MediaCityUK

Deliverable 2

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Zafer OZTURK, Yusuf ARAYICI, Helen SHARMAN and Charles O. EGBU

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PART 1: INTRODUCTION AND BACKGROUND

This report is the second deliverable prepared by the research group and it attempts to develop a vision of BIM and GIS integration for the quantitative health impact assessment.

In respect to the 'future work' identified in the previous deliverable, Health Impact Assessment of MediaCityUK regarding to the local community is discussed in this report. Additional factors affecting health , such as energy and housing are described and a structure for BIM-GIS integrated assessment model for Health Impact Assessment (HIA) is suggested.

As described by Cave and Curtis (2001), the 'health' in 'health impact assessment' usually refers to a social definition of health. This recognises the importance of housing, employment and a range of other factors for population health. This is clearly important for regeneration projects and for the health services both of which deal with people who are experiencing the effects of poor housing, poor employment etc HIA is a way of addressing the root causes of illness and health inequality.

Ison, (2000), suggests the given criteria for prioritising health outcomes:

- amount of benefit: to population, to vulnerable groups
- amount of harm: to population, to vulnerable groups
- likelihood of benefit: to population, to vulnerable groups
- likelihood of harm: to population, to vulnerable groups
- number of people affected
- size of geographical area affected
- priority within policy/strategy framework of own organisation/partnership
- priority within policy/strategy framework regionally/nationally
- priority within community group
- cost to benefit ratio of action to maximise benefit and minimise harm
- time necessary for benefit to become apparent
- capacity in community (availability of skills)
- impact/demand on public services
- impact on environmental capacity eg air quality, water supply, land use, waste production

In order to combine HIA engaged with the above criteria and MediaCityUK project, a Visionary Technology should be developed.

1.1 HEALTH AND WELLBEING IMPACT ASSESSMENT

Health Impact Assessment (HIA) is used to estimate health impacts on a population caused by policies, programmes or projects within or outside of the health sector. The main aim of HIA is to ensure that the health consequences of implementing a policy, programme or project are considered by policy-makers (Swedish Government HIA report, 2004).

The protection and improvement of health in any population depends on a wide variety of decisions taken in all policy sectors. It is therefore important that the effects of political decisions, programmes or projects within as well as outside of the health sector are assessed from a public health perspective.

Swedish Health Impact Assessment framework defines an overall aim for HIA:

"The creation of societal conditions which ensure good health, on equal terms, for the entire population".

Eleven objective domains are prioritized and defined as follows:

1. Participation and influence in society.
2. Economic and social security.
3. Secure and favourable conditions during childhood and adolescence.
4. Healthier working life.
5. Healthy and safe environments and products.
6. Health and medical care that more actively promotes good health.
7. Effective protection against communicable diseases.
8. Safe sexuality and good reproductive health.
9. Increased physical activity.
10. Good eating habits and safe food.
11. Reduced use of tobacco and alcohol, a society free from illicit drugs and doping and a reduction in the harmful effects of excessive gambling.

There are several types of impact assessment including Health Impact Assessment (HIA), Environmental Impact Assessment (EIA), Social Impact Assessment (SIA), Human Impact Assessment (HuIA) and Integrated Impact Assessment (IIA). HIA is the only framework that exclusively covers health consequences. EIA covers mainly the environmental aspects but should also cover the health aspects; both SIA and Human IA include health consequences among other social issues (employment, income etc) and IIA covers economical, environmental and social issues. Currently, the most common way of assessing health impacts is to include HIA into an EIA, as EIA is already statutory in many countries. EIA is also statutory in the EU through directive 2001/42/EC, which explicitly includes aspects on human health.

North American HIA Practice Standards Group proposed a framework for HIA standards in 2009. HIA stages and standards listed below are to be used to form a base to form an ontology for the visionary technology described in Part 3 of this report. According to the North American HIA working group, given HIA stages and their practice standards are defined as below:

1.1.1. GENERAL HIA:

- The HIA process should include at minimum the stages of screening to determine value and purpose; scoping to identify health issues and research methods; assessment of baseline conditions, impacts, alternatives and mitigations; and reporting of findings and recommendations. Monitoring is an important follow-up activity in the HIA process to track the outcomes of a decision and its implementation.
- Evaluation of the HIA process and impacts is necessary for field development and practice improvement. Each HIA process should begin with explicit, written goals that can be evaluated as to their success at the end of the process.
- To the greatest extent feasible, HIA should be conducted in a manner that respects the needs and timing of the decision-making process it evaluates.
- Meaningful and inclusive stakeholder participation in each stage of the HIA supports HIA quality.
- Ideally, HIA is a prospective activity; however, the concurrent or retrospective application of HIA to decisions may be useful to demonstrate HIA utility in new contexts and to inform subsequent decision-making.
- When feasible, HIA should be part of an integrated impact assessment process (e.g., Environmental Impact Assessment) to avoid redundancy and to maximize the potential for inter-disciplinary analysis and health promoting mitigations or

improvements, when applicable. While regulatory impact assessment processes may have specific procedural rules, HIA integrated within another impact assessment process should adhere to those procedural rules to the greatest extent feasible.

1.1.2. SCREENING STAGE:

- Screening should clearly identify all the decision alternatives under consideration by decision-makers at the time the HIA is conducted.
- Screening should clearly identify how an HIA would add value to the decision-making process.
- After deciding to conduct an HIA, sponsors of the HIA should document the explicit goals of the HIA and should notify, to the extent feasible, decision-makers, identified stakeholders, affected individuals and organizations, and responsible public agencies.
- The sponsors for and funding of the HIA should be transparent.

1.1.3. SCOPING STAGE:

- Scoping of health issues and public concerns related to the decision should include identification of: 1) the decision and decision alternatives that will be studied; 2) potential significant health impacts and their pathways; 3) demographic, geographical and temporal boundaries for impact analysis; 4) research (e.g., data, methods, and tools) expected to be used for impacts analysis; 5) gaps in the data available for the HIA, and potential studies or other methods to ensure adequate data; 6) roles for experts and key informants; 7) the standards or process, if any, that will be used for determining the significance of health impacts; 8) a plan for external and public review; and 9) a plan for dissemination of findings and recommendations.
- Scoping should include consideration of all potential pathways that could reasonably link the decision and/or proposed activity to health, whether direct, indirect, or cumulative, as opposed to limiting consideration only to those impacts that are of interest to the researcher, project proponent or community. The final scope should necessarily focus on those impacts with the greatest likelihood of occurrence and significance and those that are the subject of the greatest public concern.
- The scope should include data and methods to reveal inequities in conditions or impacts based on population characteristics, including but not limited to age, gender, income, place (disadvantaged locations), and ethnicity.

- Community stakeholders, decision-makers, and other individuals and organizations knowledgeable about and responsible for the health of a community (e.g., public health agencies, health care providers, local government) should have an opportunity to identify and prioritize potential health impacts and contribute to or critique the scope of the HIA. Hosting a public meeting to receive feedback during the scoping process, receiving public comments on the scoping findings, interviewing stakeholders and experts, or inviting local health officials to participate in the scoping process are all potential means of soliciting such input. HIA practitioners should consider and apply diverse outreach methods to gain input from different stakeholder populations.
- The scoping process should establish the individual or team responsible for conducting the HIA. Participation by municipal, state, and tribal health officials should be encouraged, to ensure adequate representation by the entities responsible for and knowledgeable about local health conditions.
- The HIA scoping process should incorporate new, relevant information and evidence as it becomes available, including through expert or stakeholder feedback.

1.1.4. ASSESSMENT STAGE:

- Assessment should include at minimum: 1) a profile of baseline conditions (e.g., baseline health status and factors known or suspected to influence health); 2) an evaluation of potential health impacts (e.g., qualitative and/or quantitative analyses) including a qualitative or quantitative judgment of their certainty and significance and evaluation of any inequitable impacts; and 3) management strategies for any identified adverse health impacts – in the form of decision alternatives, mitigation of specific impacts, or other related policy recommendations.
- Documentation of baseline conditions should include documentation of both population health vulnerabilities (based on the population characteristics described above) and inequalities in health outcomes among subpopulations or places.
- HIA findings and conclusions should rely on the best available evidence. This means:

- Evidence considered may include existing data, empirical research, professional expertise and local knowledge, and the products of original investigations.

- When available, practitioners should utilize evidence from well-designed and peer-reviewed systematic reviews.

- When available, HIA practitioners should consider published evidence, both supporting and refuting particular health impacts.
- The expertise and experience of affected members of the public (local knowledge), whether obtained via the use of participatory methods, collected via formal qualitative research methods, or reflected in public testimony, is potential evidence.
- Justification for the selection or exclusion of particular methodologies and data sources should be made explicit (e.g., resource constraints).
- The HIA should identify data gaps that prevent an adequate or complete assessment of potential impacts

- An HIA should acknowledge limitations of data and methods.

- Assessors should describe the uncertainty in predictions.
- Assumptions or inferences made in the context of predictions should be made explicit.
- Affected members of the public should have the opportunity to comment on the validity of evidence and findings.
- The HIA should acknowledge when available methods were not utilized and why (e.g., resource constraints).

- The lack of formal, scientific, quantitative or published evidence should not preclude reasoned predictions of health impacts.
- The assessment of significance of impacts or the establishment of thresholds of significance, when applicable, should reflect evidence as well as community values, and should occur through a transparent, inclusive, and documented public process.
- The HIA should include specific recommendations to address the health impacts identified, including decision alternatives, modifications to the proposed policy, program, or project, or mitigation measures.
- HIA practitioners should seek expert guidance regarding potential decision or design alternatives and mitigations to ensure they reflect current available and effective practices.
- Recommendations should account for uncertainty in HIA predictions through providing suggestions for monitoring, reassessment, and potential future measures to mitigate any identified effects (e.g., adaptive management).

1.1.5. REPORTING STAGE:

- The responsible parties should complete a report of the HIA findings and recommendations.
- To support effective, inclusive communication of the principle HIA findings and recommendations, a succinct summary should be created that communicates findings at a level that allows all stakeholders to understand, evaluate, and respond to the findings.
- The full HIA report should document the screening and scoping process and identify all the participants in the HIA and their contributions.
- The full HIA report should, for each specific health issue analyzed, discuss the available scientific evidence, describe the data sources and analytic methods used for the HIA including their rationale, profile existing conditions, detail the analytic results, characterize the health impacts and their significance, and list corresponding recommendations for policy, program, or project alternatives, design or mitigations.
- Recommendations for decision alternatives, policy recommendations, or mitigations should be specific and justified. The criteria used for prioritization of recommendations should be explicitly stated and based on scientific evidence and, ideally, informed by an inclusive process that accounts for stakeholder values.
- The HIA reporting process should offer stakeholders and decision-makers a meaningful opportunity to critically review evidence, methods, findings, conclusions, and recommendations. Ideally, a draft report should be made available and readily accessible for public review and comment. The HIA practitioners should address substantive criticisms either through a formal written response or HIA report revisions before finalizing the HIA report.
- The final HIA report should be made publicly accessible.

1.1.6. MONITORING STAGE:

- Monitoring impacts of an HIA on decision-making and impacts of the decision on health determinants and outcomes is encouraged to the greatest extent feasible.
- A monitoring plan for an HIA, if created and implemented, should include: 1) goals for long-term monitoring; 2) outcomes and indicators for monitoring; 3) lead individuals or organizations to conduct monitoring; 4) a mechanism to report monitoring outcomes to decision-makers and HIA stakeholders; and 5) resources to conduct, complete, and report the monitoring.

- Methods and results from monitoring should be made available to the public.

1.2 ENERGY ASSESSMENT

With the increasing awareness of sustainable development in the construction industry, implementation of an energy rating procedure to assess buildings is becoming more important. Today, a great deal of effort is placed all over the world in achieving sustainable development in the construction industry with the aim of reducing energy consumption in both the construction and management of buildings, thus limiting its consequences on the local and global environment. Such effort can be seen at national and international levels with the launching of voluntary building environmental schemes to measure the performance of buildings.

