INNOVATIVE ROAD DESIGN WITH BIM TECHNOLOGIES: DIGITALLY TRANSFORMING THE WAY WE CREATE ROAD INFRASTRUCTURE

S YUNOS[1] and D ALLOPI[2]

[1]Baker Baynes (Pty) Ltd, Unit 12 Sunninghill Office Park, 43 Peltier Dr, Sunninghill 2157;
Tel: 011 568-2060; Email: shuaib@bakerbaynes.com
[2]Department of Civil Engineering and Geomatics, Faculty of Engineering and the Built Environment, Durban University of Technology, PO Box 1334, Durban 4001;
Tel: 031 373-2310; Email: allopid@dut.ac.za

ABSTRACT

Infrastructure is defined by the Oxford Dictionary as “the basic physical and organisational structures and facilities (e.g., buildings, roads, power supplies) needed for the operation of a society or enterprise”. Roads form an integral part of civil infrastructure, providing safe and reliable access from a point of origin to a destination. By the year 2050, Africa is projected to have the highest urban population growth of 3.1%, with the United Nations (UN) predicting the number of people on our planet to grow to nearly 10 billion. The civil infrastructure industry must look to smarter, more efficient ways for infrastructure provision, not purely based on population dynamics but also on the smarter utilisation of land and resources. The gold standard for civil infrastructure is that which increases the quality of life whilst fulfilling its function and design life in the most economical, sustainable, and resilient way possible. This is not the norm in the civil industry today, as projects do not see out their design life due to increased design complexity, which in turn results in design errors, which then have a domino effect throughout the project lifecycle, impacting project management, deadlines, deliverables, economy, sustainability, and optimal infrastructure delivery. This poses the opportunity for exploring alternative, newer, faster, leaner, and more innovative methods to tackle road projects, with one potential alternative being building information modelling (BIM). This paper provides a high-level overview of the innovation derived from wielding BIM technologies, workflows, and processes in the road infrastructure industry.

1. INTRODUCTION

1.1 Industry Context

Transportation corridors not only have an immense impact on the economy of a country but also the safe and reliable access for citizens to other imperative infrastructures. Traditional ways of doing business in infrastructure management are inadequate to meet the greater challenges of today, especially in the road sector. (UNECE, 2021). With the acceleration in technology, professionals need to wield academia, design standards and technological innovations to derive suitable solutions. One of these solutions is building information modelling (BIM). BIM is an intelligent 3D model-based process that gives architecture, engineering, and construction (AEC) professionals the insight and tools to more efficiently plan, design, construct, and manage buildings and infrastructure. BIM has been championed predominantly by architects, but its application is just as imperative in the civil and transportation industries. This paper showcases its application and potential benefits on road infrastructure.

1.2 Methodology and Structure

This paper demonstrates the innovation and intelligence afforded by BIM technologies on road projects. The methodology applied contextualises the road industry, defines what BIM is, its benefits and application on road projects, and concludes with key points. The structure of this paper is as follows:

- *Chapter 1: Introduction*
  This chapter contextualises the current state of the road industry, including the methodology and structure applied in this paper.

- *Chapter 2: BIM: The Innovative Alternative*
  This chapter discusses what BIM is, the impact and advantages of BIM on a company, project and professional level, as well as its application on road projects.

- *Chapter 3: Top 5 Innovations: BIM for Road Networks*
  This chapter demonstrates innovative applications of BIM technologies to solve 5 complex challenges experienced on road projects.

- *Chapter 4: Conclusion*
  This chapter concludes by describing the technical value of this paper, touching on the potential hurdles to BIM adoption and recommendations.

2. BIM: THE INNOVATIVE ALTERNATIVE

2.1 What is BIM

BIM is an intelligent 3D model-based process that gives AEC professionals the insight and tools to more efficiently plan, design, construct, and manage buildings and infrastructure. The concept of BIM was envisioned by an American engineer, Douglas C. Engelbart, in his paper published in 1962 titled “Augmenting Human Intellect”, portraying his vision for the future of architecture, which was followed by the first closest documented concept of BIM in the 1970s by a working prototype called ‘’Building Description System’’ by Charles M. Eastman (known as “The Father of BIM”), where several concepts of BIM were mentioned (KORQA., 2015). Since then, BIM has progressed and evolved in leaps and bounds, being implemented and adopted across the AEC industry, as well as providing a convergence workflow and integration between manufacturing and construction.

