2026 VERSION

STARmass™
Environment Technologies Corporation - Canada

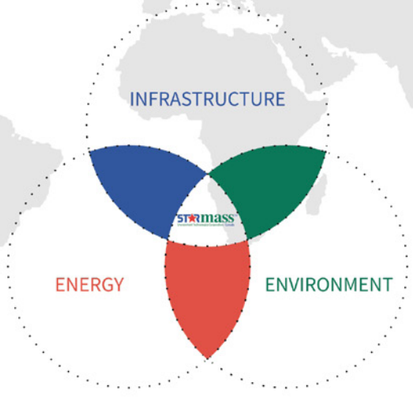
TALL BUILDINGS LIFETIME MONITORING SOLUTION

Asset Owner's
Decision Support System

Lifelong Safeguard & Protection of Building Owners' Interest

STARmass™
Environment Technologies Corporation - Canada

We understand the relation between
Infrastructure, Energy and Environment



We Understand The

- Safety
- Stability
- Integrity
- Health
- Risk
- Vulnerability
- Hazard
- Smartness
- Intelligence
- Preservation

Of Physical Infrastructure

ABOUT **STARMASS**

Brief Introduction

Smarter, safer, more profitable, sustainable, resilient infrastructure.

30+ Years
Delivering advanced infrastructure solutions.

180+ Experts
Specialists in smart, high-risk assets.

By focusing on the dynamic interaction between Infrastructure, Environment, and Energy, Starmass identifies design opportunities earlier, uncovers hidden risks, and prioritizes interventions where they generate the greatest return on every dollar invested. This systems-level view allows the team to distinguish between local defects and systemic issues, so that only the truly critical problems are targeted for immediate action.

Continuous sensing, data acquisition, and analytics further refine this process by providing granular, real-time insight into how assets behave under changing loads and environmental conditions. As a result, potential failures can often be anticipated and addressed through planned, minimally invasive repairs instead of disruptive, large-scale interventions.

Working as a single point of integration, Starmass coordinates technologies, engineering expertise, and implementation teams to ensure that each repair is executed safely and with clear accountability. This integrated approach reduces duplication of effort, avoids stacked vendor margins, and delivers infrastructure that is safer, more reliable, and more economical to own over its entire lifecycle.

Contents

Approach

Owner-Led Digital Lifecycle for Tall Buildings

Owner's decisions protected and empowered at every stage of a Tall Building's digital lifecycle.

The advent of modern digital technologies and easy access to communication networks has made it practical to offer full control at all stages of the lifecycle of a Tall Building. Starmass digital solutions for Tall Buildings are designed to protect, in principle, an Owner's interest at all stages of the life of a Tall Building. Starmass Asset Lifecycle management solutions, being digital, substantially reduce the margin of man-made errors.

A building/asset owner/investor/developer has the highest amount of risk on the asset to manage and has never-ending decision-making to undertake for the Building. Owner's decision-making remains the core for any Building and remains with the owner throughout the Lifecycle of a Building. This involves, besides a certain amount of vulnerability, a dependency upon others—Manager, Engineers, technicians.

The quality of the information and thus the data obtained will depend on and vary with each of the manpower or agencies involved collecting the information on the building. Hence, the owner's decision will be dependent on several external agencies/individuals. This has a direct financial impact on the Owner. At Starmass Canada, digital solutions for Lifecycle management of a building are automated and more realistic and eliminate to an extent such similar dependencies on the teams deployed.

Digital Transformation of Building

Data-driven risk and lifecycle cost, optimized.

The advent of modern digital technologies and easy access to communication networks has made it practical to offer full control at all stages of the lifecycle of a Tall Building. Starmass digital solutions for Tall Buildings are designed to protect, in principle, an Owner's interest at all stages of the Tall Building. Starmass Asset Lifecycle Management solutions, being digital, substantially reduce the margin of man-made errors.

