Construction (AEC) industry
- As buildings become more complex, smarter, interconnected and self-reporting, can existing technologies be used to the advantage of the end user and society?
- This study looks to determine if implementing big data to create smart buildings can improve sustainability and increase efficiency in Facilities Management (FM).

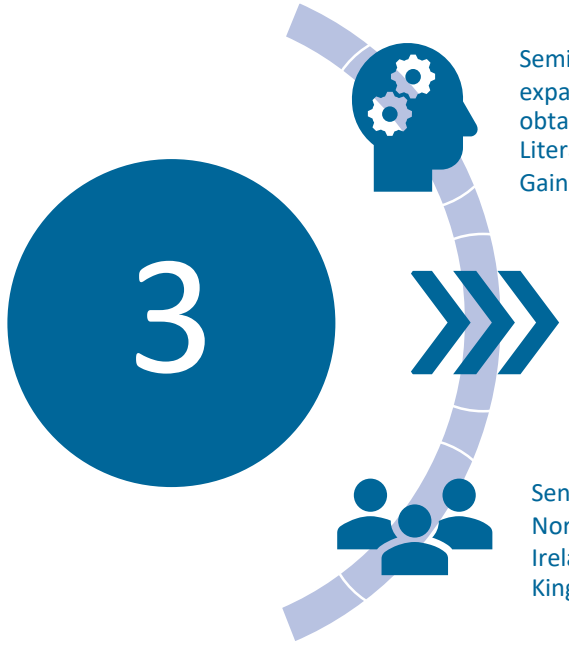
Research Methodology



Literature Review

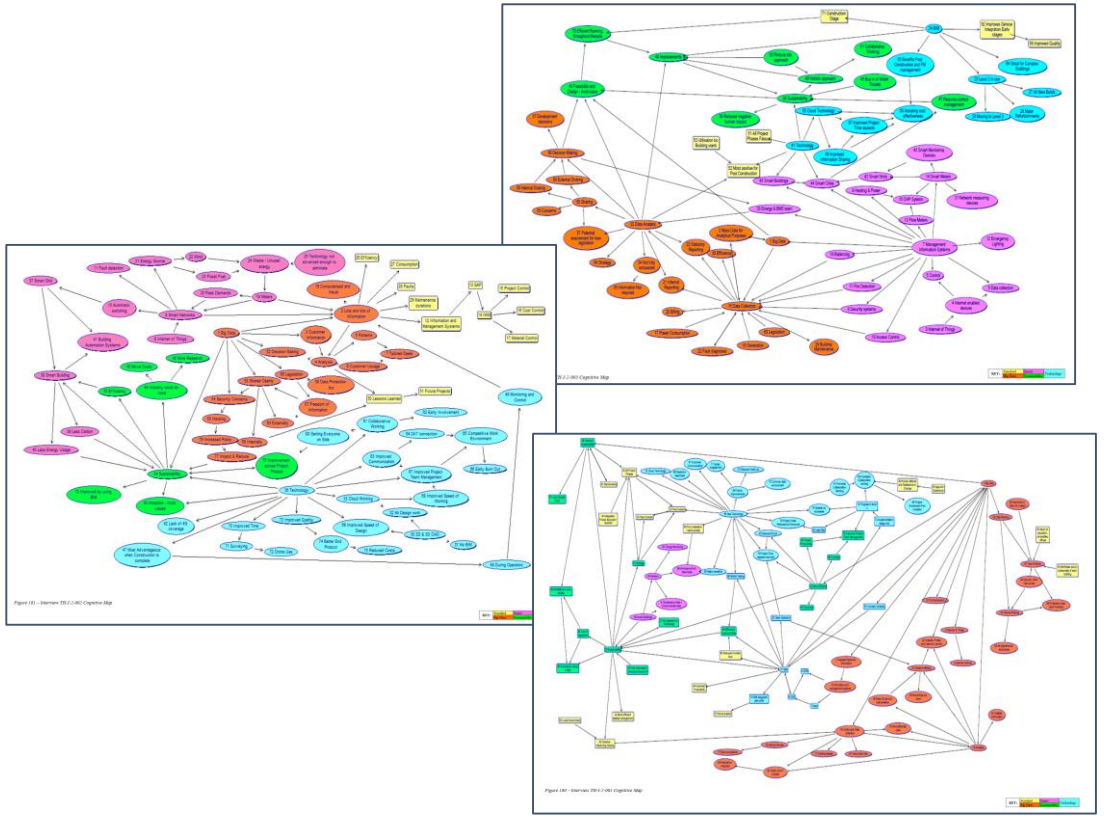
Identifying existing theories → Determining Gaps in knowledge → Research Objectives