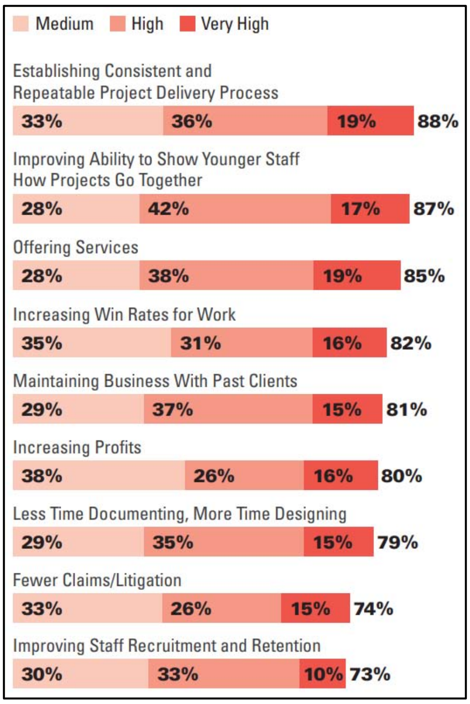
2.2 BIM on a Company Level

When looking at BIM on an organisational level, a study detailed in the report (SmartMarket Report, 2017) entitled “The Business Value of BIM for Infrastructure 2017” highlighted that the main benefits experienced are increased profitability, reduced business risk, higher retention of skilled workforce, as well as being more innovative and having a competitive edge, with the majority (87%) of BIM users in the study saying they are receiving positive value from their use of BIM.

The five most prominent benefits were:

- 34% fewer errors
- 22% greater cost predictability
- 21% better understanding
- 16% improved schedule
- 8% optimised design

When it comes to transportation projects, the study asked BIM users to rate the degree to which BIM generates 9 business benefits related to transportation infrastructure projects on a scale of 1 to 5 (none, low, medium, high, very high), with the results depicted in Figure 1. From a staffing perspective, BIM's impact on improving a company's ability to mentor younger staff on projects is the top benefit, rated high/very high by 59%. Half of BIM users (50%) experience a high/very high benefit from BIM's ability to allow their staff to spend less time documenting and more time designing. A notable percentage (43%) also considers BIM as being highly effective in helping them to recruit and retain staff.



Source: SmartMarket Report, 2017

Figure 1: BIM benefits for transportation

In a white paper "Better Business Results with BIM - Why Striking New Paths for Infrastructure" (Autodesk, 2016), the following business benefits were highlighted:

- Cost and time savings with the advantage of having visualisation as a by-product of the BIM process, and their teams united around one model of truth promoting a streamlined exchange of information with the power of the cloud and an all-digital workflow.

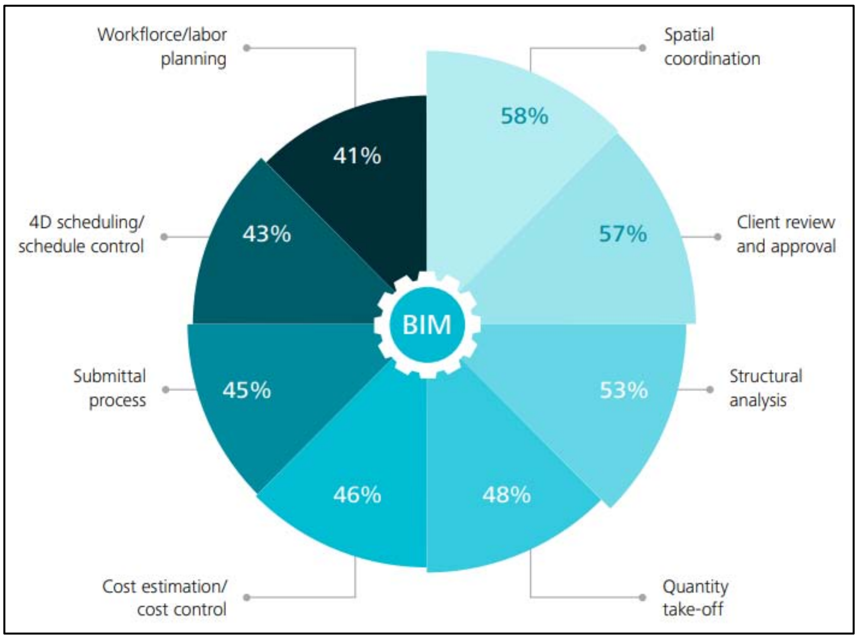
- Enhanced project execution with the use of a shared model to improve project execution on many levels, such as safety, buy-in, conflicts, and liability. Safety plans can be linked to project tasks, identifying areas of risk, with the BIM process contributing towards one collaborative, consolidated model, which can be used for clash detection, achieving reduced liability and conflicts in construction, and portraying a visual model conveying realistic design intent for streamlined project buy-in.

- Value creation beyond design and construction, with BIM data expanding the use of an asset to operations and maintenance, facilities management, virtual design, and construction, as well as value engineering, contributing to sustainable, long-term longevity of an asset, commonly referred to as holistic lifecycle management.

- The points above lead to advancing benefits for a company or organisation, with many reporting a higher return on investment (ROI), competitive advantage and advantageous expansion of offerings and expertise. This is directly proportional to the bottom line of a company, and by avoiding the bottlenecks typically experienced by traditional workflows and processes, it ensures companies can now wield the insight afforded by BIM for increased profitability.