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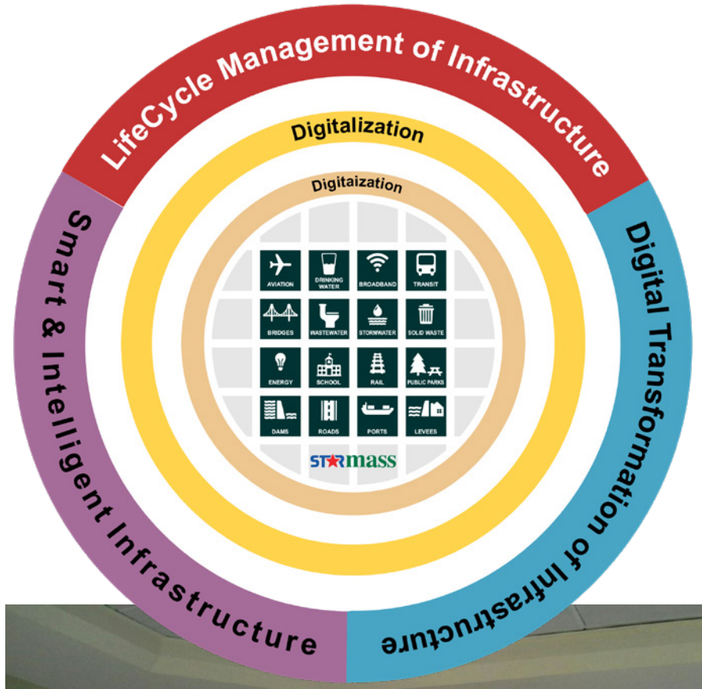
The quality of the information, and thus the data, will depend on and vary with each of the manpower resources or agencies involved. Hence, the quality of the decision will be subjective, and this has a direct financial impact. Starmass digital solutions for lifetime management of the Building are automated and more realistic and, to an extent, eliminate such dependencies on the teams deployed.



HOW DO WE FACILITITATE **DIGITAL TRANSFORMATION OF BUILDINGS?**

Facilitation & Implementation

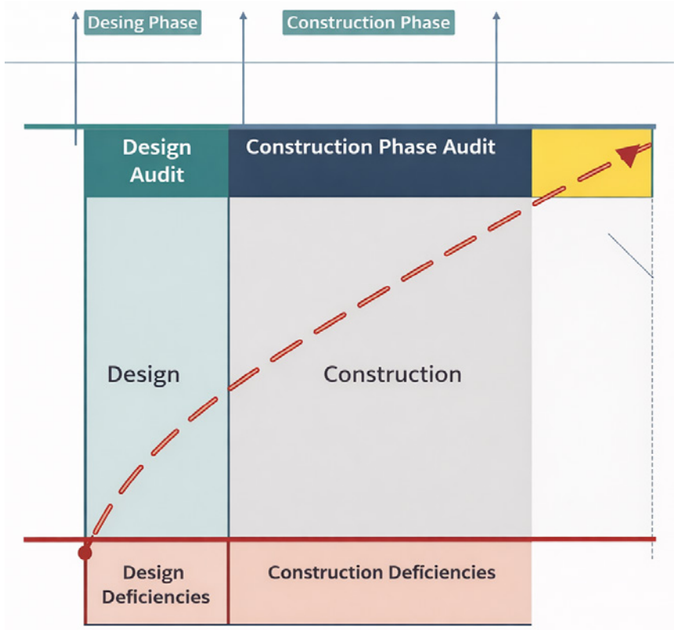
- We facilitate Digital Transformation of assets for the building owners through enabling and transforming buildings to come to life and begin direct communications with the owner.
- We implement Digital Transformation by the installation of various sensors both inside and outside the building structures in order to receive real-time data around the clock.

How does a Building Communicate with its Owner?

We utilize Digital Transformation to enable the communication between the owner and its assets through the following phases:

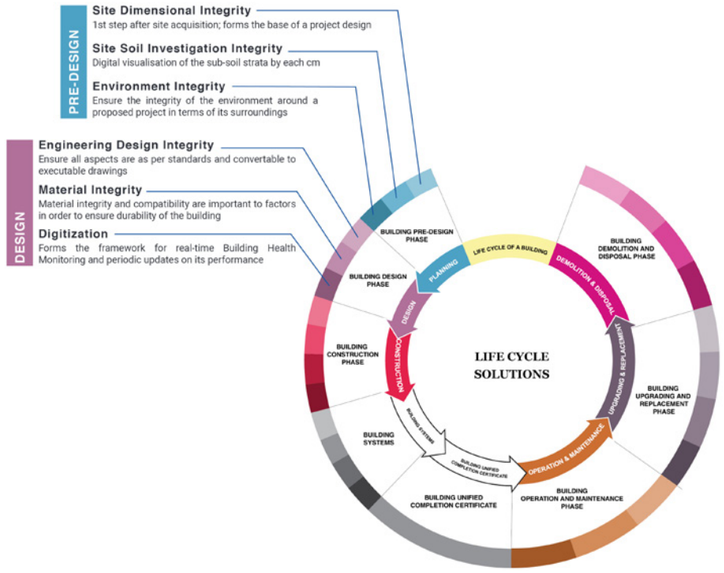
- **Design & Pre-Construction Vulnerabilities Phase**
- **Post-Construction Buildings Performance**
- **Building Systems Monitoring Phase**