BREEAM is the most widely used building environmental rating scheme in the U.K. Although it is a voluntary standard, the energy performance assessment adopts the U.K. Building Regulation as a benchmark to rate the level of performance improvement. The latest version for office buildings is BREEAM Offices 2008. There is also a new BREEAM International that is currently under development for the use in regions Gulf and Holland. BREEAM Offices 2008 defines categories of credits according to the building impact on the environment including management, health & wellbeing, energy, transport, water, materials, waste, land use & ecology and pollution. There are up to 102 credits available. The total score percentage of an assessed building is calculated based on the credits available, number of credits achieved for each category and a weighting factor. According to the score percentage, the overall performance of the building can be categorised as: Unclassified (<30%), Pass (_30%), Good (_45%), Very Good (_55%), Excellent (_70%) and Outstanding (_85%). For each category, there are a minimum number of credits that must be achieved.

The energy assessment in BREEAM is referred to as Credit Ene 1-Reduction of CO2 emissions. It allows up to 15 credits to be achieved when the assessed building demonstrates an improvement in the energy efficiency of the building fabric and building services. This counts for 14.7% of the total scheme credits. The energy performance of the building is shown as a CO2 based index. The number of credits achieved is determined by comparing the building's CO2 index taken from the Energy Performance Certificate (EPC), with the table of benchmarks as shown in Table 1.1. The EPC is generated based on the U.K. National

Calculation Methodology (NCM). It provides an energy rating for the building ranging from A to G where A is very efficient and G is the least efficient (Figure 1.1).

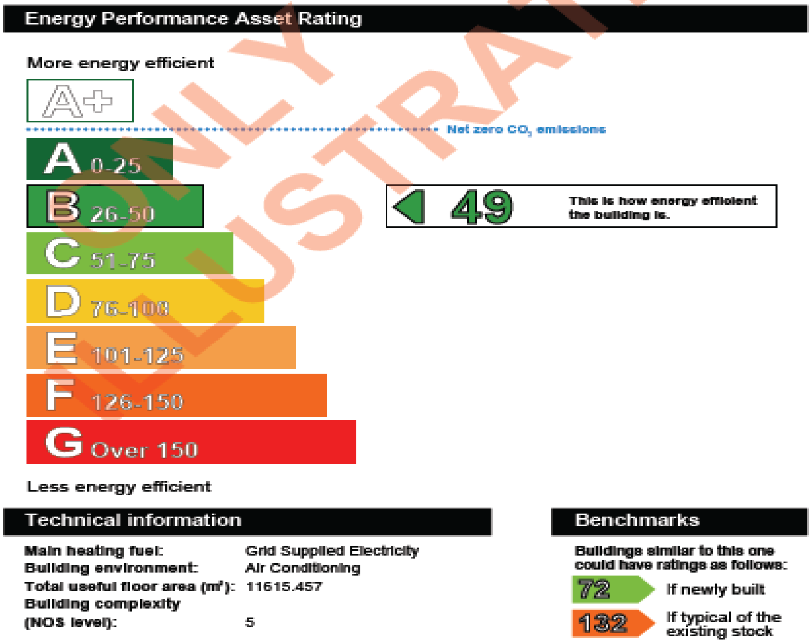


Figure 1.1, Energy Performance Certificate (EPC) (http://www.communities.gov.uk/)

To be able to set up the asset rating, two building models need to be created, which are the actual building and the reference building. The asset rating is then calculated as the ratio of the CO2 emissions from the actual building to the Standard Emission Rate which is determined by applying a fixed improvement factor to the CO2 emissions from the reference building.

BREEAM Credits	CO_2 index (EPC Rating) (New Build)
1	63
2	53
3	47
4	45
5	43
6	40
7	37
8	31
9	28
10	25
11	23
12	20
13	18
14	10
15	0
Exemplar credit 1	Carbon Neutral building
Exemplar credit 2	True zero carbon building

Table 1.1 - Credits awarded for Credit Ene1 of Reduction of CO2 Emissions for BREEAM 2008 New Offices (http://www.breeam.org/.)

Table 1.2 shows the main requirements for setting up these two building models.

	Actual building	Reference building
Weather file	CIBSE Test Reference Year weather data covering 14 locations in the U.K. are used for compliance simulations. In most circumstances, the chosen weather data shall be taken as the one from the 14 locations, which is closest in distance to the building site and used for both actual and reference building models. Where there are particular microclimate issues that need to be taken into account, one of the other 13 weather data files may be used if the weather data is more appropriate.	
Geometry	Same as design.	Same as design except areas of windows, doors and roof lights that must conform to rules set out in the NCM modelling guide.
Solar shading	-External shading including site obstructions and shading devices are to be modelled -Internal shading is to be modelled.	It must be subject to the same site shading from adjacent buildings and other topographical features as are applied to the actual building model.
Zoning requirement	Both the actual and reference buildings follow the same ruling arrangement that is defined based on HVAC and lighting.	
Material & Construction	Same as design.	-Construction U-values must conform to these U-values that are identified in the NCM modelling guide. -Special considerations apply to ground floors where the U-value is a function of the perimeter/area ratio.
	-U-values of display windows must be taken as 5.7 W/m^{2}K in both the actual and reference building models. -Smoke vents and other ventilation openings must be disregarded in both building models.	
Room data	-Each space must contain the same activity and therefore the same activity parameter values in both the actual and reference buildings. These activity parameters include occupancy times, density, sensible and latent gains, equipment gains and schedule profile, lighting lux level and schedule, heating set-point temperature, HVAC operation profile, hot water demand and outside air requirement. -The activity in each space must be selected from the NCM Activity Database.	
	-Lighting power density is allowed to use proposed design figures if known.	-Lighting power density is a fixed value dependent on the assigned room activity.
HVAC system	- System efficiency, fuel type and auxiliary energy figures are the same as design.	-Heating fuel type must be gas. -Heating SCoP must be 0.73 and auxiliary energy must be taken as 0.61W/m^2. -Cooling set point is fixed at 27 ^{o}C and the cooling SSEER must be taken as 2.25.
Hot water system	-Hot water demand is defined by the selected room activity. -System efficiency and fuel type must be taken from the proposed design.	- Hot water demand is specified by the same room activity shared with the actual building. -System overall efficiency must be taken as 45% and it must be a gas-fired system.
Infiltration & Ventilation	-The calculation method used to predict the infiltration rate must use the air permeability. The air permeability of the actual building is modelled as design and the air permeability of the reference building must be 15 m^3/(h·m^2) at 50 Pa. -Ventilation rates and profiles are defined by the selected room activity based on the NCM Activity database.	
Renewable	Yes	No

Table 1.2 guideline of setting up the actual and reference building models

(Roderick,2008)

1.3 ENERGY – HEALTH INTERACTION

Energy consumption is often treated as a marginal issue, yet any decision about energy can have health impacts at local, national and international levels. There are opportunities for health improvement through energy-related decisions in all sectors.

The links between energy and health are very diverse, ranging from the crucial role energy plays in sustaining our society and culture to the illnesses associated with air pollution from power stations and transport.

To make sense of the diverse ways in which energy is linked to health, it helps to draw a distinction between energy and energy services. Although much of energy policy is focused on the former, it is the latter that we really care about: heat, light, power and mobility. Crucially, energy services can be improved without increasing energy supply. Installing loft insulation, for example, will increase domestic warmth and may even reduce energy consumption (London Health Commission, 2003).

Energy services typically play a positive role in promoting health whereas the generation of energy tends to have negative health impacts. Consequently, there are often health trade-offs involved in energy consumption. For example, we currently use fossil fuels to keep warm in winter, but burning these fuels increases air pollution. Similarly, an ambulance driven to a casualty department will leave a trail of noxious exhaust fumes behind it.

It is crucial that any account of the links between energy and health acknowledges these trade-offs. The goal of a healthy energy policy should be to maximise the benefits of energy services while minimizing the negative impacts of energy generation.

The links between energy and health addresses three distinct areas:

- The importance of energy services in sustaining health,
- The hidden health impacts of energy consumption,
- The economic and social impacts of energy policy and their effects on health.

1.4 HOUSING – HEALTH INTERACTION

The participants of the 2nd WHO technical meeting on Housing-Health Indicators (Rome, January 15-16 2004) selected the following three overall indicators to be considered within the EHI set. These three overall indicators (comfort, safety and use/ economy) cover nine sub-indicators (Table 1.3) and provide information on the current status quo of a housing stock and its related health effects. This recommended indicator core set includes data and concepts combining architectural, functional, hygienic, physical, biological, thermal, social, and socio-economic dimensions of housing.

Indicator	Sub-Indicator
Comfort	Extremes of indoor air temperature; Radon; Dampness / Mould; Household hygiene
Safety	Housing safety and accidents; Crime / Fear of crime
Use / Economy	Accessibility; Affordability; Crowding

Table 1.3 Indicators and Sub-indicators of Housing-Health Interaction

1.4.1. COMFORT:

Extremes of Indoor air temperature: This indicator combines data on extreme climate conditions with health data (mortality and hospitalization cases), assuming that housing quality will be an essential element in maintaining acceptable indoor temperature levels. Low insulation quality, inadequate ventilation opportunities and ineffective or expensive heating systems can be relevant factors linking the indoor temperature level, housing conditions and health.

Radon: This indicator aggregates data from in situ Radon measurement and from mitigation work. It combines this quantification of exposure conditions with the existence of national policies on Radon in housing. As radon-prone areas, based on their geology, are the first reason for Radon exposure, the policy context is a most suitable tool for the reduction of residential Radon exposure. The case of use of radon-emitting building materials has been consciously overlooked.

Dampness/Mould: This indicator uses data on dampness and – on a second level – mould growth and tries to assess the amount of persons / dwellings being exposed. It is based on the quality of the dwelling (low tightness of windows, inadequate design, inefficient ventilation equipment) and can also be affected by an increasing number of residents per dwelling. As it seems difficult to directly link dampness with health effects on household level, this indicator is only dealing with the exposure conditions and does not include health data.

Household Hygiene: This indicator aggregates data on the presence – and quality – of selected hygiene amenities such as water supply, shower/bath or toilet. It includes data on dwellings, households or persons not being equipped with these amenities, and – if available – data on dwellings, households or persons being equipped with substandard amenities that do not provide efficient service. As it seems difficult to directly link the non-existence or substandard quality of hygiene amenities with health effects on household level, this indicator is only dealing with the exposure conditions and does not include health data.

1.4.2. SAFETY:

Housing Safety and Accidents: This indicator deals with the quantity of health effects and death cases as a result of accidents and injuries in and around the private home. This includes (a) the occurrence of burns, injuries and poisonings, and (b) the occurrence of deaths by home accidents, poisonings and – especially – fires. It is assumed that design and quality of housing is a relevant cause of home accidents leading to a wide range of health outcomes. This indicator deals almost exclusively with health data and tries to identify the number of housing-related injuries and deaths, as it seems difficult to access valid data on housing safety conditions per se.

Crime/ Fear Of Crime: This indicator deals with physical and mental health effects related to the occurrence of crime, and more generally fear of crime. It aggregates available data on crime rates within residential areas and distinguishes between crime against persons and objects, and describes the number of persons perceiving subjective fear of crime within their neighbourhood or the number of persons taking precautionary action. As it seems difficult to access data on the health effects of such crime and fear of crime, this indicator is restricted to the exposure level.

1.4.3. USE/ ECONOMY:

Accessibility: This indicator focuses on the accessibility of the housing stock and compares the amount of physical environmental barriers with the number of persons with functional limitations. In case the required data on number of people with functional limitations does not exist, it takes the age group of 75 years and over as the main population at risk. The indicator also includes a policy dimension, asking whether national polices on housing adaptation exist and how many dwellings have been adapted in total. This indicator does not use health data as the effect of inadequate housing, but includes health data on functional limitations as a cause for specific housing needs.

Affordability: This indicator looks at the financial resources that are required for purchasing a square meter of construction, and combines the cost for a 60 square meter dwelling with the percentage of the population living in absolute or relative poverty. The comparison of the required resources and the poverty level gives insight into the affordability level of housing and can explain the pressure households may face on the housing market. The indicator assumes that low affordability of housing will often lead to inadequate housing conditions for the less affluent part of the population, and be a relevant cause for many housing problems affecting health. The indicator does not include health data in the computation.