Qualitative Research: Interviews

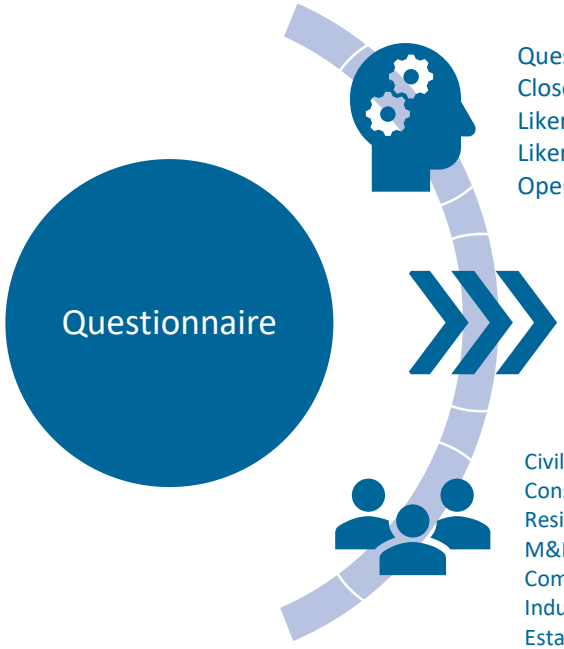


Research Areas:

- Big Data
- IoT
- Data Sources
- Types of Data
- Data Collection
- Data usage
- Data Analysis
- Data during Project Lifecycle
- Most assisted project phase
- Information sharing
- Sustainability
- Technology
- Movement to Smart
- Awareness of new technologies
- Employment of new technologies
- BIM
- Decision Making
- Influence of Data on Decision Making
- Influence of Technology on Decision Making



Quantitative Research: Questionnaire



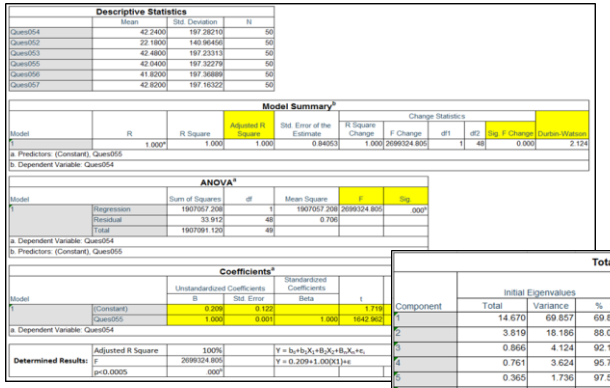
Question Types:
Closed Type
Likert Scale
Likert Scale Matrix
Open Ended

Statistical Analysis

Civil Engineering
Consultancy
Residential Development
M&E Engineering
Commercial Development
Industrial Development
Estates and FM
Manufacturing Suppliers

4 Primary Sections

1. Background and Industry
2. Big Data & IoT
3. Big Data in AEC
4. Sustainability, Technology and Big Data



Descriptive Statistics

	Mean	Std. Deviation	N
Ques054	42.2400	197.28210	50
Ques052	22.1800	140.96456	50
Ques053	42.4800	197.23313	50
Ques055	42.0400	197.32279	50
Ques056	41.8200	197.36889	50
Ques057	42.8200	197.16322	50

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	1.000[a]	1.000	1.000	0.84053	1.000	2699324.805	1	48	0.000	2.124

a. Predictors: (Constant), Ques055
b. Dependent Variable: Ques054

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1907057.208	1	1907057.208	2699324.805	.000[b]
	Residual	33.912	48	0.706		
	Total	1907091.120	49			