DESIGN & PRE-CONSTRUCTION PHASE



PRE-DESIGN PHASE

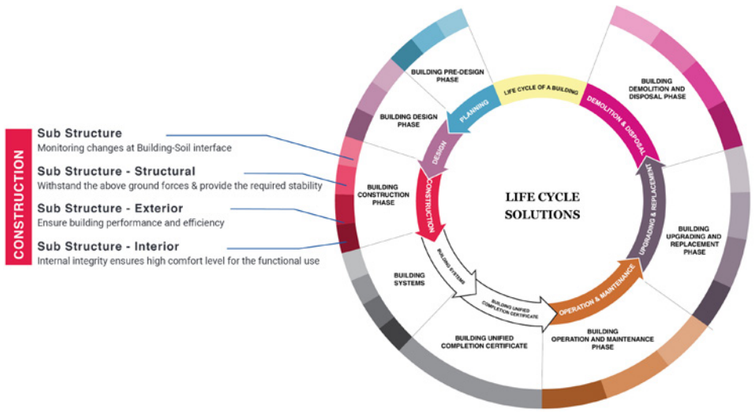
Module 1: Baseline Audit



Assest Owner's Autonomous Decision Suport System					
Tall Buildings / Public Buildings / Heritage Buildings					
Module 1: Baseline Audit					
	Description	**KPI**	**Serial Number**	**Metrics**	**Major Reference in Saudi Arabia**
Baseline Audit	For a Tall Building, a Baseline Audit is carried out to ascertain the status. This is equally applicable to an existing Tall Building or a new construction.	Key Performance Indicators (KPI) Current Status	1	Dimensionality	Upon Request
			2	Pressures	
			3	Cracks	
			4	Tilt / Bending	
			5	Material Quality	
			6	Positioning	

PRE-CONSTRUCTION PHASE

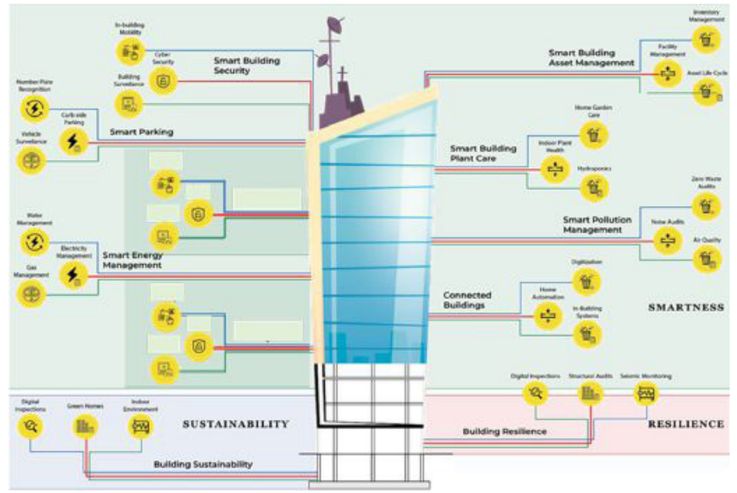
Module 2: Sub-Structure Performance Monitoring



Assest Owner's Autonomous Decision Suport System					
Tall Buildings / Public Buildings / Heritage Buildings					
Module 2: Sub-Structure Performance Monitoring					
	Description	**KPI**	**Serial Number**	**Metrics**	**Major Reference in Saudi Arabia**
Sub-Structure Performance Monitoring	The Sub-structure of a Building remains burried below the ground all through the building life. In order to ascertain as to how the building is performing in a given surrounding with several forces around, The building designers always use their experience and expertise and designs for extreme combination of loads. But the building gets into critical stage even without the assumed extreme loads. It can happen with fluctuating water table for instance. Hence Sub-structure performance monitoring becomes crucial.	Key Performance Indicators (KPI) Current Status	7	Soil Test Report Validation	Upon Request
			8	Ground Performance loads	
			9	Constructing sequence Monitoring	
			10	Ground water Monitoring	
			11	Corrosion Prevension	
			12	Ground Subsidence	