Crowding: This indicator combines data on households and residents with the statistical information on room number and floor area. Using national definitions, it identifies the number of households with less than one room per person and – on a second level – the number of households with less than 14 square meter per person. As it is difficult to obtain data linking the occurrence of crowding with health effects on household level, this indicator is restricted to the identification of exposure to crowding.

PART 2: MEDIACITYUK CASE STUDY

2.1 ENERGY PERFORMANCE AND CO2 IN MEDIACITY

As stated by SKM consulting, creating sustainable communities requires the integration of social, environmental and economic goals and an understanding and appreciation of the natural assets, resources, typography and community of an area and its role within the regional, national and international context (www.skmconsulting.com/).

The UK Government is driving sustainable development and challenging local authorities; developers and designers to ensure all new developments and regeneration schemes are designed and built sustainably. This is further demonstrated by the Planning Policy Statement (PPS1) which positions sustainable development as a core principle underpinning planning policy.

The goal is to deliver sustainable communities that are environmentally sensitive and positive places for people to work, learn, live and play – considerate of the environment and well designed and built featuring a quality environment. By their very nature they need to be well connected with good transport services and communication, linking people to jobs, schools, leisure and health services.

The challenge is to deliver a practical approach to implementing national, regional and local planning policy requirements with economic, social and environmental objectives being met within the built environment. The framework provides the objectives for achieving this and will require developers, planning consultants and local planning authorities to not just demonstrate but verify the extent to which these requirements are met within masterplans that are put forward for planning approval.

The natural evolution is a third party assessment and certification scheme to promote compliance and provide benchmarks for excellence at statutory planning application stage.

Known as BREEAM Communities, this system, based on the Building Research Establishment's already established BREEAM model for buildings, offers an open source sustainability assessment framework for an entire development. It provides a simple assessment methodology that measures the development's commitments ensuring that sustainability targets set by the local planning authority are met before planning permission is granted and that all relevant criteria are considered.

The framework should ideally provide:

- A structure and process for delivering sustainable developments.
- Assistance to review planning submissions and reduce pressure on planning departments.
- More efficient (quicker) approvals at lower cost.
- An open and transparent framework for developers and planners.
- Verification on a developments overall commitment.
- Sustainable solutions which optimise community assets.

The BREEAM system includes:

- A flexible and non-prescriptive delivery mechanism through the use of compliant assessment methodologies. This ensures key targets and requirements set out in the framework are correctly addressed by the developer.
- Enables both planners and developers to set and agree on appropriate targets for developments.
- Targets are based on key sustainability objectives and core planning policy requirements, adapted for the specific development and surrounding area
- Reflects real sustainability obligations for the site.

Additionally, Cofely, the contractor of tri-generation unit in mediacity site states that the installation of the CHP Energy Centre will result in an annual saving of £560,000 in energy costs when compared to sourcing the power, heat and cooling to be provided by the scheme from conventional sources. It will also produce 29% less CO2 emissions than if the development had opted to use traditional grid electricity and standard onsite boilers.

By their design, Cofely won the Combined Heat and Power Association Award in The industrial and Commercial Award Category. This category recognises CHP projects that have demonstrated multiple benefits of combined generation – reduced carbon emissions, enhanced security of energy supply, lower energy costs and/or employment benefits – in an industrial and commercial setting (www.cofely-gdfsuez.co.uk).

Also, as stated in the article by Salfordstar, Over the years Blue Peter has been at the forefront of raising children's awareness of climate change and ecological issues. Salford, as well as being the new home to MediaCityUK, is also home to Chat Moss, site of incredibly biologically important raised bogs which house rare grasses and wildlife, and act as carbon sinks, storing huge amounts of carbon dioxide (www.salfordstar.com).

The bogs contain peat which has been extracted on the site for years, releasing huge amounts of carbon dioxide into the environment. The way that the peat is extracted is by bleeding the land dry, draining it of water until it `dies'.

An application for further extraction has been submitted to Salford City Council by contractors Williams Sinclair, but the land is owned by Peel Holdings which has the power to stop such ecological vandalism. Peel also owns the site of MediaCityUK, site of the new Blue Peter Garden when the BBC moves north next year.

News of the further destruction of rare mossland on Peel Holdings' land is bound to be embarrassing to Blue Peter, as it finalises plans to re-site its Garden on Peel Holdings' MediaCityUK in Salford.

2.2 MEDIACITYUK AND BREEAM

MediaCityUK is a leading example of sustainable regeneration on a grand scale. MediaCityUK is a purpose built home for creative and digital business. Located at Salford Quays, in the north west of England, it is anticipated it will house over one thousand companies including the BBC and employ over fifteen thousand people when completed.

From the outset, the development team has been committed to maximising the sustainability potential of the site and ensuring the development incorporates world leading sustainability whereby all interactions and possible impact on the local and wider community are taken into consideration. Nothing is taken for granted. MediaCityUK embodies sound environmental practices through design, construction and operation providing opportunities for local economic growth, sustainable living as well as flexibility for future growth. SKM acted as sustainability advisor to Peel Holdings providing an independent review of the development’s energy and sustainability strategy. SKM also provided the lead designer role for the tri-generation system on the site.

Released from conventional solutions, the modular energy centre at MediaCityUK provides the development with power, heating and cooling through a gas fired Combined Heat and Power unit.

This tri-generation system works in conjunction with a canal water cooling system to maximise efficiencies of energy usage, particularly in the winter period where the generated heat from the CHP unit is fully utilised for heating and canal water temperature is low enough to provide free cooling.

The modular design of the energy system provides a number of benefits including cost saving phased installation, flexible operation and maintenance and adaptability for future proofing and changes in fuel sources. This innovative approach will free up valuable real estate and reduce emissions usual associated with multi-site boilers. The energy system capitalises on the entire development as a 'total asset' and optimises the use of the surrounding environment.

SKM identified the potential for MediaCityUK to be a pilot for the BRE's BREEAM Communities scheme and led the project team through the process and onto achieving the highest scoring 'Excellent' rating in the UK (www.skmconsulting.com).

2.2.1. BREEAM COMMUNITIES: TWO STEP PROCESS

1. **Regional Sustainability Checklists –** used as a dialogue tool, it provides the development team and local planning authority with an opportunity to ensure the sustainability objectives and planning policy requirements are clearly identified.

2. **BREEAM Communities Assessment –** after the core team has established the development's sustainability and planning policy commitments, an independent BREEAM Communities Assessor will check and verify that all the commitments have been met.

The aggregate of the two stages results in an independent third-party certification report, summarising the commitments of the developer to address sustainability objectives and planning policy requirements as outlined by the local planning authority.

Using the two steps, developers are able to assess the sustainability of their design as well as understand its strengths and weaknesses. Since all the issues are considered at the master planning stage it reduces the need to re-work development designs and plans therefore saving time and money. Better still, local authorities can see that sustainability commitments are being met that achieve development goals for the local area. This facilitates benchmarking of sustainability performance with other local authorities and helps to improve reporting to the electorate, business and Government (www.breeam.org/).

2.3 HEALTH IMPACT ASSESSMENT IN MEDIACITYUK

HIA is discussed several times by the project team during two health related workshops and two follow up meetings. Here are the general outcomes of the meetings:

The overall research aim is i) to assess and appraise the MediaCityUK project to what extent it will contribute to the sustainable communities vision put forward by the UK government and ii) to investigate how that could be simulated via the integrated use of BIM (Building Information Modelling) and GIS (Geographic Information Systems). Following figures 2.1, figure 2.2, figure 2.3 and figure 2.4 below illustrates the aim and the vision of the research.