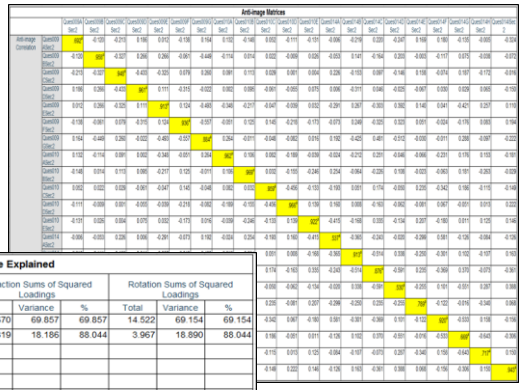
a. Dependent Variable: Ques054
b. Predictors: (Constant), Ques055

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t
		B	Std. Error	Beta	
1	(Constant)	0.209	0.122		1.719
	Ques055	1.000	0.001	1.000	1642.962

a. Dependent Variable: Ques054

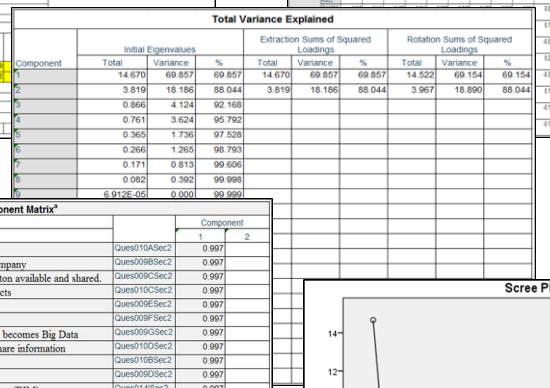
Determined Results:	Adjusted R Square	100%	$Y = b_0+b_1X_1+B_2X_2+B_nX_n+\varepsilon_i$
	F	2699324.805	$Y = 0.209+1.00(X1)+\varepsilon$
	p<0.0005	.000[b]	



Anti-image Matrices

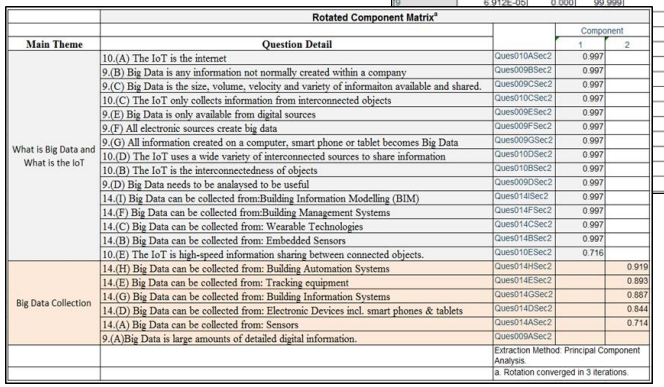
		Ques054	Ques052	Ques053	Ques055	Ques056	Ques057
Anti-image Covariance	Ques054	.706	-.125	-.215	.199	.012	.164
	Ques052	-.125	.020	-.037	.035	-.002	-.029
	Ques053	-.215	-.037	.040	-.035	.019	.026
	Ques055	.199	.035	-.035	.033	-.002	-.027
	Ques056	.012	-.002	.019	-.002	.000	.002
	Ques057	.164	-.029	.026	-.027	.002	.022
Anti-image Correlation	Ques054	.667[a]	-.915	-.813	.915	.913	.915
	Ques052	-.915	.667[a]	-.917	.915	.913	.915
	Ques053	-.813	-.917	.667[a]	-.915	-.913	-.915
	Ques055	.915	.915	-.915	.667[a]	.913	.915
	Ques056	.913	.913	-.913	.913	.667[a]	.913
	Ques057	.915	.915	-.915	.915	.913	.667[a]

a. Measures of Sampling Adequacy(MSA)



Total Variance Explained

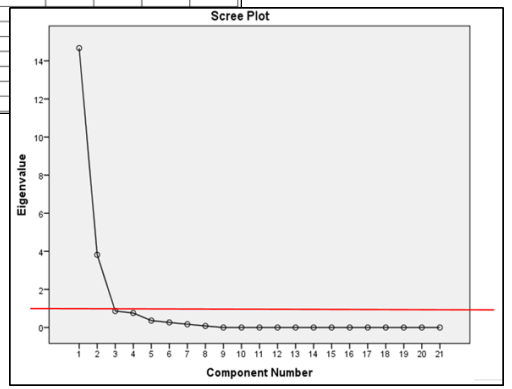
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	Variance	%	Total	Variance	%	Total	Variance	%
1	14.670	69.857	69.857	14.670	69.857	69.857	14.522	69.154	69.154
2	3.819	18.186	88.044	3.819	18.186	88.044	3.967	18.890	88.044
3	0.866	4.124	92.168						
4	0.761	3.624	95.792						
5	0.365	1.736	97.528						
6	0.266	1.265	98.793						
7	0.171	0.813	99.606						
8	0.082	0.392	99.998						
9	6.912E-05	0.000	99.999						
10	1.000E-05	0.000	100.000						