PRE-CONSTRUCTION PHASE

Module 3: Construction Phase Monitoring



Assest Owner's Autonomous Decision Suport System					
Tall Buildings / Public Buildings / Heritage Buildings					
Module 3: Building Construction Phase Monitoring					
	Description	**KPI**	**Serial Number**	**Metrics**	**Major Reference in Saudi Arabia**
Construction Phase Monitoring	This is a very important phase in the construction of Tall Buildings. There are many aspcts that need to be monitored where neither the designer nor the contractors would be happy to be actually get the work key parameters measured and understand the deviation from the initial assumptions.. The Monitoring of this phase is essential, may not be as much from the designer and the contractor perspective, but it never the less helpful as the basis of safe and secure tall building.	Key Performance Indicators (KPI) Current Status	13	Concrete Quality	Upon Request
			14	Concrete Strength	
			15	Form Work / Shuttering	
			16	Building Line & Alignment	
			17	Structural Shortening	
			18	Environmental Impact	

POST-CONSTRUCTION **BUILDING PERFORMANCE**

Buildings, like all engineered systems, undergo a natural process of wear and degradation over time. Understanding the stages of this lifecycle is key to ensuring structural longevity, minimizing risk, and optimizing maintenance costs. The following overview explains how degradation typically progresses and how timely action can make a dramatic difference in preservation and cost efficiency.

- A building is constructed for a certain finite period of time in its designed Life.
- A building starts the slow process of degradation within the designed life, which starts from first day.
- Based on several factors such as environment, material sustainability, use & abuse- the process of degradation can change within the designed life.
- First phase of 40% drop in building quality is a slow process spread over a long period of 75% of the building designed life.
- The second phase of 40% drop in Building quality takes place very fast and is steep and ultimately leading to failure.
- Every dollar spent in attending to building degradation in phase one can save up to 10 times in the second phase.
- In order to redress the building distress, the faster we get the information the action can be initiated.
- Starmass offers an automated process direct to the decision makers to make actionable decisions.

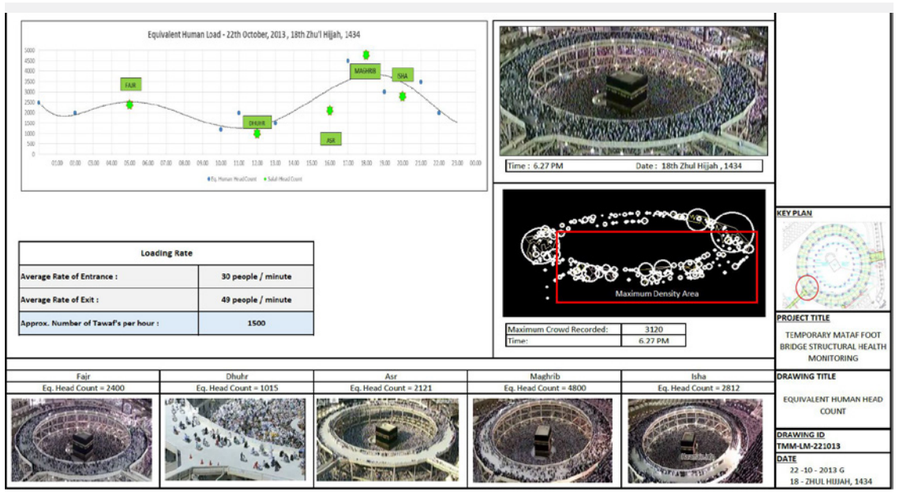
POST-CONSTRUCTION PHASE

Module 4: Structural Perfromance Monitoring

Assest Owner's Autonomous Decision Suport System					
Tall Buildings / Public Buildings / Heritage Buildings					
Module 4: Structural Performance Monitoring					
	Description	**KPI**	**Serial Number**	**Metrics**	**Major Reference in Saudi Arabia**
Structural Performance Monitoring	For any building it is essential to continue to be stable, sound and safe for its economic benefits. As such Structural Health Monitoring is an essential requirement for Tall buildings. Establishing the Structural Health Monitoring system as the base to measure periodically the performance of the structure. This SHM Monitoring becomes significant in case of a major natural event, or the abuse of the building in terms of illegal alterations, To monitor major alterations to the building for functional needs. In case of an unfortunate event.	Key Performance Indicators (KPI) Current Status	**19**	**Vibration**	Upon Request
			20	**Strain**	
			21	**Bending**	
			22	**Cracks**	
			23	**Building Line & Alignment**	
			24	**Structural Cracks Monitoring**	