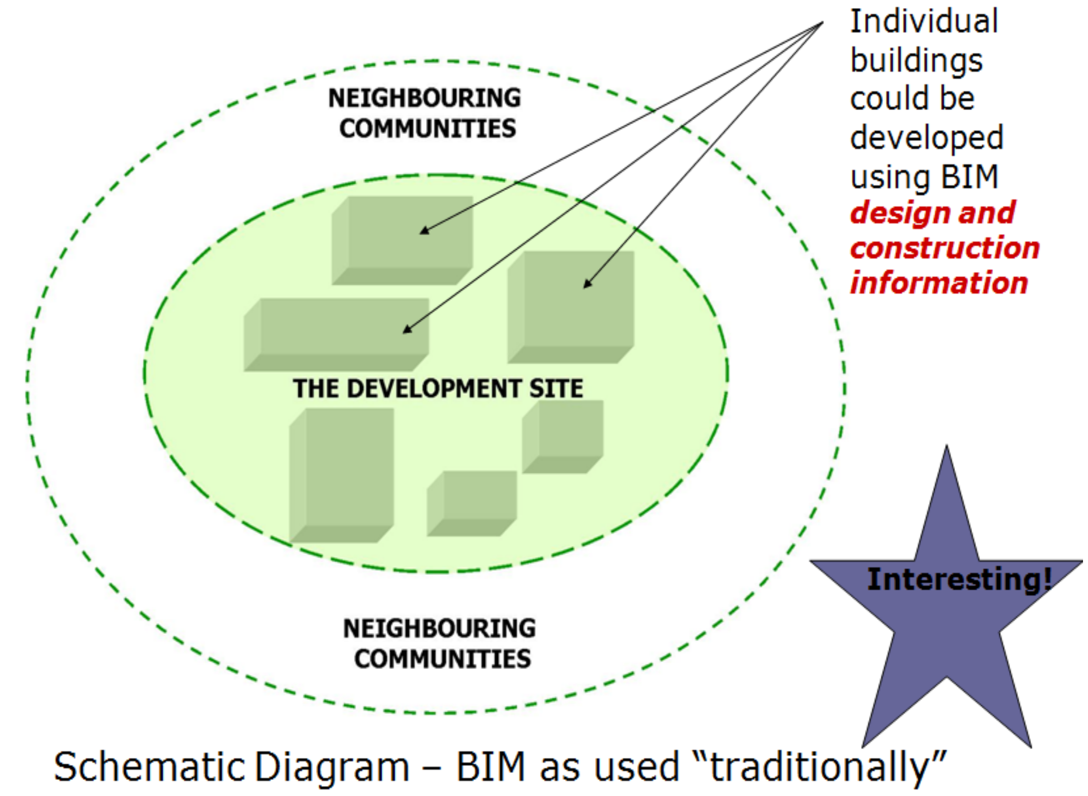


Figure 2.1: BIM focuses on the individual buildings

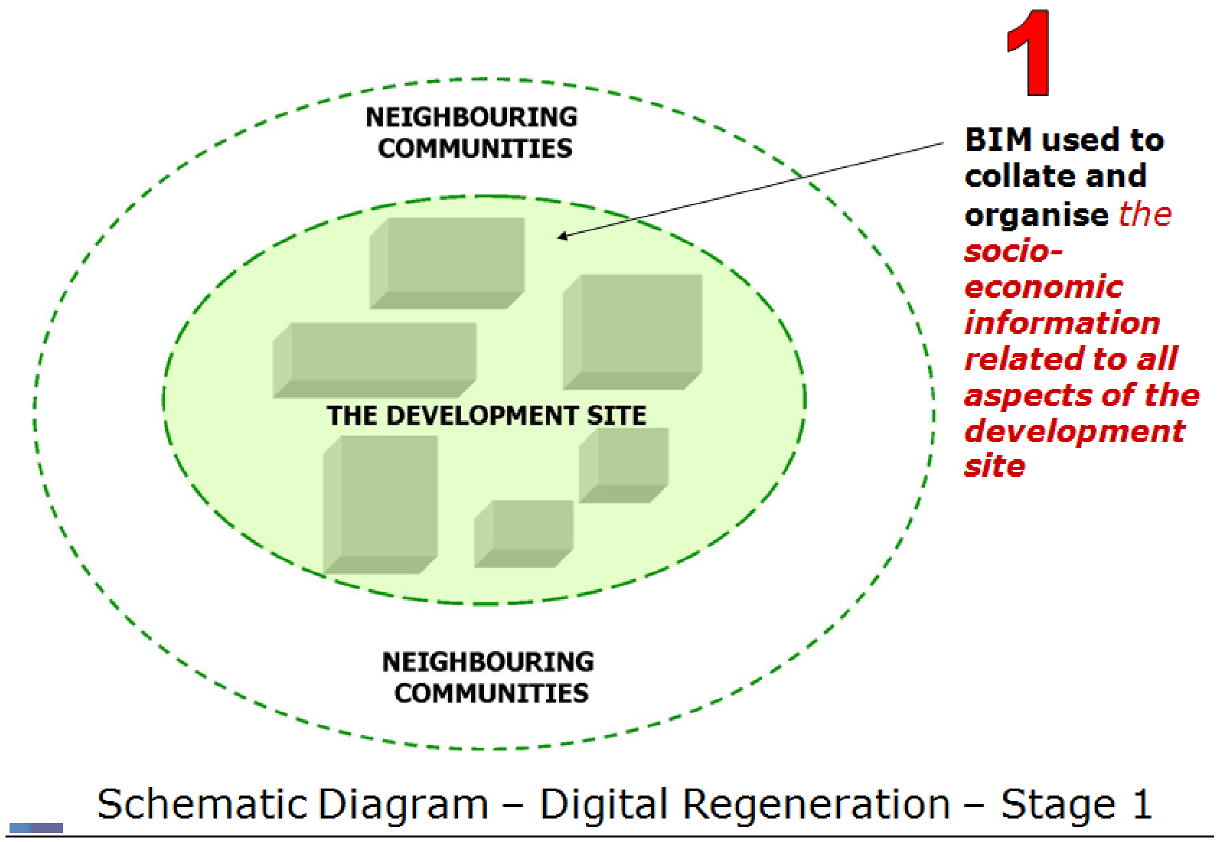


Figure 2.2: Expansion of BIM towards its use for socio-economic assessment

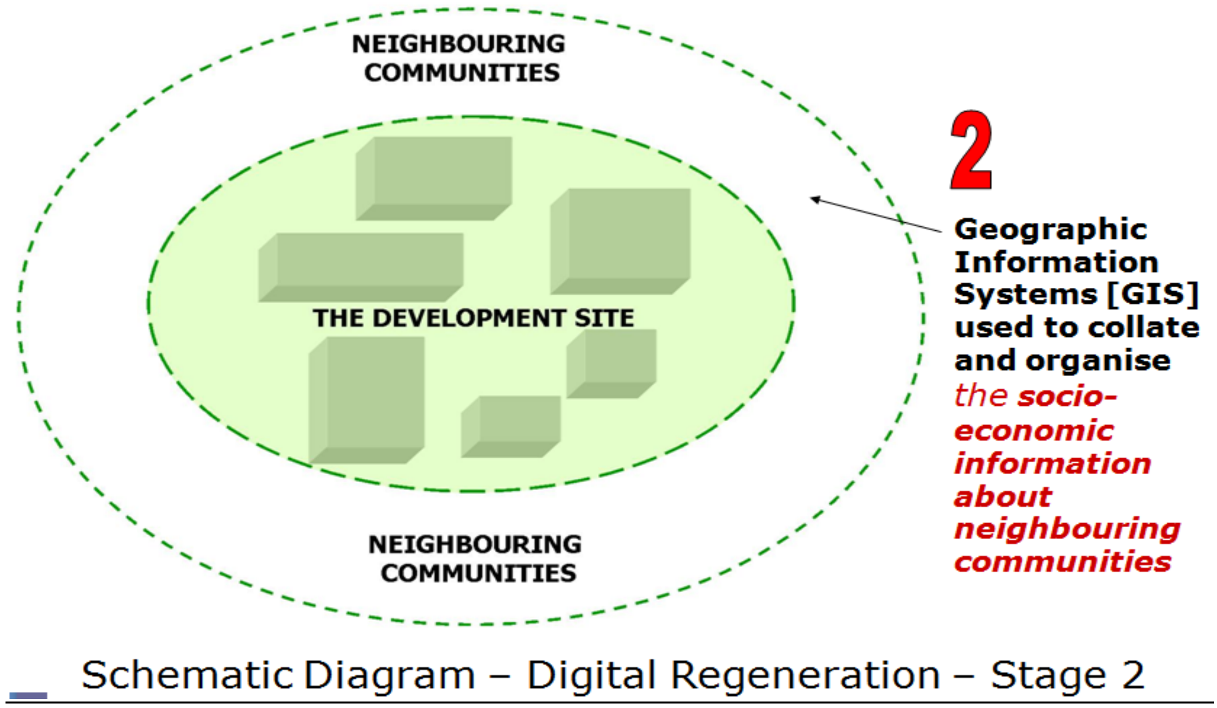


Figure 2.3: GIS focuses on urban level spatial information

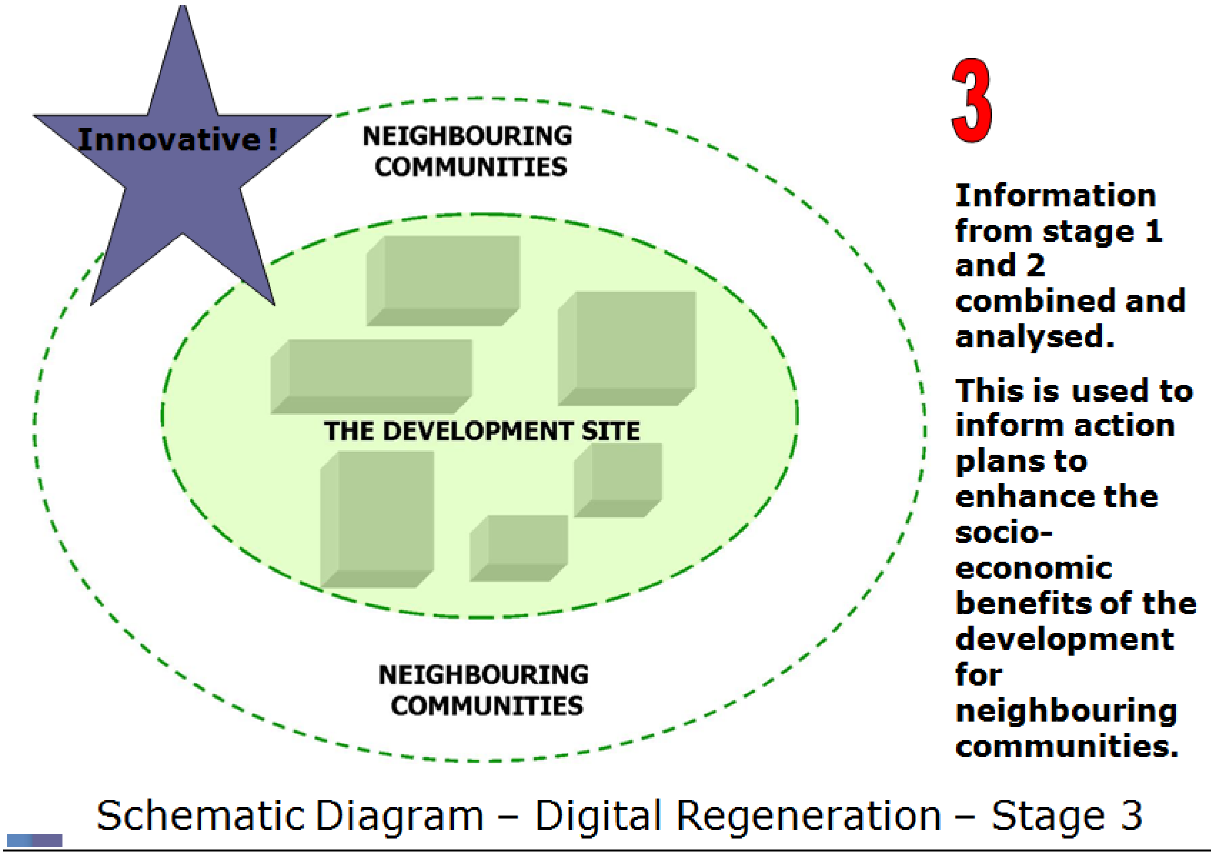


Figure 2.4: integrated use of BIM with GIS for socio-economic assessment of regeneration projects at both building and community level

- Usage of BIM for Facilities management: As summarized by REVIT (BIM tool developer), the benefits of using BIM during building design have been well-publicized and are fuelling its adoption rate among architects worldwide - transforming their drawing-based processes to model-based processes. The benefits of using information from a building model for facilities management are likewise compelling - fuelling the discussion surrounding building lifecycle management and nudging facilities management towards model-based processes.
- Public health as a component of the project: Education and health are chosen as issues to focus on during this project
- N-D modelling is explained: In addition to 3D, parameters like time, cost etc can also be defined as dimensions. That enables a more detailed design or implementation of a project. In this case, new dimensions can be defined in order to adopt BIM to HIA.

2.3.1. OUTCOMES FROM THE HEALTH IMPACT ASSESSMENT (HIA) WORKSHOP:

A general description of Health impact assessment, determinants of health and monitoring is made, a simple evaluation form is generated: The HIA is defined by London Health Commission as an approach that ensures decision making at all levels considers the potential impacts of decisions on health and health inequalities. It identifies actions that can enhance positive effects and reduce or eliminate negative effects. HIA is a relatively new tool, and although there is no single agreed national approach or methodology, the value of HIA is increasingly being recognised, both nationally and internationally.

The HIA project for MediaCity has just started and no specific health indicators are presented yet. However, they will be presented in the next report.

Figure 2.5 Determinants of Health

- Methods in HIA : Sampling between reality and speculation
- It is expressed that modelling of HIA is currently at the development stage, so BIM and GIS integration would be easier to test
- Research team indicated that parameters used in Insurance sector could be a good point to start for initial evaluation however, every insurance company has its own criteria (no criteria set is used as fixed indicators)

	NOW	*FUTURE*
Age		
Sex		
Health Status: -Health conditions -Disability - Lifelong illness (Diabetes) -Smoking -Alcohol etc.		
Social Network: -Home -Work -Visitor		
Income		
Group /Type		

Table 2.1 Health Impact Assessment Scenario

2.3.2. WHY NEED TO QUANTIFY HIA?

- To strengthen policies (support decision making ; intervention targeted)
- Limitations of current techniques for HIA
- Lessons learnt from case studies to be identified
- No evaluation of previous HIA (Hard to do, because of limitations like monetary limitation)

Therefore aim is to form a model of health and wellbeing of community at individual level. Unit of analysis and focus of the health impact assessment will be individuals, not group of people forming communities as illustrated in figure 2.6 below.

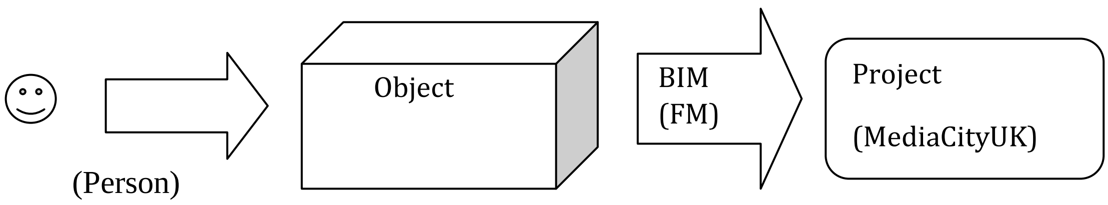


Figure 2.6 HIA and BIM integration Methodology

The following research questions are identified for future research;

- What is the potential of BIM in adapting it to Health and Well-being modelling?
- How could BIM enabled HIA and decision making, monitoring and evaluation of the project be done?

PART 3: VISIONARY TECHNOLOGY DEVELOPMENT

The worlds of geographers, engineers, architects, planners, facility maintenance and capital asset managers are converging. Maps aren't just maps – they are data rich information systems. Buildings are no longer only a geometric shape on a piece of paper but rather symbols or shapes containing information about the building structure, use and site. They are BIM. Building information models, BIM, should be geo-referenced to allow data sharing between both worlds and facilitate record retrieval over long periods of time. Buildings change names, shapes, functions, addresses, agencies and institutions, but they rarely change geographic locations (Napier, B., Connolly, K., and Jernigan, F, 2008).