2.3 BIM on a Project Level

The impact of BIM on a project level could be closely associated with those on a company level, as it has a directly proportional effect on profitability. Besides the points raised in the previous section, the following were noted as highest value project activities (SmartMarket Report, 2017).



Source: SmartMarket Report, 2017

Figure 2: BIM value drivers on projects

2.4 BIM on a Professional Level

With BIM having a significant impact on business and project levels, it also has a positive impact on AEC professionals. This was the topic of discussion during a webinar titled “Bridging the Gap BIM Knowledge and Industry Expertise” hosted by the South African Institute of Civil Engineers (SAICE) and Baker Baynes (SAICE & Baker Baynes, 2021).

BIM enables AEC professionals to be more innovative and creative, combining academic knowledge and technology for futuristic problem-solving and project delivery. The wielding of technology and academia form the perfect symbiosis, contributing to a holistic professional. BIM empowers users and professionals to be creative in terms of problem-solving and solution mapping and be the best they can be on a company, region, country and global scale in their respective fields. BIM also, to a certain extent, serves as a means of mentoring, by allowing fresh graduates to apply their textbook knowledge in a technological arena and gauging the results. This leads to graduates becoming broader-minded in their approach to problem-solving, task achievement and application.

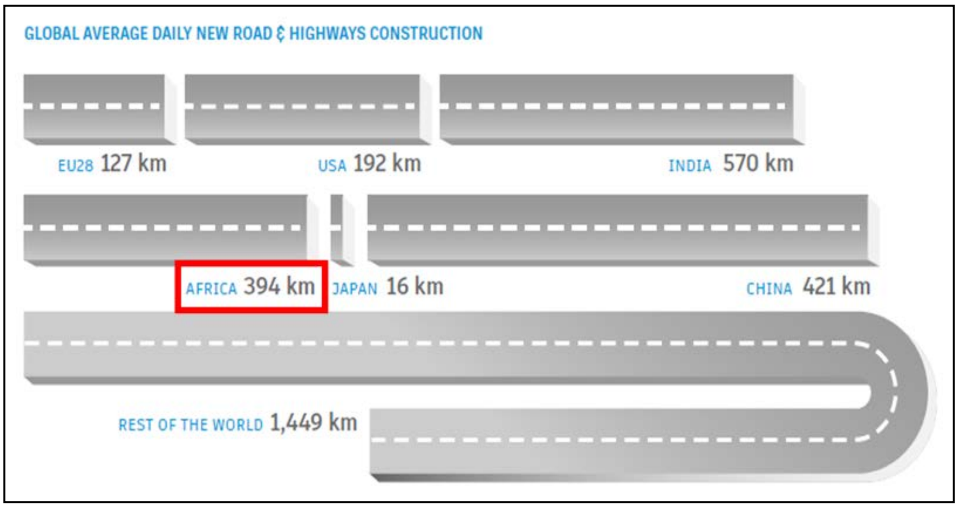
When it comes to seasoned or mature professionals who possess a wealth of experience, practicality can be incorporated or further interrogated using BIM. In most cases, a balance between technology implementation and project experience and practicality can be achieved by bridging the gap between younger professionals and older professionals. Innovating problems of today using the experience and practicality gained yesterday, between new and seasoned professionals, for a better tomorrow.

From a developmental perspective, BIM opens windows of opportunities for further growth and new career roles. Currently, these new career paths or roles seen in the AEC industry are BIM engineer, BIM technician/modeller, BIM coordinator, BIM manager, digital lead, as well as chief technology officer. Roles headed by those advising companies on people, processes, and technology are occupied by professionals in the technology consulting space, serving as industry leaders/guides in ushering companies and professionals to successful adoption, implementation and training, having the title of BIM technical specialist. They typically have a combination of industry experience and technological certifications.