POST-CONSTRUCTION PHASE

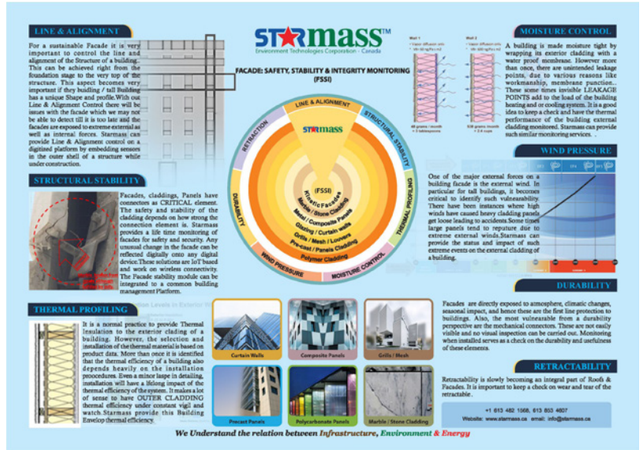
Module 5: Building Perfromance Monitoring



Assest Owner's Autonomous Decision Suport System					
Tall Buildings / Public Buildings / Heritage Buildings					
Module 5: Building Perfromance Monitoring					
	Description	**KPI**	**Serial Number**	**Metrics**	**Major Reference in Saudi Arabia**
Building Perfromance Monitoring	For a building to remain healthy and operational it is essential to collect periodic measurements to get a real understanding of the building and not reliant on assumed inputs at the design stage.	Key Performance Indicators (KPI) Current Status	26	Termal Performance	Upon Request
			27	Air Quality / Pollution	
			28	Moisture & Dampness	
			29	Building Envelope	
			30	Space Occupancy Monitoring	
			31	Human Comfort	

POST-CONSTRUCTION PHASE

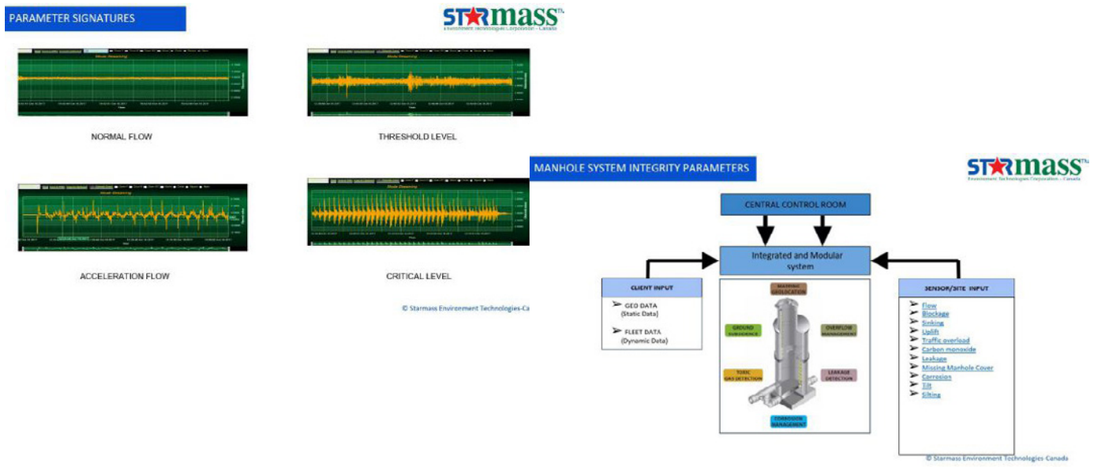
Module 6: Architectural Perfromance Monitoring



Assest Owner's Autonomous Decision Suport System					
Tall Buildings / Public Buildings / Heritage Buildings					
Module 6: Architectural Perfromance Monitoring					
	Description	**KPI**	**Serial Number**	**Metrics**	**Major Reference in Saudi Arabia**
Architectural Perfromance Monitoring	It is a general practice that once a building is constructed it is assumed the building would continue to run on its own. A long term perspective is to keep all the building systems up and running. Architectural performance monitoring is very important. Some of the related aspects are highlighted.	Key Performance Indicators (KPI) Current Status	31	Facade Monitoring	Upon Request
			32	Thermal Expansion Joints	
			33	Floors & Walls - Finishes	
			34	Building Line & Alignment	
			35	Building Functionality	
			36	Environmental Impact	