This convergence has enormous implications for our future as custodians of the built environment. With this bridge into GIS, BIM can become part of geospatial applications. Both BIM and GIS can then share information and integrate that information in context for emergency preparedness and other infrastructure assessment needs. (Jernigan, 2007)

3.1 BUILDING INFORMATION MODELLING (BIM)

"A Building Information Model is a digital representation of physical and functional characteristics of a facility. As such, it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life cycle from inception onward." (National Institute of Standards and Technology, 2004). In this definition the models are characterized by intelligent representations of building elements and components; that include data to describe how they behave (analysis); in a consistent, non-redundant and coordinated way. They are developed using various software packages. Figure 3.1 shows an exterior model of Salford Media School in MediaCityUK and in figure 3.2, it is illustrated that how building elements are linked in terms of data and function in BIM models Another definition exists that defines BIM as a verb: *"Building Information Modeling … is a modelling technology and associated set of processes to produce, communicate and analyze building models."* (Eastman, 2008). However, BIM is not a project delivery method. The "associated set of processes" is applicable to all types of contracting methods to improve outcomes (Napier, B., Connolly, K., and Jernigan, F, 2008).

The concept of parametric objects is central to BIM. By defining the rules (parameters) that affect an object, the object can reconfigure to respond. In general, anything that can be described and documented can become a parametric object. A single parametric object contains rules that describe multiple options (en.wikipedia.org/wiki/Building_Information_Modeling). As an example, a user can select 'window type-double hung' from a pull-down list of parameters. Immediately the generic window object will reconfigure itself into a Double Hung Window, with all double hung window characteristics. The same pull-down menu would also allow the window to become a casement window, an awning window or a fixed window .Parametric objects can mimic real-world behaviours and attributes. A parametric model is aware of the characteristics of components and the interactions between them. It maintains consistent relationships between elements as the model is manipulated (Napier, B., Connolly, K., and Jernigan, F, 2008). For example, in a parametric building model, if the pitch of the roof is changed, the walls automatically follow the revised roofline. Or, place the window in a wall and the wall knows how to accept the window.

The individual objects and the model as a whole have rules for viewing in a non-redundant way. A floor plan, elevation, section and even the 3D image is a view of the same object or set of objects. Similarly data can be extracted such as a window schedule. If the window height is changed in elevation view, it is automatically changed on the schedule.

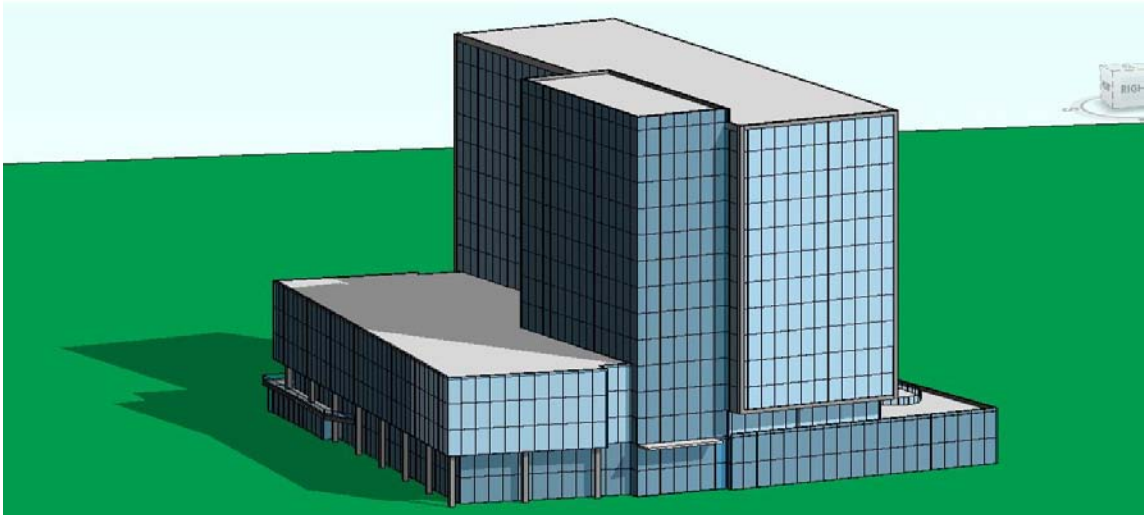


Figure 3.1 BIM model of the school building in Mediacity

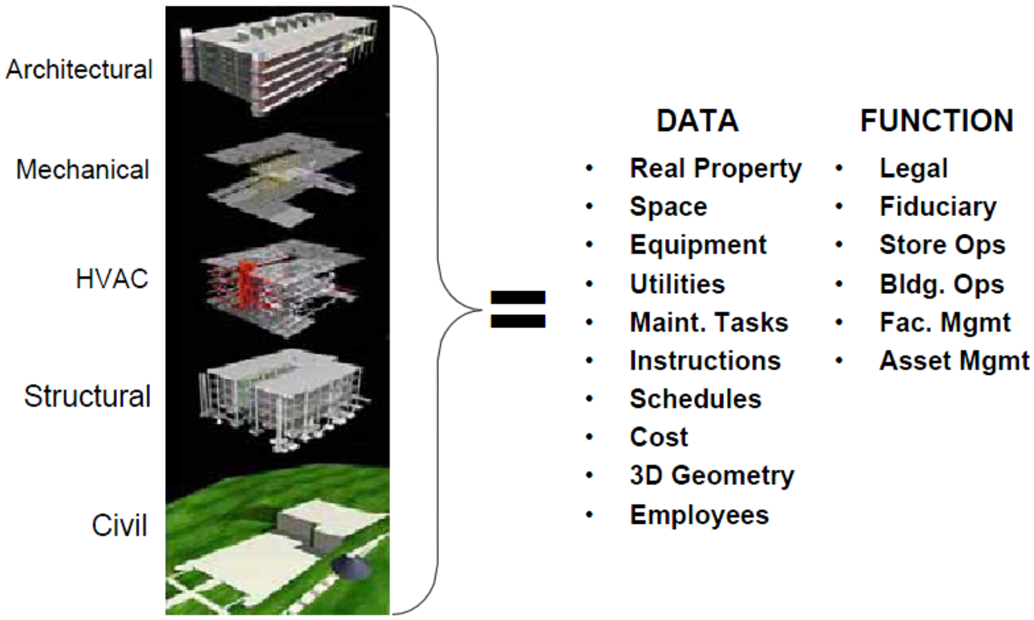


Figure 3.2 Multipurpose usage of BIM (Towne, 2009)

3.2 GEOGRAPHICAL INFORMATION SYSTEMS (GIS)

A Geographic Information System (GIS) is a computer-based system designed to collect, store, integrate, manipulate, analyze & display data in a spatially referenced environment. It allows you to analyze data visually and see patterns, trends, and relationships that might not be visible in tabular or written form (www.gis.com).

A GIS can be represented as several different layers where each layer holds data about a particular kind of feature. By layering information such as wells, industries, and population, spatial relationships among the objects being mapped can be emphasized. Someone might see that the highly contaminated wells are located next to a particular industry. Or, they could see how many families are potentially at risk if their drinking water comes from a contaminated well (www.epa.gov).

A GIS differs from other information systems because it combines common database operations such as query and statistical analysis with the benefits of visual and geographic analysis offered by maps. Figure 3.3 shows layers of data used in GIS and illustrates how these layers are spatially visualised.

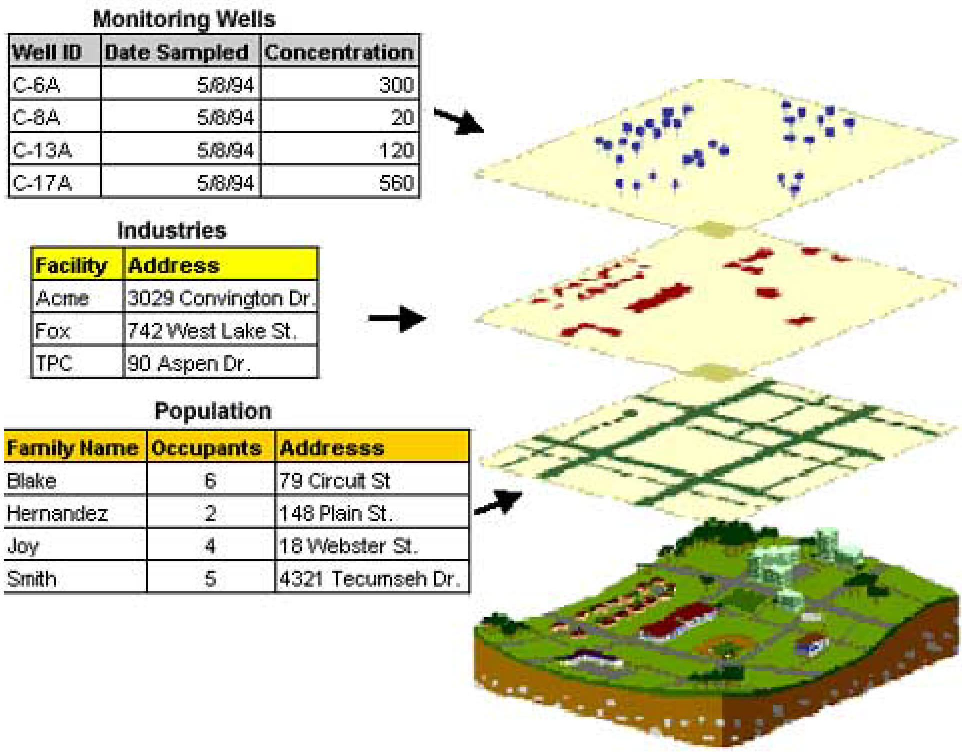


Figure 3.3 the layers contain different type of information in a GIS system (www.epa.gov)

3.3 CITYGML

CityGML is a common information model for the representation of 3D urban objects. It defines the classes and relations for the most relevant topographic objects in cities and regional models with respect to their geometrical, topological, semantical and appearance properties including generalization hierarchies between thematic classes, aggregations, relations between objects, and spatial properties. These thematic information goes beyond graphic exchange formats and allow to employ virtual 3D city models for sophisticated analysis tasks in different application domains like simulations, urban data mining, facility management, and thematic inquiries (www.citygmlwiki.org/).

CityGML is release as an open data model and XML-based format for the storage and exchange of virtual 3D city models. It is implemented as an application schema for the Geography Markup Language 3 (GML3), the extendible international standard for spatial data exchange issued by the Open Geospatial Consortium (OGC) and the ISO TC211 (http://en.wikipedia.org/wiki/CityGML).

CityGML can contain:

- Structures
- Terrain
- Water bodies
- Transportation
- Street furniture
- Vegetation
- User defined objects (Fredericque and Lapierre, 2009).

CityGML does not only represents the graphical appearance of city models but especially takes care of the representation of the semantic information such as thematic properties, taxonomies and aggregations of Digital Terrain Models, sites (including buildings, bridges, tunnels), vegetation, water bodies, transportation facilities, and city furniture. The underlying model differentiates five consecutive levels of detail (LOD), where objects become more detailed with increasing LOD regarding both geometry and thematic differentiation (www.CityGML.org). CityGML files can contain multiple representations for each object in different LOD simultaneously. Figure 3.4 given below shows different" levels of detail" (LOD) in CityGML models.

Portion of a CityGML model of Berlin with buildings in Levels-of-Detail 1, 2, and 3

Simple model of the city Königswinter including LOD 1 buildings, terrain, and streets

Buildings in LOD 3, automatically generated from IFC building objects.