2.5 BIM and The Roads Industry

2.5.1 BIM for Roads

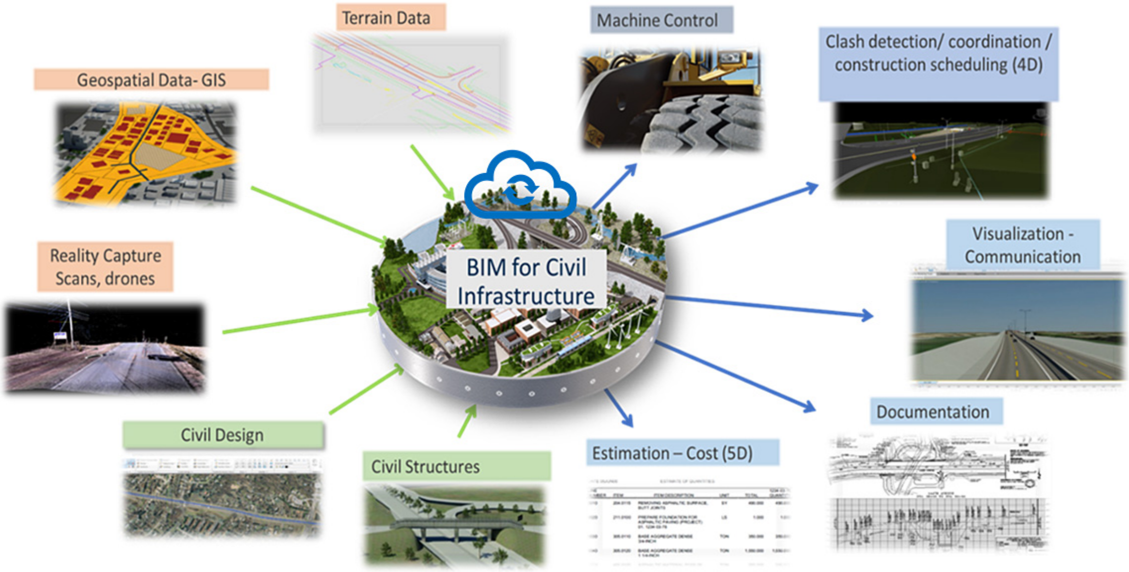
Population has a directly proportional effect on civil infrastructure demand and delivery, and with a rapid acceleration in urbanisation, resilient infrastructure provision is required sooner than ever. Figure 3 below depicts the estimated daily global averages for new roads and highways constructions (Autodesk & Statista, 2019).



Source: Autodesk & Statista, 2019

Figure 3: Global average daily new road & highways construction

With this high demand for road construction and infrastructure provision, the traditional methodologies of the past need to be infused with innovative technologies and processes to tackle the increased design complexities of today and the future. BIM affords this innovation to AEC professionals, serving as an intelligent means of combining 3D modelling technology, cloud computing and engineering standards to provide faster, leaner, and more resilient civil infrastructure, with a bird's eye view of BIM for Civil Infrastructure illustrated in Figure 4 below.



Source: SAICE & Baker Baynes, 2021

Figure 4: BIM for civil infrastructure

BIM for road and highway design facilitates the creation of coordinated and consistent design data that results in smart 3D models. This allows designers to instantly evaluate the effects of changes to road vertical curves, grades, profiles, etc. in a dynamic, live environment. As an integral part of the design process, civil engineers can utilise the information model to enhance and optimise their road designs in terms of constructability, sustainability, and safety to achieve an economically viable roadway design (Lombardo, 2019).

BIM also serves as a foundational requirement in the digital twinning process. BIM alone is not designed for real-time operational response, which is the distinguishing feature of a digital twin. In this way, a digital twin is the next evolutionary step of BIM (WSP, 2020). In the case of roads, digital twins represent a solution to providing constant access to digital representations of physical assets. Sensors that feed into the BIM Model collect digital data in real-time that is used to monitor both the physical environment and unstructured material characteristics data (Meza et al., 2021).

This results in preventative maintenance, contributing to sustainable and resilient road infrastructure. One of the most formidable drivers in reviewing alternative approaches and processes is that of the economy, and when this is achieved, it is often not quantified, because it is difficult to compare old ways to new techniques. BIM is certainly in this category, as most who adopt it soon realise that there is no turning back, as BIM affords new means and advantages that prior processes cannot match. Although it is difficult to calculate total savings and direct comparisons, incremental savings and anecdotal evidence demonstrate significant cost savings (Informed Infrastructure, 2015).

2.5.2 BIM for Roads Success Stories

BIM technologies, workflows and processes have been successfully implemented on road/transportation projects across the world. Africa's largest (longest and tallest) cable-stayed bridge, the Bouregreg River Bridge in Morocco, which involved 6 companies collaborating across 3 continents, applied a BIM 3D-model approach over traditional methods to derive shop drawings. This resulted in zero clashes upon running a clash detection based on minimum tolerance between the cables, no rework and only one design submittal (Autodesk Customer Success Stories Africa, 2015).

In South Africa, HHO Consulting Engineers applied BIM to visualise tough engineering challenges on a Bus Rapid Transport (BRT) project. The project consisted of a varying median on which the stations would be positioned, the roadway, as well as a retaining wall of varying elevation to separate the BRT lanes from the general mixed traffic lane, all within a confined site/space. The technical engineering design was linked and translated to a highly visual platform, realistically conveying design intent, and incorporating the architectural stations which led to the project being approved and moving ahead (Autodesk Customer Success Stories Africa, 2021).

In China, the Chongqing Architectural Design Institute of China (CQADI) applied BIM to help speed up a complex interchange project. The project consisted of a variety of complex components, such as the widening of the elevated and underpass main and auxiliary roads, the creation of a viaduct, the demolishing of an existing bridge, the excavation of the underground passage, as well as auxiliary roads to ensure smooth traffic flow on and off the Taohuaxi bridge. Using BIM, 3D modelling, clash detection, reality capture and cloud collaboration, CQADI were able to produce a BIM model that met strict environmental regulations and deadlines within budget (Autodesk Customer Success Stories Asia, 2019).

