Avvir: Do or Do Not, There Is A Try

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It was the March of 2020, the third month since the outbreak of Covid-19 and the very month Covid-19 struck New York City. Unfortunately, New York City was also the location where many potential and existing customers of Avvir were situated, and where Avvir was based. Co founded by Raffi Holzer, Avvir has had a respectable record of sales and product development since Avvir was founded in 2017 with its latest funding round, the seed round, with $2.5 million raised – a sum above the average seed round funding. Amongst the investors in the seed round included Khosla Ventures, a highly reputable venture capital that had an investment portfolio of $5 billion, as the lead investor.

However, the effects of Covid-19 were unforgiving to the American economy. The construction industry was badly affected due to the operational nature of close physical proximity work among construction workers in the worksites. As a result, construction sites were labelled as potential hotspots for the transmission of Covid-19 and had to be shutdown.

Avvir, being a construction technology startup, was directly impacted by the impartiality of Covid-19. Construction projects had to be halted for prolonged durations. Hence, the revenue for Avvir came to a literal freeze until construction projects could restart. As the Chief Executive Officer, Raffi must draw on everything he could, with his team, to weather through this storm.

The Inception of Avvir

While Raffi was completing his undergraduate studies in Yeshiva University for a Bachelor of Arts in Physics, he did an internship at Carnegie Mellon University's Robotic Institute. During his internship stint, Raffi conducted research applications in Civil Engineering, point clouds, photogrammetry, and construction processes – fields which were relevant to the scope of industry Avvir was positioned in subsequently. This sparked his first interest in the construction industry.

However, entrepreneurship was something Raffi had not considered seriously during his time at Yeshiva University. Eventually, he stuck to his initial plan – the furthering of his studies for a M. ENG in Bioengineering at University of Pennsylvania. It was during his study in University of

Pennsylvania that Raffi discovered his passion in creating his own products and materializing them in the market.

Upon graduation, Raffi continued to toy with the idea of entrepreneurship while being a product manager. Subsequently, he founded a reversible eye frame startup and continued to grow it. However, he realized if he wanted to pursue the path of an entrepreneur, he should solve huge pain points that would generate high value - one that requires dedication and not any half-hearted effort. As per the words of Yoda: “Do or do not, there is no try”.

Shortly after, Raffi connected with an advisor he respected and trusted back in University of Pennsylvania to seek his advice on entrepreneurship and potential startup ideas. His advisor proposed the idea of solving age-old issues in the construction industry – an industry which was recognized as the second least digitized industry by analysts with plenty of room for innovation and issues (Exhibit A: McKinsey Global Institute Industry Digitization Index).

The epiphany came when the entrepreneurial drive connected with Raffi’s shelved interest in the construction industry during his stint in Carnegie Mellon University’s Robotic Institute. With the help of his advisor, he met the first co-founder of Avvir subsequently, Vamsi, who just obtained his PhD in Civil, Environmental and Sustainable Engineering then. Since then, it was the birth of Avvir and Raffi did not look back ever since.

Constructing the Pain Points in the Construction Industry

The construction industry has always known to be a traditional industry with plenty of pain points and potential areas of development. Analysts from Mckinsey have touted the construction industry to be ripe for disruption due to the prevalent and common pain points such as cost and schedule overruns so deeply entrenched that they were considered as norms (Exhibit B: McKinsey’s Global Estimation of Cost and Schedule Overruns for Infrastructure, Mining, Oil and Gas Industries).

In the words of Raffi and Vamsi, they had to decide on which elephant in the room to target.

Drawing on Raffi's past experiences in the research applications back in Yeshiva University and Vamsi's research in the industry, both of them realized that $1 trillion has been wasted each year due to insufficient monitoring in the construction industry and $800 billion has been wasted each year due to information loss during project handovers.

As coined by Tim Brown, the executive chair of IDEO and advocate of design thinking, the sweet spot of innovation consists of desirability, viability, and feasibility (Exhibit C: The Sweet Spot of Innovation). The costly pain points signaled a huge market desirability from the stakeholders in the construction industry to resolve these pain points.

Within the next few weeks, they realized that to capturing a 10% market share alone in the North America Digital Twin Industry would equate to a revenue of $92.1 million (Exhibit D: Digital Twin and its TAM, SAM SOM). Their brainstorming sessions led them to be convinced that their potential solution would be feasible, and that the business model would be viable. However, they knew that their hypotheses would still have to be tested especially the pricing model.

Then came July 2017. After hours of searching and trying, Raffi and Vamsi launched Avvir, a living digital twin that brings internet of things and building automation systems to life (Exhibit E: Overview of Avvir's Product Offering).