Figure 3.4 LODs for CityGML models (www.CityGML.org)

3.4 CAD-GIS-BIM INTEGRATION AND USAGE SCENARIOS

In the GIS users communities, many organizations and software vendors have adopted OGC standards for encoding and exchanging geospatial information: Web Map Server (WMS) for serving maps, Web Feature Server (WFS) for serving intelligent vector features with transactional capabilities and Web Coverage Server (WCS) for serving satellite imagery, digital elevation models, and triangulated irregular networks (TINs) (Lapierre and Cote, 2008). CityGML is also meant to exchange semantically rich 3D urban objects in Extensive Markup Language (XML), either through a file or served through WFS. While CityGML is a good step towards merging the GIS world and the BIM world, it is however meant to be used at a broad scale, covering large areas like a whole city, not at the level of detail required in a BIM model for engineering and construction.

The OGC Reference Model is the framework for the interoperable solutions, specifications and applications developed by the Open Geospatial Consortium (www.opengeospatial.org). This reference model establishes the basic Publish-Find-Bind pattern (figure 3.5) by which users are able to discover information resources that may be available on servers distributed anywhere on the internet. OGC servers consolidate and make information resources available regarding a broad range of feature types and publish metadata about their capabilities, the feature types that they hold and information about their specific feature instances. Service metadata is harvested by OGC Catalog Services for the Web (CS/W), thus, OpenGIS servers publish their metadata, users Find resources by searching catalogues, and Clients then Bind to services in order to access feature instances (www.opengeospatial.org).

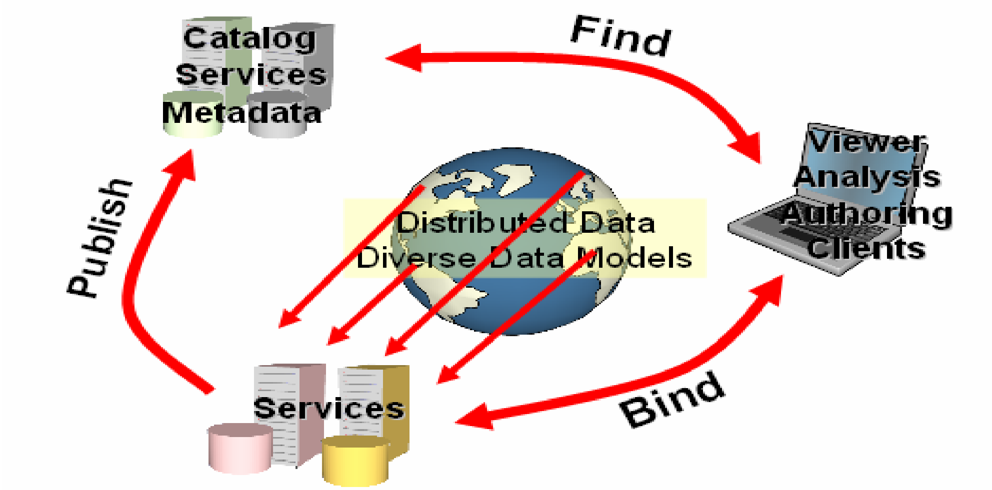


Figure 3.5 - The OGC Reference Model (www.opengeospatial.org)

In the AEC world, actors are converging on standards for structuring and exchanging highly detailed information about buildings and building project lifecycle. The development of a BIM standard is being coordinated by the International Alliance for Interoperability (IAI) through their development of the exchange specification, Industry Foundation Classes (IFC) (*www.**iai**-tech.org/*).

This general standard is being used as a platform for developing Domain specific views by government agencies and consortia in the AEC industry, such as the National Institute for Building Standards (NIBS), National Building Information Model Standard (NBIMS), The United States General Services Administration (GSA) BIM Guide; INSPIRE in Europe and Byggsok in Norway (Mohus and Kvarsvik, 2006).

In response to all that interest, most developers of tools for modelling buildings are supporting IFC as an option for open exchange of building information. However, there is no current adopted standard for serving IFC data over web services and it became obvious to the OWS-4 (Open Geospatial Web Services Phase 4) participants that this was a candidate for a new web server specification that would help bridge the gap between the GIS and BIM worlds. Table 3.1 shows OWS-4 concepts for GIS and CAD.

OWS-4 CAD/GIS Concepts	
CAD/GIS/BIM Interoperability	Interoperability across building/infrastructure lifecycle Service oriented architecture for CAD/GIS/BIM
Information models and Encoding	CityGML: GML3 application profile for virtual 3D city models IFC: UML models for “thing” occurring in the built environment TransXML: Schemas for exchange of transportation data
Object modelling	CAD space management 4D for construction
Use cases (CAD/GIS WG progress)	Navigation to GIS to CAD to GIS Indoor Coordinates 3D visualisation: W3DS and WTS

Table 3.1 OWS-4 GIS/CAD concepts

The participants also favoured to use of the OGC Web Services Common Specification as a proven and widely adopted infrastructure for designing the web services for BIM, here referred as the WFS-BIM server (Cote, P., 2007). For example, Figure 3.6 illustrates the information relationship between BIM and GIS in terms of geo-referencing of building models.

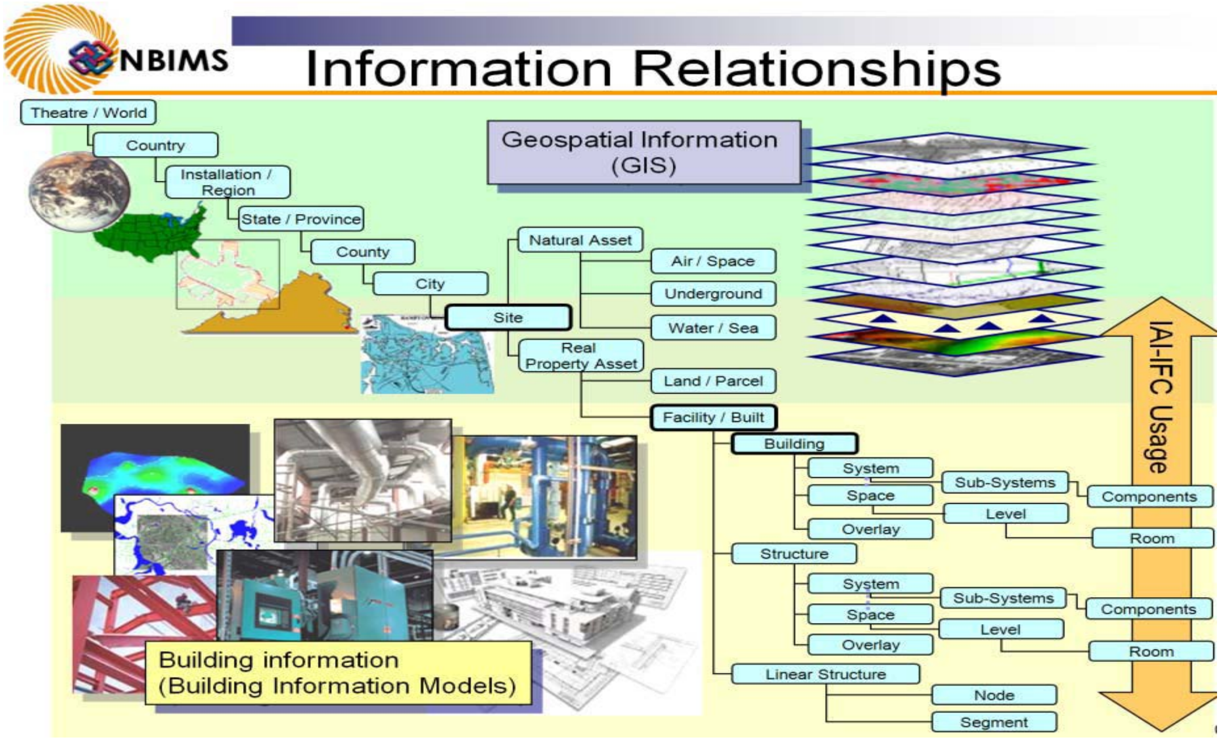


*Figure 3.6 Information relationships between BIM and GIS (*ontolog.cim3.net*)*

There are some case studies available as trials of integrating BIM and GIS, they do not indeed occupy GIS function, but use underlying maps like Google earth to give geo referencing. Figure 3.7 shows a FM (Facilities Management) application for BIM and how it is geospatially referenced. Colour codes indicate the function of space in the building and the underlying map is used as a route finding tool to access specific spaces externally.

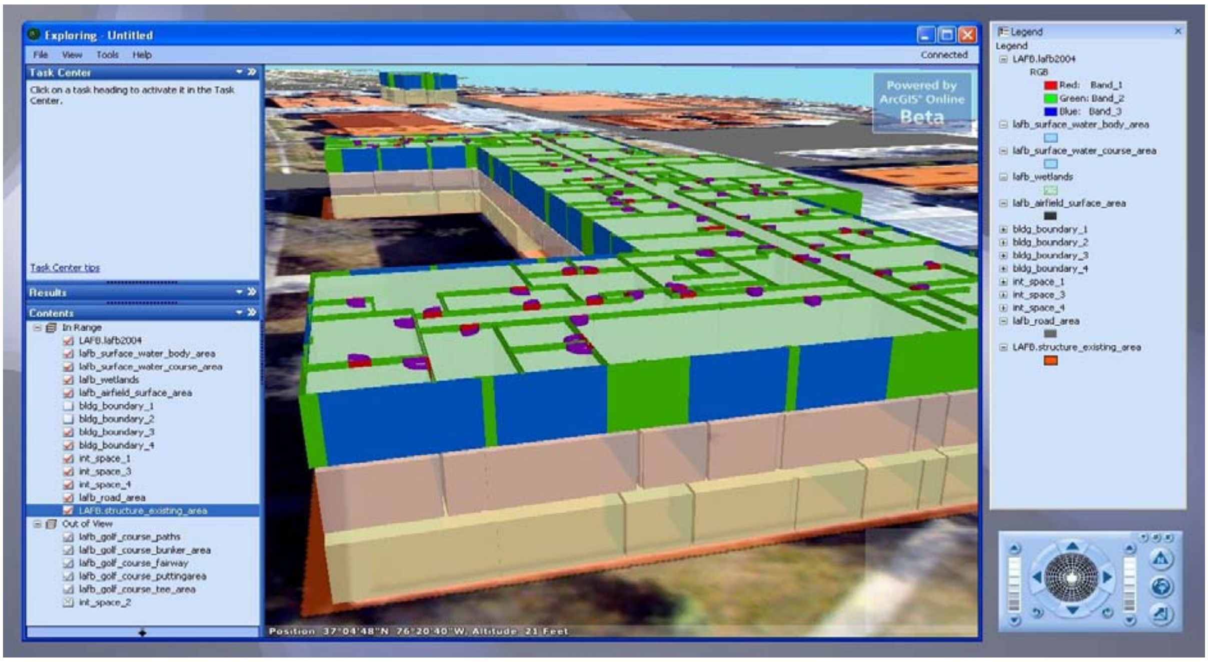


Figure 3.7 BIM model developed for FM and linked with geospatial data (Young and Sankaran, 2008)

Figure 3.8 below is a simple application of landscape information modelling for sun/shade analysis

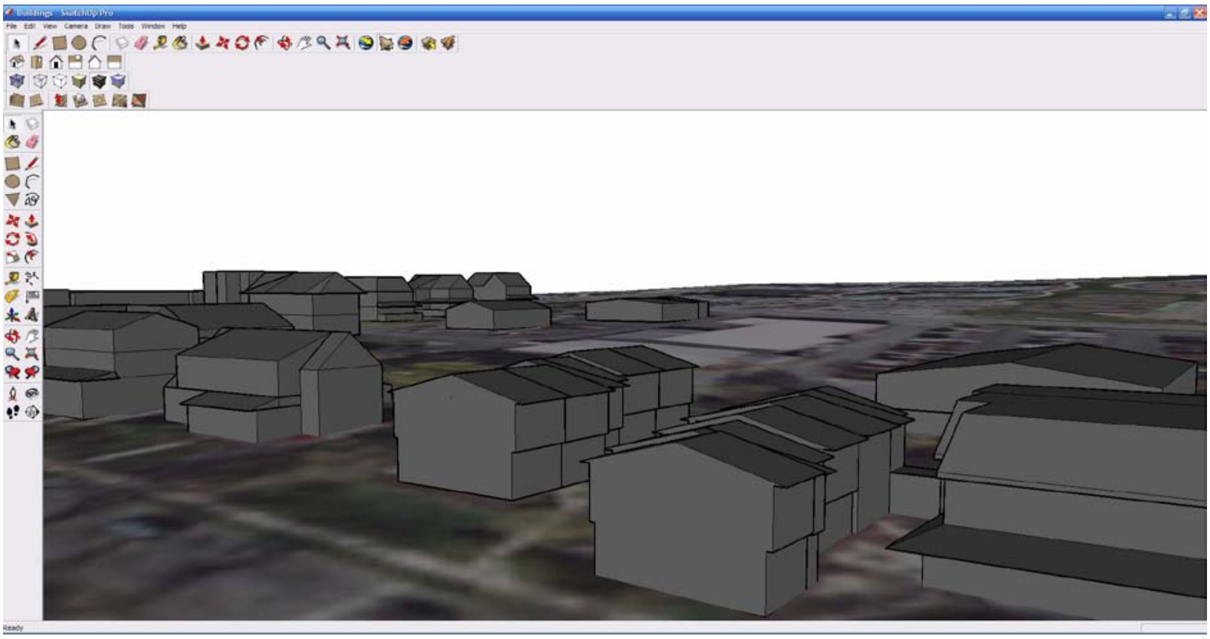


Figure 3.8 Simplified BIM models linked to geospatial information (Zambelli , 2008)

3.5 ONTOLOGY

In computer science and information science, an ontology is a formal representation of the knowledge by a set of concepts within a domain and the relationships between those concepts. It is used to reason about the properties of that domain, and may be used to describe the domain (www-ksl.stanford.edu).