POST-CONSTRUCTION PHASE

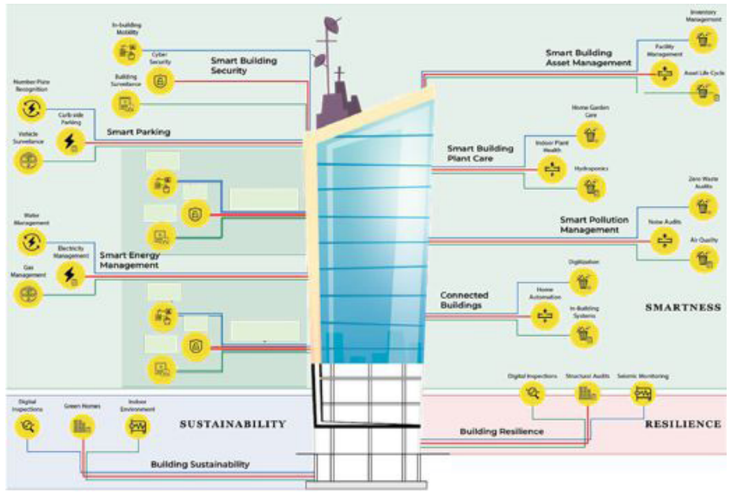
Module 7: Building MEP Perfromance Monitoring



Assest Owner's Autonomous Decision Suport System					
Tall Buildings / Public Buildings / Heritage Buildings					
Module 7: Building MEP Perfromance Monitoring					
	Description	**KPI**	**Serial Number**	**Metrics**	**Major Reference in Saudi Arabia**
Building MEP Perfromance Monitoring	In facility management MEP holds a distinct role. Continuous and constant systems monitoring is essential. Till recently facility management meant supervisory control on the operations and running of a facility. In the solutions offered by Starmass Canada, aspects over and above the operational aspects are looked into. These are the health of different systems which are kept running. Some of these essential MEP aspects that need performance monitoring are highlighted here.	Key Performance Indicators (KPI) Current Status	37	Digtal Water Counting	Upon Request
			38	Power Consumption Monitoring	
			39	Gas Consumption Monitoring	
			40	Waste Water Disposal Monitoring	
			41	Illumination Optimization	
			42	Systems Test & Balance	

POST-CONSTRUCTION PHASE

Module 8: Safety & Security Monitoring



Assest Owner's Autonomous Decision Suport System					
Tall Buildings / Public Buildings / Heritage Buildings					
Module 8: Safety & Security Monitoring					
	Description	**KPI**	**Serial Number**	**Metrics**	**Major Reference in Saudi Arabia**
Safety & Security Monitoring	The concept of Building Safety and Security till the recent past has been the use of CCTV cameras. However, with the advent of Industry Four Technologies using the standard CCTV camera feed and using Artificial Intelligence a detailed visual analytics is achievable.	Key Performance Indicators (KPI) Current Status	43	Fire Safety Monitoring	Upon Request
			44	Evacuation Path Flow	
			45	Mobile Asset Tracking	
			46	Asset Inventory	
			47	Geofencing	
			48	Event Breach Log	

POST-CONSTRUCTION PHASE

Module 9: Crowd / Guest Monitoring

Assest Owner's Autonomous Decision Suport System					
Tall Buildings / Public Buildings / Heritage Buildings					
Module 9: Crowd / Guest Monitoring					
	Description	**KPI**	**Serial Number**	**Metrics**	**Major Reference in Saudi Arabia**
Crowd / Guest Monitoring	Guest Monitoring / Crowd Monitoring / Crowd Control are some of the useful applications using Industry 4.0 IR technologies. Such detailed analytics is achievable with the availability level of technologies.	Key Performance Indicators (KPI) Current Status	**49**	**Crowd Counters**	Upon Request
			50	**Crowd Movement**	
			51	**Human Tracking**	
			52	**Event Monitoring**	
			53	**Anomaly Detection**	
			54	**Disaster Mitigation**	

WHAT ARE THE NEW **TECHNOLOGICAL ADVANTAGES OF DIGITAL TRANSFORMATION?**

Digital Transformation Technological Advantages

Till recently, almost all the systems deployed for managing the lifecycle of a building were third-generation solutions.

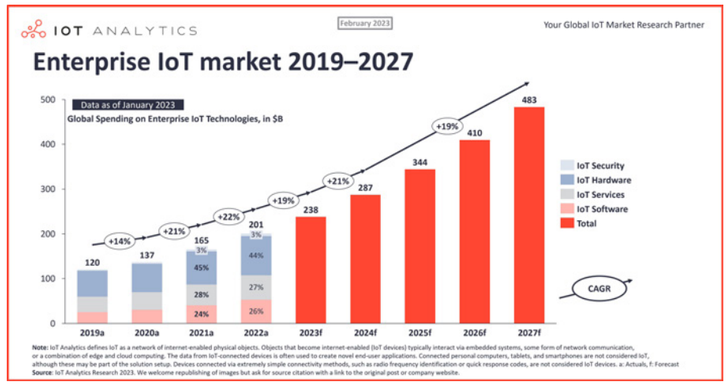
Most of these were stand-alone systems and, moreover, operational systems, so decision making was not real time as the data underwent a process to arrive at meaningful results.