In Japan, the Mikusa Tunnel project on the Kinki Highway Kisei Line was the first of many projects to apply construction information modelling/management CIM (a localised term used in Japan’s construction industry in place of BIM) for the entire building process. Working with CIM/BIM, the team was able to realise a 35% increase in construction-management efficiency (Autodesk Customer Success Stories Asia, 2018).

Yüksel Proje with its head office in Ankara, Turkey, used BIM on multiple large-scale projects, such as the 3-Deck Great Istanbul Tunnel (when completed, it is going to be the first 3-deck tunnel in the world) and the Yavuz Sultan Selim Bridge (also called the Third Bosphorus Bridge), being the tallest suspension bridge in the world, comprising pylons higher than the Eiffel Tower. Yüksel Proje had switched from 2D design to BIM, resulting in shorter project durations and a significant increase in accuracy saving 20% in project design time. Applying a cloud-based approach allowed them to reduce IT costs and enable fast access to the latest technologies and updates, as well as easy access to a collaborative platform (Autodesk Customer Success Stories Asia, n.d.).

In New Mexico, the New Mexico Department of Transportation (NMDOT) adopted BIM workflows and technologies for the design and construction of a transportation network. By adopting BIM, NMDOT was able to effectively synchronise road and bridge teams, affording benefits such as ease of performing what-if analysis, dynamically linking design models and materials quantities, the automatic updating of drawings and other documentation when design changes are made, the visualisation of project context and scenarios, as well as cost and time savings (Autodesk Customer Success Stories (The Americas, 2014).

3. TOP 5 INNOVATIONS: BIM FOR ROAD NETWORKS

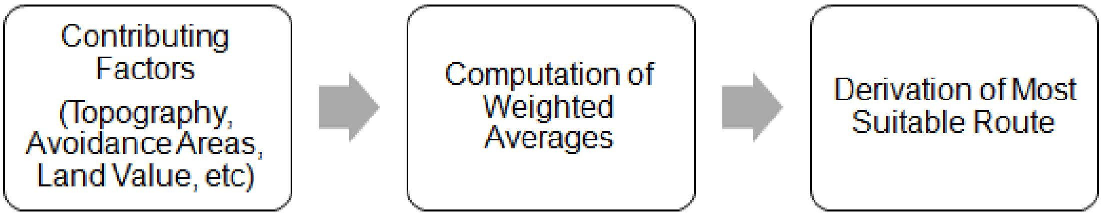
This section demonstrates innovative applications of BIM technologies to solve 5 complex challenges experienced on road projects.

3.1 Route Determination and Optioneering

Route determination is an intensive process, especially when applying traditional methodologies of the past to overcome the complex challenges of today. With the computational power of BIM technologies and geographic information systems (GIS), insightful iterations can be executed to derive an optimal, suitable solution.

3.1.1 Routes with Defined Start and End Points

In scenarios where a proposed route has a defined start and end point (origin and destination), computational analysis can be run in relation to various contributing factors such as topography, protected areas and land value. With the respective contributing factors applied to derive a weighted average, the most suitable route can be obtained (Baker Baynes, 2021).



Source: Created by Shuaib Yunos

Figure 5: Route determination process

3.1.2 Route Optioneering – Routes Without Defined Start and End Points

In scenarios where a proposed route does not have a defined/fixed origin and destination, multiple corridor analyses can be conducted along suitable points, that can then be further iteratively refined to arrive at a suitable solution. These options can be derived using a single BIM-base model, eliminating the need for unnecessary rework.

Factors such as specifying the type of road cross-section, grading limit distances, cut and fill slope ratios for daylights/roadside embankments, minimum radii and maximum grade for the horizontal and vertical alignments, as well as the automatic insertion of bridges and tunnels at specified maximum and minimum fill heights and cut depths can be set for enhanced automation and intelligent design. The earthwork quantities can then be derived, with a detailed output of the computation available for review by designers for each option.