In theory, an ontology is a "formal, explicit specification of a shared conceptualisation". An ontology provides a shared vocabulary, which can be used to model a domain — that is, the type of objects and/or concepts that exist, and their properties and relations (www.jfsowa.com).

Ontologies are used in artificial intelligence, the Semantic Web, systems engineering, software engineering, biomedical informatics, library science, enterprise bookmarking, and information architecture as a form of knowledge representation about the world or some part of it. The creation of domain ontologies is also fundamental to the definition and use of an enterprise architecture framework. Contemporary ontology shares many structural similarities, regardless of the language in which they are expressed. As mentioned above, most ontology describes individuals (instances), classes (concepts), attributes, and relations. In this section each of these components is discussed in turn (en.wikipedia.org/wiki/ontology).

Common components of ontology include:

- Individuals: instances or objects (the basic or "ground level" objects)
- Classes: sets, collections, concepts, classes in programming, types of objects, or kinds of things.
- Attributes: aspects, properties, features, characteristics, or parameters that objects (and classes) can have
- Relations: ways in which classes and individuals can be related to one another
- Function terms: complex structures formed from certain relations that can be used in place of an individual term in a statement
- Restrictions: formally stated descriptions of what must be true in order for some assertion to be accepted as input
- Rules: statements in the form of an if-then (antecedent-consequent) sentence that describe the logical inferences that can be drawn from an assertion in a particular form
- Axioms: assertions (including rules) in a logical form that together comprise the overall theory that the ontology describes in its domain of application. This definition differs from that of "axioms" in generative grammar and formal logic. In those disciplines,

axioms include only statements asserted as *a priori* knowledge. As used here, "axioms" also include the theory derived from axiomatic statements.

- Events: the changing of attributes or relations

Ontology is commonly encoded using ontology languages. There is a good example of ontology in indoor 3D navigation which partly adopts BIM and GIS concepts. Figure 3.9 and Figure 3.10 show the ontology defined according to context awareness and how it is interlinked with semantic features of BIM to form an indoor navigation tool. Such tools are useful because different users have specific physical and perceptual capabilities. User profile is important in topological network construction, for example, physically handicapped people can travel from one floor to another only with elevators. In emergency situation, they cannot escape a room from a window. User's location will be tracked as the start point in the network analysis (Yuan and Zizhang, 2008).

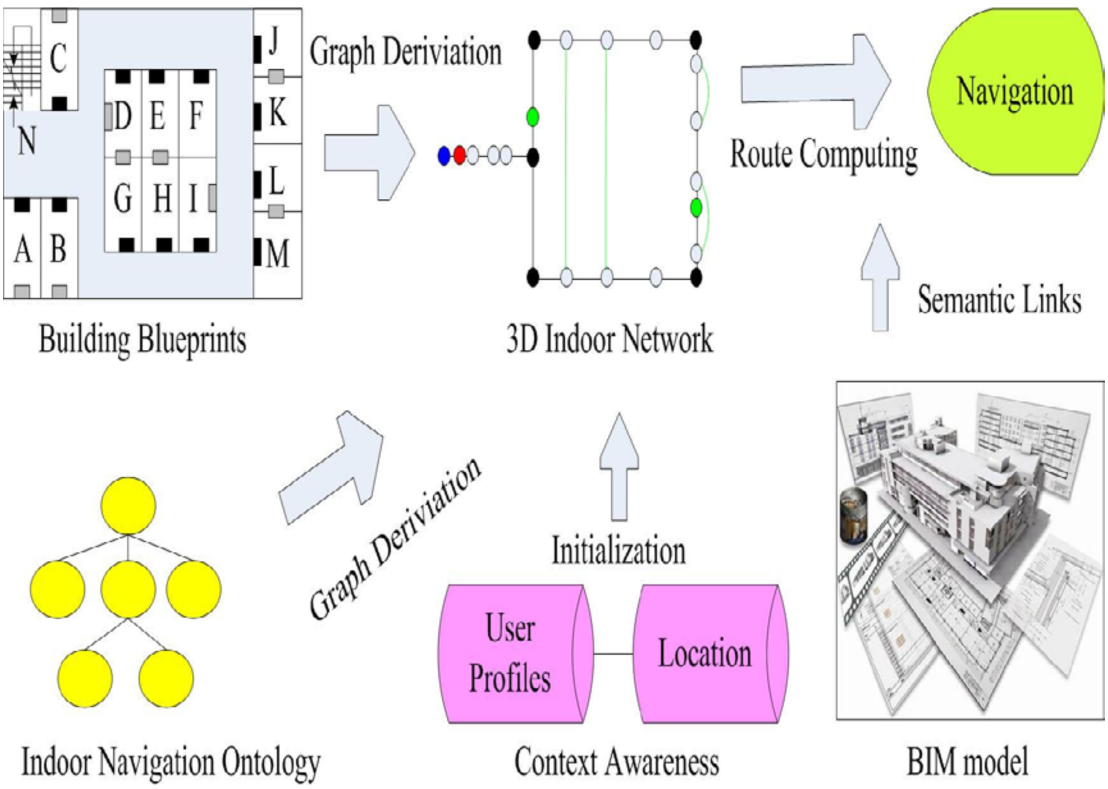


Figure 3.9 indoor navigation ontology applied with BIM semantics

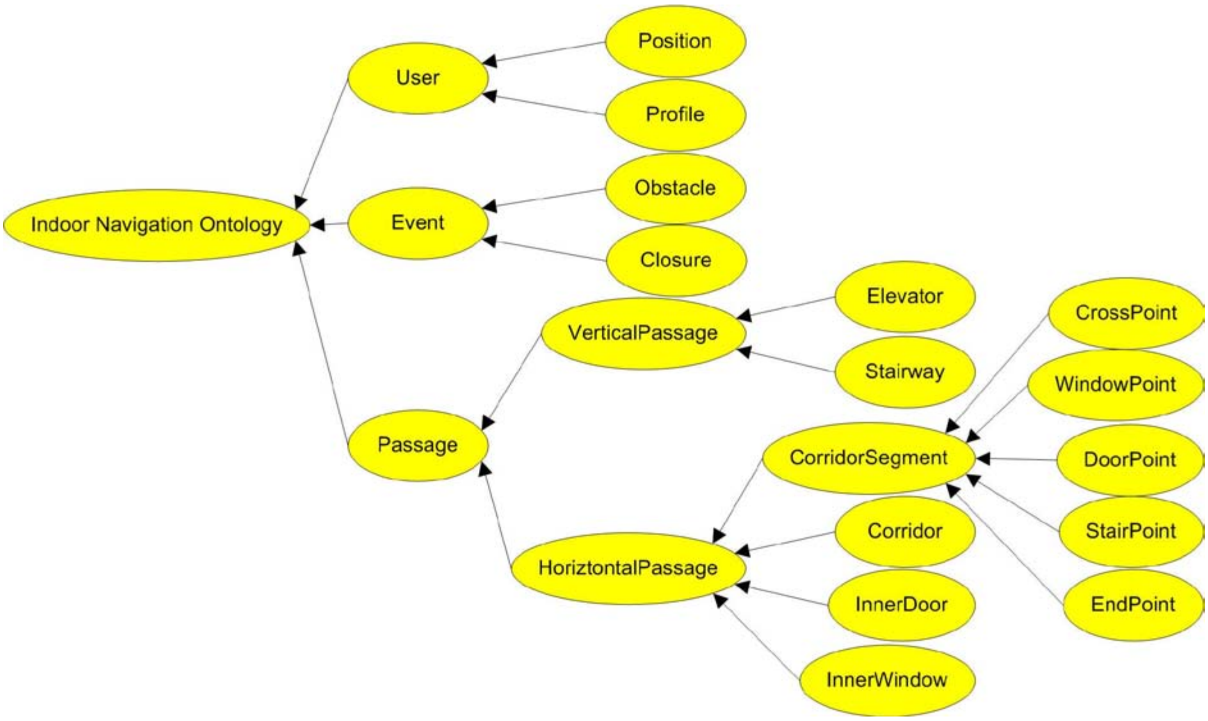


Figure 3.10, Indoor navigation ontology

In MediaCity case study, the research group will develop ontology for visionary BIM-GIS integration model to assess health and wellbeing.

3.6 RESEARCH GROUP'S VISION TO INTEGRATE BIM AND GIS

Research group proposes developing a strategy to integrate BIM and GIS in order to make environmental and social sustainability simulations. The general structure of integration strategy is shown in figure 3.11. Given figure contains different components:

GIS SERVER: This structure suggests using a GIS server to make analysis and evaluations. GIS servers act as database and spatial data processors. In order to analyse and assess the data a GIS server is essential throughout the process.

INDICATORS: Initially, indicators of health and wellbeing are going to be determined to model the Health Impact Assessment (HIA) in MediaCity and surrounding community. At this stage, it is not essential to determine indicators of retrofitting and energy but throughout the lifecycle as a part of Facilities Management (FM), those indicators should be identified.