In the last few years, technology has advanced at a fast pace, and now, throughout the lifecycle of a tall building, fourth-generation technologies are being deployed. These technologies have provided a definite advantage by enhancing the quality of decision making by the owner of the tall building. The biggest advantage is that these technologies bring realistic data and information to the owner without any human intervention. The mode, form, and format of the data and information thus reaching the owner are helpful in making fast decisions towards lifecycle management of the tall building.

The new 4IR technologies add value to data through greater visibility, transparency, predictive capability, and adaptability, making legacy stand-alone systems like ERP, MES, and SCADA increasingly redundant.

Market Implementation of Technical Solution

The global market for enterprise Internet of Things (IoT) is expected to grow to 483 billion U.S. dollars by the end of 2027. The technology reached 201 billion dollars in market revenue for the first time in 2022, and forecasts suggest that this figure will grow to around 238 billion by 2023.



DID STARMASS **IMPLEMENT SUCH TECHNOLOGICAL SOLUTIONS?**

The best and the most prominent user case where most of these technologies aredeployed are in Saudi Arabia.

These 4IR technologies are being deployed by Starmass in one of the largest building expansion projects: the King Abdullah Haram expansion project in Makkah, as well as the Masjid Al Nabawi expansion project in Madinah. Starmass designed a network of over 10,000 sensor nodes for Masjid Al Nabawi. Starmass has been deploying these 4IR technologies in Haram Makkah since 2009. The number of sensor nodes deployed is more than 2,000 and the work is in progress.

One distinct advantage of deploying 4IR technologies for lifecycle management of buildings is that decision making by the asset owner becomes independent, as all the technical data is converted into a comprehensible management decision support system. As with all digital systems, these building lifecycle management systems are cost-effective, and the possibility of an integrated solution—as against multiple standalone systems—exists. Once deployed, these solutions impart full visibility and control at the highest level of ownership of the asset.

Distribution of Sensor Nodes Deployed by Starmass

2,000+

Masjid Al-Haram

10,000+

Masjid An-Nabawi

50 **quantifiable key performance indicators**

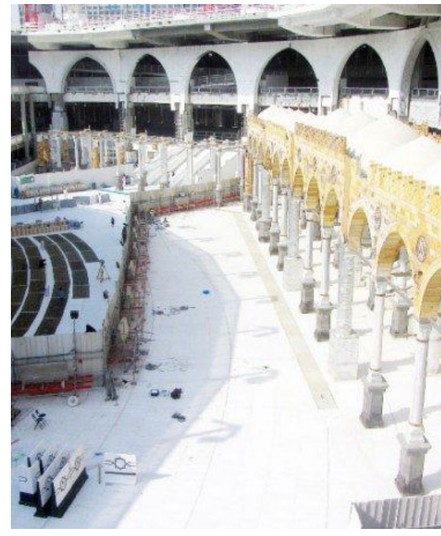
Well defined metrics that can be benchmarked.

152 **sensors to be installed on the Mataf Bridge**

18 pressure cells and 134 strain and stress sensors

Tall building sustainability and building use optimization can happen with periodic measurement of performance indicators. It provides essential data that building owners can use as a decision-making support system. It can identify inefficiencies, reduce energy consumption, optimize building performance, and, more than anything, ensure regulatory compliance and improve occupant comfort.

In a building there are measurable key performance indicators. All the building systems have well-defined metrics that can be benchmarked, measured, and optimized. Starmass has identified around fifty (50) such quantifiable key performance indicators. The measurable critical parameters include the building components as well as the environment around the building, such as the ground on which the building stands and the surroundings of the building.