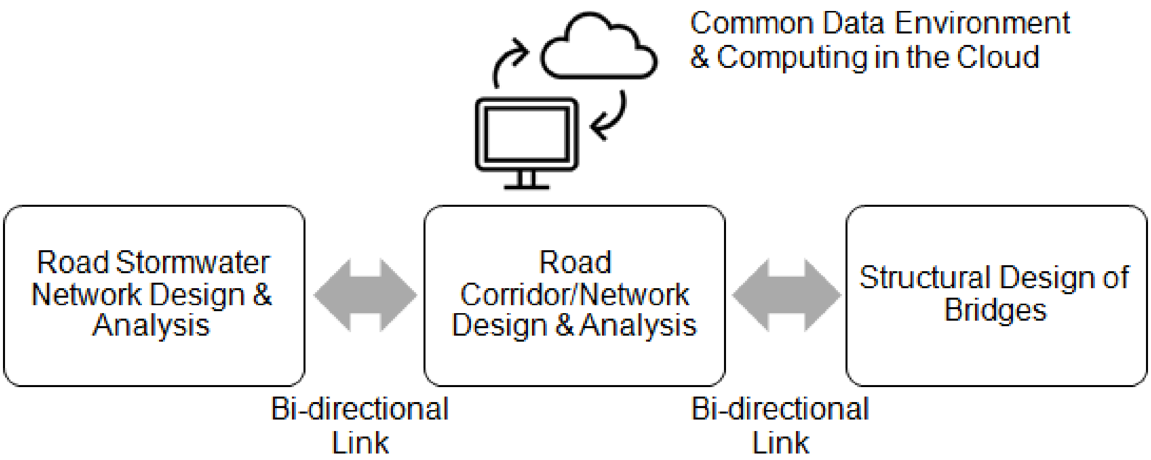
With visualisation being the by-product of using BIM technologies, professionals are then able to convey their technical design in a visually rich, realistic and digestible manner, easily understood by non-technical project members. After pitching the options available, a decision can be arrived at much quicker due to the transparency, accuracy, and realism afforded at this stage, streamlining the approval process and getting the project go-ahead. The selected route can then be used for detailed engineering design, where geometric standards, economy and safety can be defined, without the loss of any data from the planning and feasibility phase, eliminating the silo effect experienced when applying conventional methods.

Construction documentation, setting out data and accurate costing and quantification can be established well ahead of the actual construction phase, resulting in insightful bidding totals and infrastructure costs. With the intelligence afforded by BIM technologies, route determination and optioneering can be executed and derived through a more holistic and comprehensive process, resulting in more thoroughly thought-out routes.

3.2 Geometric, Stormwater and Structural Coordination

With parametric modelling, cloud collaboration and computational analysis, coordination across road corridors, bridges and stormwater design is effectively synchronised and managed. The road corridor and bridge can be linked to each other, and in the instances of changes affecting the road corridor and/or bridge, the designer will receive a notification indicating a change has been made, prompting a reload of the model to reflect the changes for real-time, up to date design. This coordination enables geometric and structural disciplines to communicate effectively, ensuring that all involved are on the same page, working towards the common project vision/deliverable. The dynamic nature afforded by the usage of BIM technologies and workflows ensures that all corresponding views, long sections and construction documentation update instantly, resulting in accurate elevation, positioning and quantity values.

When it comes to effective road stormwater design, road and stormwater professionals can work together by referencing the same model, ensuring that the road corridor complements and aids in the efficiency of the stormwater network. The linking between these two disciplines ensures that the design arrived at is practical and contributes to the design life and safety of the roadway and its commuters. Superelevation of the road corridor can be interrogated, with the final design surface analysed in depth to ensure that the stormwater flows in the correct direction relative to the stormwater network for effective dispersion of stormwater from the roadway. Watershed analysis can be computed taking into consideration the site topography and final road surface. This results in the derivation of watersheds and contributing catchments and flow paths, which designers can then review and implement in their design calculations, arriving at a suitably sized stormwater network.



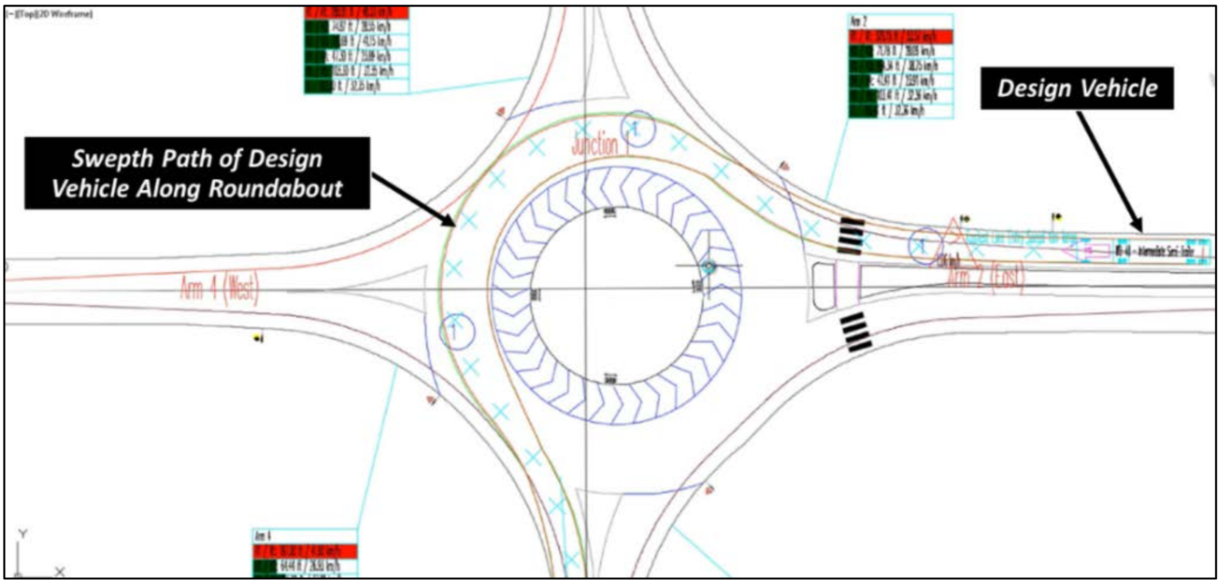
Source: Created by Shuaib Yunos

Figure 6: Coordination process between geometric, stormwater & structural disciplines