Rotated Component Matrix[a]

Main Theme	Question Detail		Component 1	Component 2
What is Big Data and What is the IoT	10.(A) The IoT is the internet	Ques010ASec2	0.997	
	9.(B) Big Data is any information not normally created within a company	Ques009BSec2	0.997	
	9.(C) Big Data is the size, volume, velocity and variety of informaiton available and shared.	Ques009CSec2	0.997	
	10.(C) The IoT only collects information from interconnected objects	Ques010CSec2	0.997	
	9.(E) Big Data is only available from digital sources	Ques009ESec2	0.997	
	9.(F) All electronic sources create big data	Ques009FSec2	0.997	
	9.(G) All information created on a computer, smart phone or tablet becomes Big Data	Ques009GSec2	0.997	
	10.(D) The IoT uses a wide variety of interconnected sources to share information	Ques010DSec2	0.997	
	10.(B) The IoT is the interconnectedness of objects	Ques010BSec2	0.997	
	9.(D) Big Data needs to be analaysed to be useful	Ques009DSec2	0.997	
	14.(I) Big Data can be collected from:Building Information Modelling (BIM)	Ques014ISec2	0.997	
	14.(F) Big Data can be collected from:Building Management Systems	Ques014FSec2	0.997	
	14.(C) Big Data can be collected from: Wearable Technologies	Ques014CSec2	0.997	
	14.(B) Big Data can be collected from: Embedded Sensors	Ques014BSec2	0.997	
	10.(E) The IoT is high-speed information sharing between connected objects.	Ques010ESec2	0.716	
Big Data Collection	14.(H) Big Data can be collected from: Building Automation Systems	Ques014HSec2		0.919
	14.(E) Big Data can be collected from: Tracking equipment	Ques014ESec2		0.893
	14.(G) Big Data can be collected from: Building Information Systems	Ques014GSec2		0.887
	14.(D) Big Data can be collected from: Electronic Devices incl. smart phones & tablets	Ques014DSec2		0.844
	14.(A) Big Data can be collected from: Sensors	Ques014ASec2		0.714
	9.(A)Big Data is large amounts of detailed digital information.	Ques009ASec2		

Extraction Method: Principal Component Analysis.
a. Rotation converged in 3 iterations.



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Section 2: Research Objectives and Findings

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Achieving Smarter Buildings And More Efficient Facilities Management: The Implementation Of Big Data