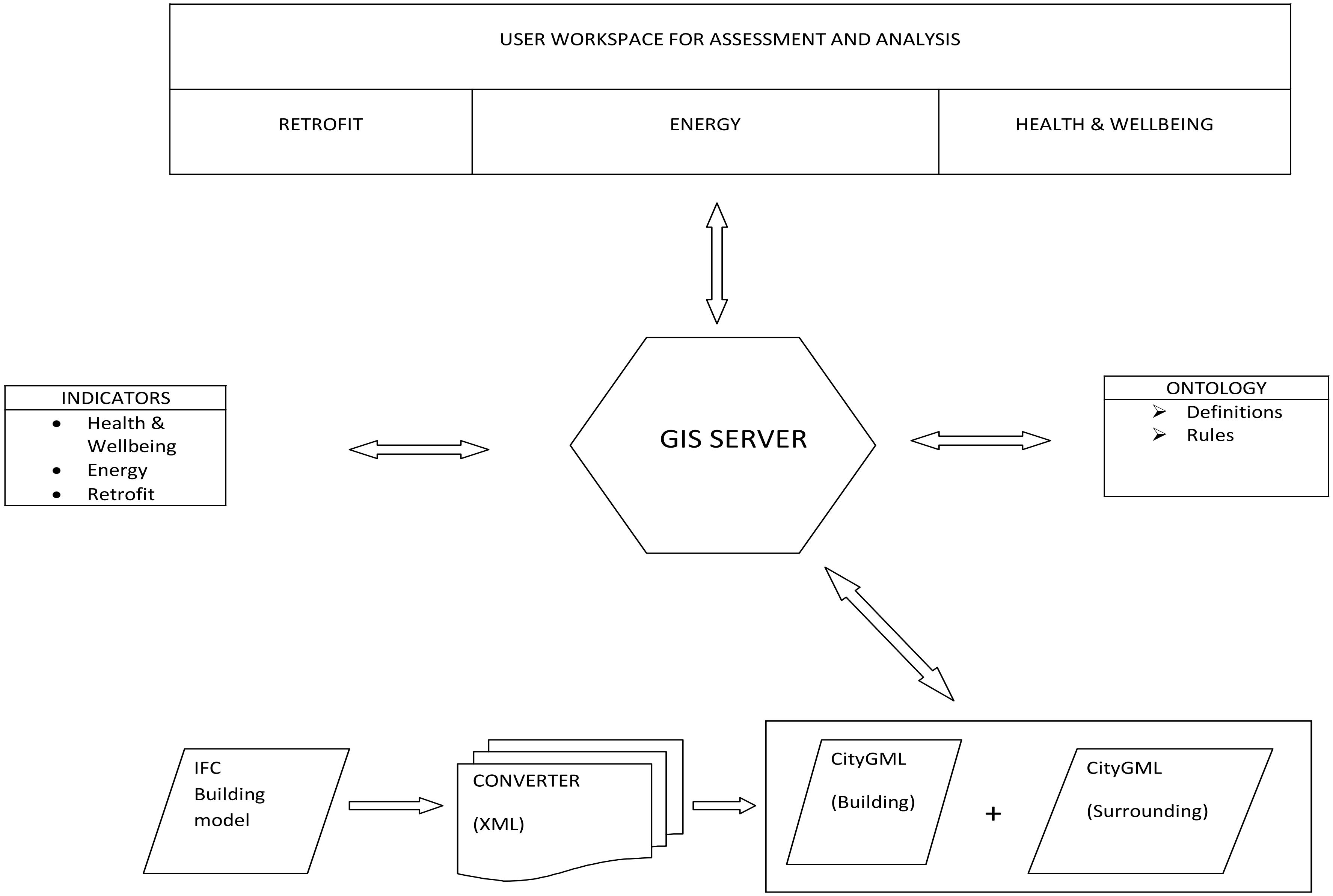
ONTOLOGY: Ontology (a set of rules/criteria) is to be defined clearly. This ontology will enable the model to produce scenario based simulations.

IFC BUILDING MODEL: This is the BIM model of the mediacity buildings. IFC Building Model will include all the data and functionality information regarding to the building materials.
CONVERTER: This will be an XML (Extendible Markup Language) based conversion tool to convert IFC data into CityGML data. IFC is going to be converted into CityGML because they both are object oriented models. Obtained CityGML data then will be processed via GIS SERVER.
USER WORKSPACE: This is where the users will obtain and evaluate the processed data for assessment and analysis.

The given figure 3.11 is the “system architecture” of the general concept of integration strategy for BIM-GIS interoperability. This figure can be divided into two process stages in order to get a better understanding of the overall process flow. These are:

Stage-1: Building Scale Process (Figure 3.12) and
Stage-2: Neighbourhood Scale Process (Figure 3.13)

FIGURE 3.11 General Structure of BIM-GIS integration



Given figure 3.12 illustrates Stage 1, which is the building scale process of the model. It accepts BIM data to make energy and retrofitting assessment and produces output related to energy and retrofit requirements of the building. This output is assessed by the aid of an ontology (which is formed by health indicators regarding to energy and building conditions related to health, energy and retrofit issues at building scale) and the final assessment of Stage-1 is complete. This stage is a looping process, which means that if the assessment at the end of the procedure is "not satisfactory" the process starts from the beginning. At each start, an improvement should be supplied to the required fields to meet the required criteria of ontology in order to stop the loop and complete the cycle of Stage-1. Once the loop stops, it indicates that process Stage-1 is complete. The output of Stage-1 is a set of preconditions for Stage-2.

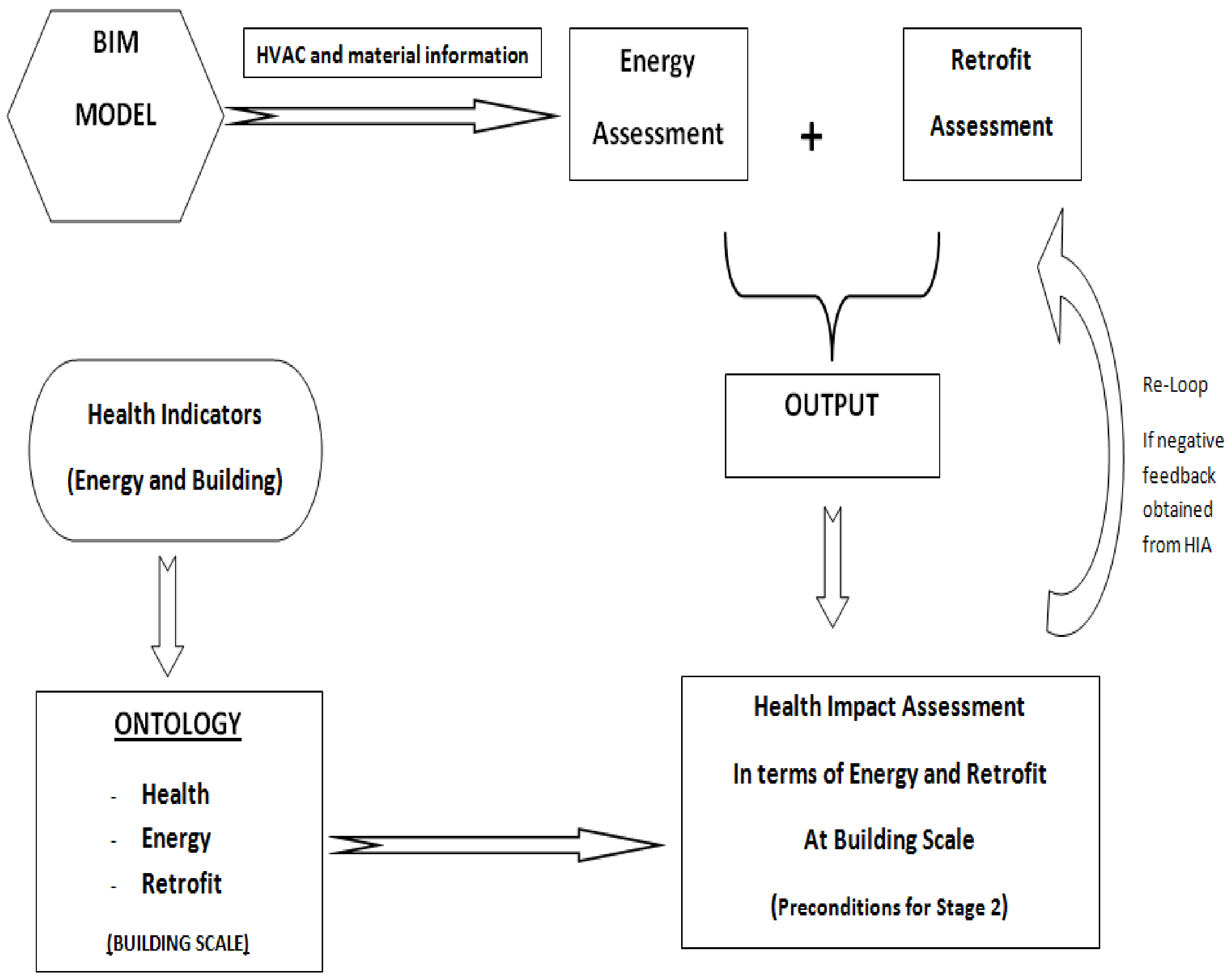


Figure 3.12 Stage 1 – Building Scale process

Given figure 3.13 illustrates Stage-2, which is the neighbourhood scale of the model. An ontology is formed by using Health indicators regarding to deprivation and preconditions received from Stage-1. This ontology and a CityGML model of surrounding environment are then processed in a 3D GIS server and a Health Impact Assessment for the surrounding community is obtained,

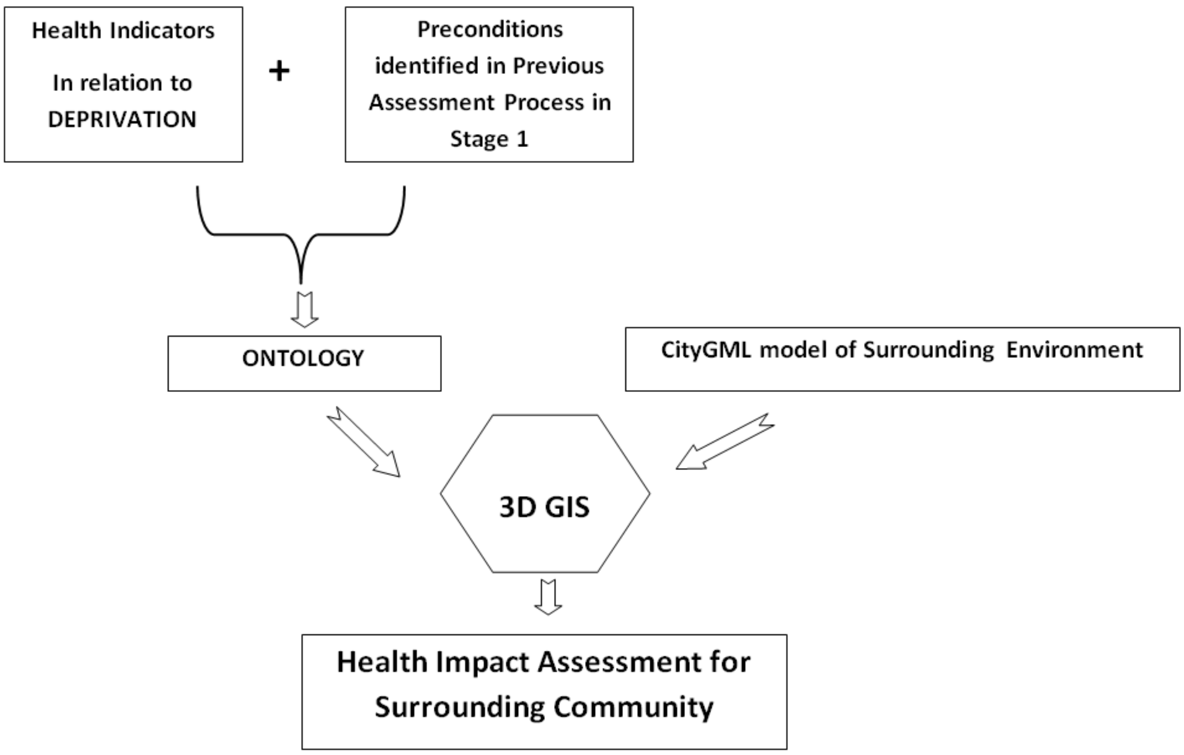


Figure 3.13 Stage 2 - Neighbourhood Scale process

PART 4: CONCLUSION

As Walsh et al indicate in their report regarding to Glasgow population health, deprivation is a fundamental determinant of health. The important link between socio-economic circumstances and health is well established.

In respect of deprivation and health relation stated by Walsh et al, as MediaCityUK is located in one of the most deprived regions of the country, developing a health impact assessment strategy is essential.

This research investigates an optimum approach to Health Impact Assessment in terms of interaction between MediaCityUK and the local community via developing a vision for interoperable use of BIM and GIS concepts in order to model social sustainability issues that have the potential to be influenced by physical sustainability conditions. Within that context, physical issues like energy and housing conditions are taken into consideration in this report to identify to what extent they interact with health.

As an important outcome, this report proposes a general structure of a visionary ICT implementation that has the potential to supply interoperability of BIM and GIS and make assessments of interactions regarding to social and physical sustainability.

As a next step:

Ontology and indicators (which are shown in figure 3.11) are to be identified in order to form a simplified model that makes assessment and evaluation of interaction between Building itself (MediaCityUK) and the people living around.

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