With geometric, structural and stormwater disciplines effectively synchronised, the challenge of ensuring that associated, contributing civil infrastructure is suitable and will fulfil their design function is overcome, resulting in resilient civil infrastructure. The process of designing and correctly sizing bridge components and drainage elements is transparent, with issues and concerns identified and rectified before hitting the ground on the construction site, promoting economy, sustainability and effective use of time and resources.

3.3 Simulation and Visualisation

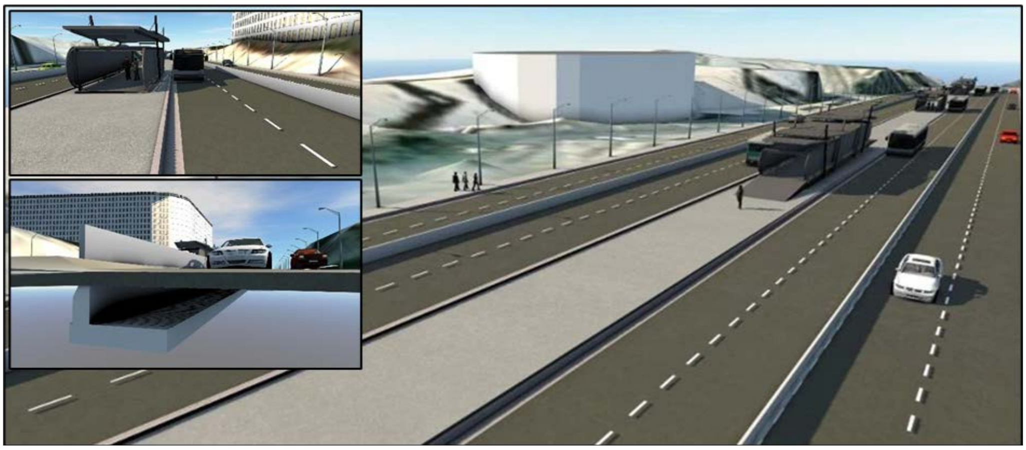
Various simulations such as that of vehicles and pedestrians can be conducted to examine the suitability of the road network relative to the design vehicles and interaction of people within the vicinity for effective urban planning and safety. Design vehicles can be examined by checking the turning radii at intersections are sufficient, including the checking of sight distances and associated safety calculations. A vehicle`s swept path can be simulated to observe the behaviour of the movement envelope generated, demonstrating to designers if the design radius at intersections and roundabouts is suitable or would need to be modified. This analysis can be applied to parking lots as well as airport runways to simulate the swept path of cars parking, loading trucks, and aircraft.



Source: Created by Shuaib Yunos

Figure 7: Simulation of a design vehicle's swept path to check design suitability

Mobility analysis, which includes the element of pedestrians can also be simulated, to envisage the resultant environment based on the provisioned road infrastructure and expected traffic at various times and scenarios along the day, to gauge the difference between peak and off-peak times. Textures, lighting and sun positioning can be set based on date and time of day across the year, to provide a realistic visual representation of the effects of lighting and shadowing of surrounding buildings that may impact the road. Panoramic virtual reality (VR), immersive VR, augmented reality (AR) and gamification can be created to provide the utmost realism of the constructed environment, allowing urban planners and related professionals to make the best decision in the development of the area for current and future development and master planning.



Source: Autodesk Customer Success Stories Africa, 2021

Figure 8: HHO Consulting Engineers BRT Project Visualisation Model

3.4 Lean, Connected Construction

BIM offers benefits to the project team during the actual construction phase. It provides a smoother and better-planned construction process, helping to coordinate construction site activities, people and materials, minimizing conflicts and errors while saving money and time (UNECE, 2021). With the dynamic nature and computational advantage provided by BIM technologies and workflows, road design and construction can be as lean, economical and connected as possible. Road profiles can be optimised based on maximum cut and fill, relative to the topography, promoting sustainable, economical design. The horizontal and vertical profiles can be interrogated to ensure that slopes and gradients are design-compliant, with the profile data and earthwork quantities updating instantly. The location of borrow pits can be specified within the design where applicable, resulting in a well-informed mass haul diagram. Pavement layer quantities can be derived directly from the corridor model, informing material requirements, and dynamically updating should any model modifications occur.