Research Participants

Interviews

FM and Estates Management
Energy Sector
Construction and FM

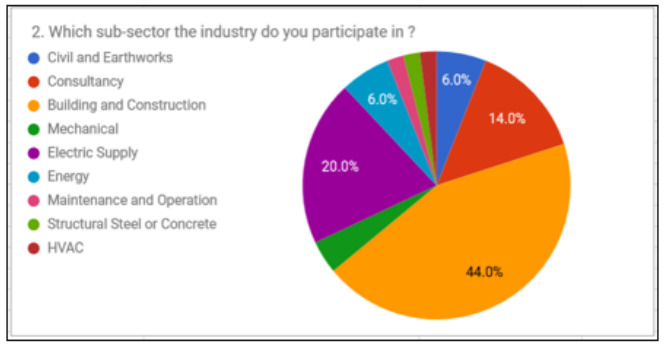
20+ years

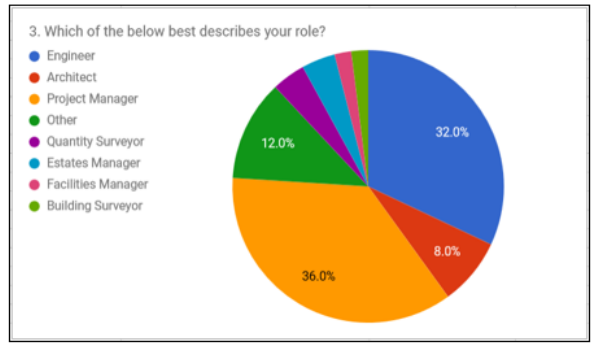
Northern Ireland

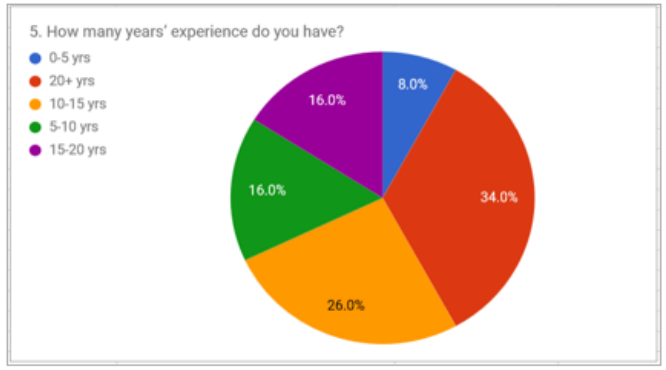
Ireland

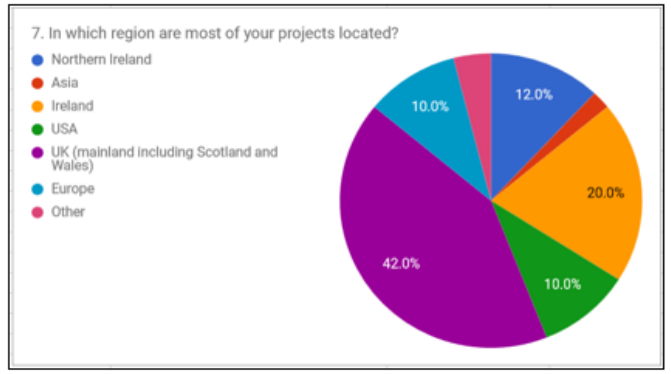
United Kingdom

Questionnaire Responses









Research Objectives

1. To establish the levels of understanding and use of big data and the IoT within the construction industry and throughout the life cycle of a project.
2. To examine what data the industry is collecting and examining from big data and the IoT.
3. To investigate how big data and new associated technologies are influencing decision making.
4. To investigate which phase of the project lifecycle is best assisted by big data, the IoT and new technologies.
5. To determine if sustainability can be improved through employing big data analysis technology in creating smarter, greener and efficient buildings from inception.
6. To investigate if the implementation of big data, IoT and new technologies creates more efficient FM and sustainable smart buildings.

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1 To establish the levels of understanding and use of big data and the IoT within the construction industry and throughout the life cycle of a project.

Literature Review Results	Indicates extensive research on these subjects and their concepts but limited within the context of the construction industry.
Qualitative Research Results: Interviews	Determines that there is not a clear understanding of the terminology or concept for either big data or the IoT.
Quantitative Research Results: Questionnaire	Determines that much confusion exists around what is big data, but those surveyed favour the description that big data is large amounts of detailed digital information, large in size, volume, velocity and variety that can be collected from any source on an AEC project. Further identifying the IoT as the 'interconnectedness of objects that use a wide variety of interconnected sources to share information' with the IoT essential for creating smart buildings, grids and smart cities

CIOB: Chartered Institute of Building, 2015. Code of practice for Project Management for construction and development.

Achieving Smarter Buildings And More Efficient Facilities Management: The Implementation Of Big Data

2 To examine what data the industry is collecting and examining from big data and the IoT.

Literature Review Results	Extensive research on this subject shows sensors as the largest contributors to the IoT and big data, that the technology is in its infancy with some application within the industry though embedded sensors. Predominantly applications are limited to energy efficiency, structural health monitoring or wearable technologies.
Qualitative Research Results: Interviews	Determines that there is limited collection of data within the industry and that much of the data collected is done with the focus on efficiency, temperature, environmental control, customer satisfaction or for legislative requirement.
Quantitative Research Results: Questionnaire	Determines BIM creates big data, that big data can be collected from sources on any type of AEC project and that AEC companies are using information from big data and big data analytics daily, with BIM creating a lot of the big data that AEC companies are using and analysing daily.