The Early Days

Raffi felt that if he wanted to go far, he needed to build a team. Having worked in Pivotal Labs as a Product Manager for a couple of years, Raffi got to know Tira Odhner, a Senior Software Developer in Pivotal Labs with prior experiences as a Software Engineer in multiple companies such as Amazon. Raffi knew that bringing in a Software Engineer would be necessary to build the technology stack in Avvir. In less than a month, in September 2017, Raffi managed to convince Tira, the current Chief Technology Officer and co-founder, to build Avvir together.

Half a year later, Avvir landed its first customer - Swinerton Inc., a reputable construction firm based in San Francisco founded in 1888 with over 2000 employees. Raffi and his team pitched

the capabilities of Avvir being able to capture information of the construction projects, such as potential construction errors, through overlaying laser scans captured on the construction site and the Building Information Model. Like many B2B startups, a letter of intent was acquired from Swinerton Inc. Shortly after, the pilot project commenced.

With the sales outreach efforts and Avvir's improving reputation from having worked with a reputable construction company like Swinerton Inc., more General Contractors and Building Owners from reputable companies such as ExxonMobil started to work with Avvir.

A more targeted direction and Avvir

By April 2018, Avvir had a few Letter of Intents and were due to start on a few other projects. Raffi and his team felt that they were ready to raise a seed round in other to continue growing the team and development of Avvir's product features. However, like how uncertainties are part of entrepreneurial journeys, Raffi and his team met with an uncertainty that might threaten Avvir's growth – Vamsi's pursuit for his passion as an academia.

Fortunately Avvir already had a stable footing in its organizational structure and over the next month, Raffi and Tira managed to lead Avvir into joining URBAN-X - an accelerator which supports startups that aim to shape the future of cities through technology and design. Being part of the URBAN-X Accelerator Program allowed Avvir to gain more recognition in New York City and the connections in the region which led projects eventually. Furthermore, New York was the state with the third highest construction activity across all states in the United States and a total of $409 billion worth of construction projects in the pipeline. This also contributed to the success of obtaining more construction project contracts in New York subsequently.

This gave Raffi and Tira the confidence and bandwidth to invest in more resources such as adding more members to the existing team. Knowing that software development and machine learning algorithms would be required to develop Avvir in the short and medium run, Cody Phillips joined the team as a Machine Learning Engineer within the next month. In the following months, more members joined Avvir's existing team of 6 members to help build the product

features, to better execute the operational roles, as well as to strengthen the sales pipeline. These members included Karin Berzins, the Head of Operations, and Matt Curry, the Head of Product. Both of which, together with Cody, then joined Raffi and Tira as the new management team (Exhibit F: Avvir Organization Chart).

The investment choice in hiring additional resources proved to be helpful in building Avvir's product and sales pipeline. In March 2019, Avvir raised $2.5 million from a seed funding round with Khosla Venture, a highly reputable Venture Capital firm that had an investment portfolio of $5 billion, as the lead investor. This was a respectable amount for a seed funding and for a startup which was founded only 20 months ago as the median VC-led seed funding was approximately $1.3 million in 2019. With that, Raffi and his team felt that they were heading in a good direction.

Over the span of 20 months from the very beginning in March 2019, Avvir has redefined itself as a more targeted and specific startup – a Software as A Service (SAAS) which uses laser scans and Artificial Intelligence to capture construction deviations, monitor construction progresses, as well as produce updated and accurate digital twins (Exhibit E: Overview of Avvir's Product Offering).

With a clearer direction, Avvir focused its developmental goals into building and refining the three main products – Deviation Analysis (3D element), Progress Analysis (4D element), Cost Analysis (5D element). All of these would be made possible as long as customers provide a BIM model and laser scans.

Deviation Analysis (3D element)

During the design phase of building projects, design consultants would have to come up with the building designs. Traditionally, these designs entailed multiple 2D floor plans. With the advent of design software pioneered by Autodesk Inc, 3D models could be designed on the software platforms developed on Autodesk Inc.

After the design phase, projects would move into the construction phase. During the construction phase, the construction of the building parts would tend to deviate from the initial design due to deliberate changes in plans by the contractors and customers, imperfect workmanship of construction workers, or simply not following the design plans. These reasons for the deviation between the design plans and the constructed buildings can be either intentional or not. Either way could lead to disastrous consequences. Deviated structural parts of the building, such as structural columns, could lead to an unsafe building and a greater likelihood of structural failures. Deviated electrical pipes could lead to the electrical pipes being too near to water sources and risk electrical short circuits. The list of potential consequences of deviated building parts goes on.