The construction schedule can then be linked to the road corridor model, affording the consultant and/or contractor to simulate their construction in 4 or 5D, with 4D being the additional dimension of time allocated to a construction task linked to the corresponding portion/elements on the 3D road model, and 5D being the dimension of cost. This affords construction professionals insight as to how the construction will take place based on the current construction program, with the ability to modify tasks accordingly in instances where the project may be tracking behind schedule, with the ability to compare planned and actual task executions and completion dates. Clash detection is another advantage afforded to professionals, a process used to identify clashes in a consolidated model (especially on large road projects involving a lot of utilities and existing services) and rectify these clashes well before construction commences. Once construction commences, with the aid of a common data environment (CDE) in the cloud, construction progress, issues, requests for information (RFIs), site logs, reports, punch lists and other related documentation can be communicated effectively between design and construction teams. With all project documentation housed in the cloud, the CDE serves as the single source of truth and data depository, maintaining a digital trail of all activities across the project and enabling streamlined communication across all teams involved, reducing project delays and bottlenecks typically experienced in a conventional project.

3.5 Smart Road Networks

With road construction complete, the as-built nature of the road can be captured in many ways. Unmanned aerial vehicles (UAVs) are a hot topic in the industry and have become popular in capturing sites, especially roads due to their length and linear traversing nature across large distances.

With the technological integration of BIM technologies, a point cloud can be produced from the photogrammetry captured by a UAV and/or scan data captured by a mobile mapping unit of the roadway. With intelligent point recognition, linear features of the as-built nature of the roadway such as centrelines and edge-of-travel way (ETW) can be automatically or manually extracted to derive elevation profiles. A corridor design model can then be developed to match these profiles, resulting in an as-built model for handover. With the availability of a BIM as-built model of the roadway, the ability to maintain the road effectively is possible. Periodic inspections and condition assessments can be done using UAVs, and the process applied to derive the as-built nature of the road explained above can be repeated to deduce the current state of the road. The deterioration points can then be identified and suitable remedial action recommended.

A more futuristic method will be that of creating a smart road network model, that being a digital twin (DT). The BIM model of the as-built nature of the road will form the foundational, recommended requirement for the creation of a DT. It will serve as a digital replica of the road infrastructural asset, and with the incorporation of sensors, dashboards, etc (Internet of Things (IoT) and Industry 4.0) progress to become a virtual, live asset – a DT. With the live loops of data and configurational prowess inputted to the DT, data such as traffic, loading, pavement conditions and other valuable information can be derived to inform preventative maintenance. This data will allow infrastructure owners to foresee any possible deterioration of the roadway based on data consumed to make preventative decisions rather than reactive decisions, contributing to the design life of the road infrastructural asset. The DT of the roadway can then become interactive with the surrounding environment or other DTs within its vicinity, leading towards the pursuit of a smart city. With this aggregated DT, the way we utilise our land, energy, water and resources will change, providing us with a much wider lens to understand and tackle current and foreseeable challenges, informing the development and master planning for future expansion against associated key indicators as illustrated in figure 9 below.

Source: Bee Smart City, n.d.

Figure 9: Six Key Smart City Indicators

Another promising area of research is that of living building materials (LBMs). LBMs are materials that possess self-healing/remedial properties. As more data and testing occur, we may soon be able to apply LBMs to road pavement layers, but only the future will tell. As research and development (R&D) progress in these fields, we will further understand what is capable in terms of data aggregation, material properties, as well as their limitations.

4. CONCLUSION

Technological innovation is essential for sustainable transport (United Nations, 2016), being a sector lacking in digital transformation. There is significant potential for improvement through the digitalisation of processes and applications of BIM, a methodology suited to improving efficiency in the road sector (UNECE, 2021). A survey conducted in 2019 by the Institute of Civil Engineers (ICE) and ALLPLAN UK involved 250 ICE members, the objective was to measure the profession's latest progress in implementing BIM. According to the survey, most civil engineers (82%) believed the adoption of BIM was a smart decision, with close to half stating it has contributed to increased profitability (35%) and delivery speed (41%), as well as reducing cost overruns (37%) (ICE & ALLPLAN UK, 2019). A BIM survey was carried out by NBS which involved people from every continent besides Antarctica where 58% said if they do not adopt BIM they will fall behind (NBS, 2020). By wielding BIM on road projects, professionals will be able to provide engineering solutions that are innovative, futuristic, sustainable and economical within time and budget, boosting service delivery.

Despite BIM walking the walk and being a winning formula, the adoption of BIM and digital transformation has been lagging in the civil infrastructure industry. In addition to scalability issues and skills shortages, there is a lack of a BIM mandate in developing nations and regions, which is thought to hinder BIM adoption. As a way to overcome these obstacles, public and private sectors, professional and educational bodies, as well as technology companies and asset owners, must exert their influence in order to ensure increased adoption so that the economy and sustainability of land and resources can be maximized for resilient infrastructure. By embracing BIM and digital transformation, the way we create roads and other civil infrastructure today and in the future as an industry will be a road towards resilient infrastructure and smart cities, contributing to a better quality of life for all.

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