3 To investigate how big data and new associated technologies are influencing decision making.

Literature Review Results	Identifies limited research into how big data is assisting or influencing decision-making, business performance and competitive advantage in business. Limited research on how big data can influence decisions within the construction industry.
Qualitative Research Results: Interviews	Determines that participants interviewed use data to assist with decision-making.
Quantitative Research Results: Questionnaire	Determines that big data, big data analytics and new technologies are improving decision-making for AEC companies.

4 To investigate which phase of the project lifecycle is best assisted by big data, the IoT and new technologies.

Literature Review Results	Identifies limited research on this subject, identifying the existence of new technology, big data and the IoT, but not making any connection to project phases.
Qualitative Research Results: Interviews	Determines all project phases are assisted, with the majority identifying feasibility and design phases while others identify post-construction as most assisted by big data, IoT and new technology.
Quantitative Research Results: Questionnaire	Returns similar results as qualitative research identifying the early phases of the project at inception and design as most assisted by big data, IoT and new technology.

5 To determine if sustainability can be improved through employing big data analysis technology in creating smarter, greener and efficient buildings from inception.

Literature Review Results	Identifies limited research on this subject, discussing sustainability, smart buildings and identifying links between efficiency and sustainability but no research identifies how big data analysis could be used to predict best design for future projects putting sustainability at the forefront.
Qualitative Research Results: Interviews	Determines participants are of mixed opinions on this but majority is adamant that technology and big data can assist in improving sustainability.
Quantitative Research Results: Questionnaire	Identifies big data, big data analysis and technology can come together and through design to improve sustainability.

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6 To investigate if the implementation of big data, IoT and new technologies creates more efficient FM and sustainable smart buildings.

Literature Review Results	Identifies limited research on this subject, with existing research discussing facilities management, sustainability and smart buildings in segregation.
Qualitative Research Results: Interviews	Determines that improvement through use of big data and technology can be achieved, especially if implemented at the early stages of the project.
Quantitative Research Results: Questionnaire	Determines that facilities management can be improved by using big data analytics and that BIM is essential for facilities management. Further identifies an opinion that BIM and BMS should be integrated leading to improved facilities management. Also identifies that those surveyed are of the opinion that big data, the IoT, BIM and new technologies will improve the efficiency of facilities management.

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Section 3: Research Conclusions, Implications for Industry and Further Research

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Research Conclusions

General:

- New Technologies and Advances are leading to a reliance on artificial intelligence
- The Construction Industry is embracing new and developing technologies
- Client driven adoption of new technologies
- Big Data, Big Data Analytics, IoT and Cloud Technologies off opportunity for growth, improvement in sustainability and efficiency
- AEC companies are using information from big data and big data analytics daily
- BIM is creating a lot of the big data that AEC companies are using and analyzing daily
- This analysis can improve decision making for AEC companies

Research Returned Favoured Explanations:

- Big Data: big data is large amounts of detailed digital information, large in size, volume, velocity and variety that can be collected from any source on an AEC project
- The IoT is the interconnectedness of objects that use a wide variety of interconnected sources to share information, establishes the IoT as essential for creating smart buildings, smart grids and smart cities
- Big data can be collected from sources on any type of AEC project

Project Phases, Sustainability and Efficiencies in FM

- Early project phases of inception and design as most assisted by big data, the IoT and new technology
- Differing opinions relating to the ability of technology alone to improve sustainability
- Big data, big data analysis and technology coming together through design can improve sustainability
- Incorporation of big data and technology in the early stages of the project, can bring improvement in facilities management, especially through use of big data analytics and BIM
- Suggestions that BIM and BMS should be integrated to further improve facilities management, bringing efficiency of facilities management and advantage to end users

Implications for Industry

- Positive benefits achievable from the willingness to adopt new technologies
- Mixed, unrelated use and misunderstanding of terminology could leave construction lagging other industries

Further Research .....

- Improvements
- Measurement of Improvements
- Interconnectivity

Sustainability and Efficiencies in FM

Technology

- Adoption
  - Speed
  - Preferences
  - Implementation processes
- Adaptation of existing
- Integration

- Influences of technology
- Impact on projects
- Possible improvements

Improvements to Collaborative Working

Integrations between BIM and BMS

- Can it be done
- How can we do it
- Impact for the industry

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Thank you

Mary-Catherine Greene

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