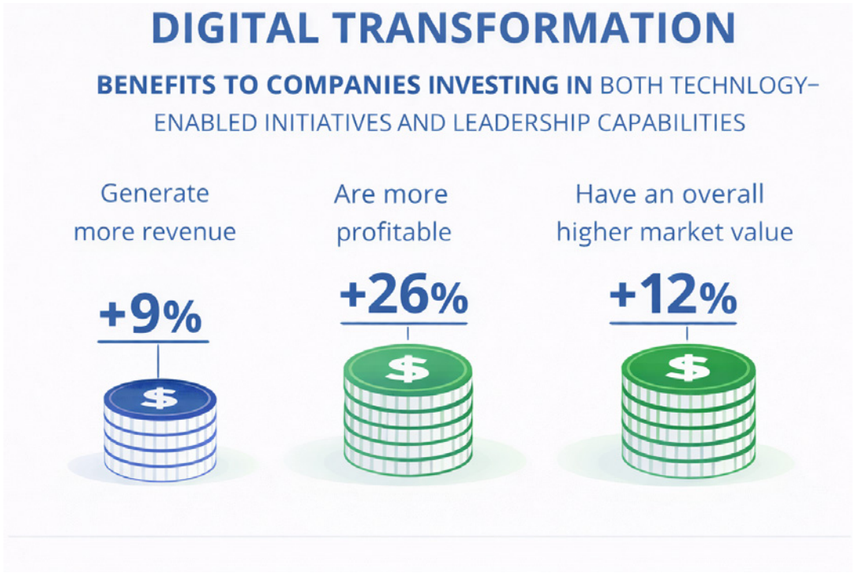


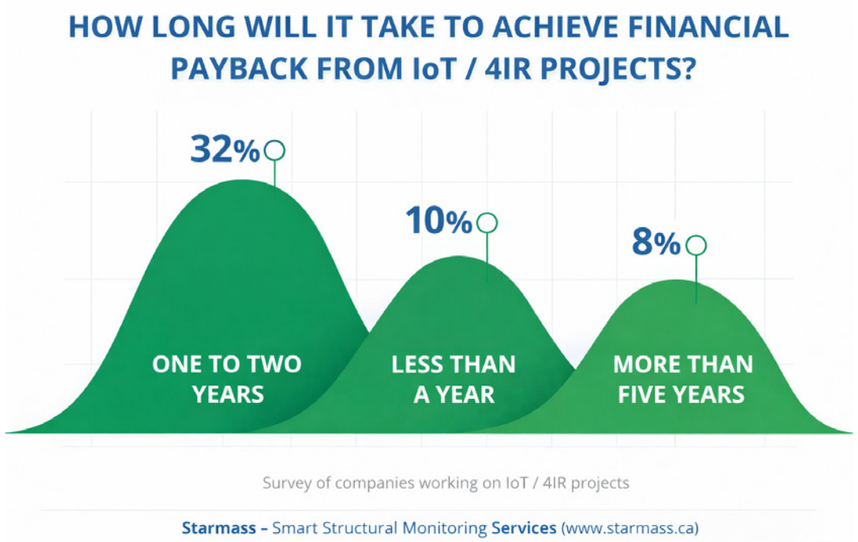
Current Implementation of Technological Solutions

King Abdullah Mataf Expansion Project is one of the very important projects for structural health monitoring. The role of Starmass is to install sensors in different stages of construction, like below the raft, in the raft, in the columns, and in the minarets, to monitor pressure and stress on the surfaces of the structure.

The total number of sensors that are to be installed on the bridge is 152, of which 18 sensors are pressure cells and the remaining 134 sensors are strain and stress sensors. The monitoring process initiated in the Permanent Mataf Project is successful, and the results are very reliable. The sensing technology implemented in the Mataf Bridge yielded positive results in terms of geotechnical and structural monitoring. The data from pressure below the raft and the bottom-layer critical strain and top-layer critical stresses at the raft, and the critical stress/strains on column rebar above the raft and in the ground floor columns, were reported.

FINANCIAL BENEFITS OF NEW TECHNOLOGICAL SOLUTIONS





INTERNATIONAL **COMMITMENT**

Saudi Vision
2030

Starmass Canada supports Saudi Arabia's Vision 2030 through its expertise in auditing, digitizing, and upgrading infrastructure. With major developments planned over the next decade, the company plays a key role in creating smart, intelligent, and future-ready infrastructure across the Kingdom.

UN Goals
SDG17

Starmass Canada has been assisting nations to accelerate and achieve the UNSDG17 Goals and meet the targets. Starmass Canada has identified the following of the SDG17 Goals:

GOAL 6: Clean Water & Sanitation
GOAL 7: Affordable & Clean Energy
GOAL 9: Industry, Innovation & Infrastructure
GOAL11: Sustainable Cities & Communities

Goals by
ESG

Starmass Canada is committed to ESG goals, emphasizing environmental management and human comfort through sustainable infrastructure. By driving digital transformation as part of good governance, it enhances operational quality, efficiency, and performance. This is reflected in initiatives such as green buildings, green energy, and environmentally responsible infrastructure.

UNDERSTANDING **INFRASTRUCTURE, ENVIRONMENT & ENERGY**

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STARmass™
Environment Technologies Corporation - Canada

*A **Starmass Group Company** – Specialists in Infrastructure Lifecycle Integrity*

For more info, visit **www.starmass.ca**