Raffi and his team knew that these consequences can be extremely costly to stakeholders in the construction industry. Furthermore, due diligence was constantly performed by the Avvir team religiously to check out for market competitors. The strongest players in the deviation analysis were only able to compare BIM model to photogrammetry scans by manually tagging them with visual judgement. Hence, Raffi and his team felt a strong need to focus on the development of a deviation analysis feature which can identify construction mistakes.

Eventually, the direction of development in deviation analyses and the speed at which it was developed paid off. In February 2020, two and half years after Avvir was founded, the deviation analysis feature is developed with elaborate algorithms. The early hiring of Machine Learning Engineers and software engineers such as Cody Phillips paid off as their contributions to this feature allowed the deviation analysis to be a unique selling point of Avvir's suite of product features. This was due to the ability to identify construction deviations down to the accuracy of an inch eventually (Exhibit H: Deviation Analysis (3D) Product Feature) as long as a quality laser scan and BIM model was being provided by customers. The accuracy of the deviation analysis would be further improved through additional quality checks and necessary adjustments by the Operations Team before the final product was being presented to customers.

Progress Analysis (4D element)

Apart from deviation analyses, Raffi and his team saw that one of the Jobs-To-Be-Done (JTBD) in the construction industry was to accurately track the progress statuses of the construction projects. Most contractors and developers in the construction industry tracked the construction progresses through verbal and manual updates which could be cumbersome, imprecise, and inaccurate. By tracking the construction progresses, potential customers of Avvir such as contractors and developers could know the current state of the construction project. This would allow them to expect project delays so that they could invest the necessary resources into the construction projects, e.g. more construction workers, to mitigate the project delays.

Through the combination of laser scans and BIM models, the production of progress analyses and reports of a much higher precision and accuracy became an additional identified opportunity and JTBD for construction stakeholders and potential clients. This would likely be a more expensive approach compared to other competitors (Exhibit H: Competitor Analysis) which utilized other scheduling means such as those achieved through manual entries and visual checks. A basic scanner, without factoring the man hours required for scanning operations, would already cost a few thousand dollars. However, Raffi and his team noticed a rising trend towards the adoption of digital twins and felt that its higher accuracy and precision compared to manual entries and visual checks would be well received (Exhibit I: Progress Analysis (4D) Dashboard).

Cost Analysis (5D element)

Similar to the Progress Analysis feature, another JTBD in the construction industry was that contractors wanted to track the costs expended during the construction phase so that their customers could pay the contractors based on the installations and construction work which have been done.

Many contractors had to submit their estimated progress so that they could request for payment claims from the customers on agreed phases. The customers would then verify, approve, and

release these payments to the contractors. These laborious tasks could be subjected to inaccuracies and disputes. Hence, Raffi and his team decided to invest the resources into building the feature of tracking the cost element made possible through utilizing laser scans and BIM models (Exhibit J: Cost Analysis (5D) Dashboard).

Direction is more important than speed, but speed is still important Within the next 5 years, from 2019 to 2025, market analysts predicted a 45.4% Compound Annual Growth Rate (CAGR) in the digital twin industry (Exhibit K: Market Analysis of Digital Twin Market). The high CAGR indicates that there will be a lot of growth within the Digital Twin Industry. This led to their belief in the growth strategy Avvir should adopt to stay competitive, capture their share of the market, and take advantage of the wave of industrial growth.

Furthermore, market analysts predicted that the North American Digital Twin Industry will continue to continue to hold the largest share in the global Digital Twin industry up till 2025 (Exhibit K: Market Analysis of Digital Twin Market). Hence, Raffi and his team felt that for Avvir to be a front runner, the speed at which Avvir grew was important.

This led to the continued focus on the product development and sales pipeline, supported by the hiring of more resources and manpower. With the amount of funding garnered from the seed funding, not only could Raffi and his management team continue to grow the team, Avvir could have a larger working environment where the growing team could work together more effectively.

In March 2019, Avvir successfully enrolled and moved into the Urban Future Lab of New York University Tandon School of Engineering, an incubator which houses pre-seed to Series A startups.

A Good Problem

With the recognized capabilities and desirability for Avvir's product features by a number of retained established customers, as well as revenue generated from the seed funding round, the first 2 months of 2020 ended with a plan to raise funding for Series A by the end of 2020.

"This is an excellent product (deviation analysis)! It actually saved us thousands of dollars as we were able to identify the difference in the built works and the design." – A customer of Avvir

As Avvir started to gain more customers and continued to retain existing customers, the increasing revenue also meant a need to further improve the product. Avvir had to continue catering to the customers' needs and wishes. By then, Avvir had many experienced employees where most had a minimal formal education of master's degree while a few held a PhD – an uncommon trait in early stage startups which could be a strength and a weakness due to the high operating expenditure.

With the main features developed, Raffi and his management team were stuck at the next problem. Should the next focus be on the improvement of the existing features, i.e. improved user experience through the integration of Autodesk Forge or improvement of the algorithm accuracy, or the research and development of a photograph product?

Autodesk Forge

As a SAAS, Avvir has to offer a pleasing user experience journey. The issue with viewing the BIM model on Avvir's portal was the unintuitive panning and navigation around the BIM model. Looking for model information, such as searching for a structural column located at a specific area of a building, was not the most pleasant experience for Avvir's customers. In addition, the difficulty in navigating around the BIM model translated to a longer time required for the Operations Team to perform its Quality Assurance checks before presenting the final product to the customers. This also meant a high level of operational resources was required to produce the final product to the customers.

Furthermore, the portal had a limitation of having only a certain number of building elements allowed for each model. This meant that large buildings, beyond a certain building element count, could not be viewed on a single model on Avvir's portal. This posed an issue for large projects with bigger project sums and revenue for Avvir.

With the impact on a less pleasant user experience, operational resources required, and the improved appeal to large construction projects, Matt Curry, the Head of Products, Tira, and her team investigated possible solutions on how these issues could be resolved or mitigated. After their investigation, they concluded that the integration of Autodesk Forge into Avvir's portal would be able to resolve these issues. However, this was not an easy feat and would take some time as it required the entire viewing platform to be ported over to a different technology stack which would likely be done in phases.

Algorithm Accuracy

As deviation analysis was the unique selling point of Avvir, the continuous improvement in this algorithm accuracy would primarily lead to even more accurate deviation analyses. Secondarily, this would also lead to lesser time required for the time-consuming process of Quality Assurance checks performed by the Operations Team before presenting the final product to the customers. In addition, although existing customers have mentioned that they would prefer more priority to be given to other features like the integration of Autodesk Forge to the viewing platform and the Photograph Product, they would still hope to see an improved level of accuracy of the deviation analyses.

The improvement in algorithm accuracy would also mean that the duration taken by the Operations Team to complete their operational work would be shorter. As a result, more projects could be taken up by the Operations Team. Hence, generating slightly more revenue or generating revenue at a slightly lower cost. This was expected to take a medium duration compared to the integration of Autodesk Forge. However, this was not a risky developmental plan as the confidence level of the development team was rather high in improving the algorithm accuracy. Hence, the resources required for the improvement of the algorithm were comparatively low.

Photograph Product

To expand Avvir's share of the market (SOM), another alternative was to develop the photos

product. Tira, Cody, Matt, and the Engineering Team found out that it was feasible to utilize photographs, taken by smartphones, to be compared against BIM models instead of using laser scans to produce deviation (3D), progress (4D), and cost (5D) insights. This was a much cheaper alternative to laser scans as laser scanners are easily 10 to 50 times the cost of a smartphone. In addition, smartphones are not additional assets potential customer would have to invest in since most working adults in the construction industry already own one. Hence, they could simply use their own smartphones to take these pictures.

The idea of the Photograph Product was pitched to existing and potential customers during sales calls for Raffi and his team to better understand the desirability of this product. Fortunately, the idea of the photograph product was well received. Many existing customers expressed their excitement for the launch of this product while potential customers made verbal promises that they would like to jump on Proof of Concepts with Avvir on this product once it was launched. Hence, strengthening the motivation to develop the photograph product.

However, the development of the photography product, requires a long duration to see fruition. Hence, this would require a heavy investment of resources to further the research and development in this arena. The development of a photograph product was expected to be rather risky and would take a long period of time; a duration which would be similar to that of the integration of Autodesk Forge.

A Bad Problem

Just when Raffi and the management team thought that they had a good problem in sight, Covid 19 struck most New Yorkers by surprise the very next month in March 2020. The decision on the next product developmental plans turned into a bad problem.

Due to the shutdown in construction projects across North America, where the bulk of the customer projects are situated in, Avvir's projects with the customers either came to a halt or were ejected. Hence, affecting the revenue and its goal to raise another respectable round of funding for Series A by the end of the year. This left Avvir having to face 2 main issues:

Short Term – Lack of revenue generated by Avvir

Due to the nature of Avvir's business model of requiring laser scans to be sent to Avvir for insights to be generated from Avvir's end, the inability for scanning of construction sites due to construction project shutdowns caused Avvir to not be able to generate any revenue. Until construction projects resume, laser scanning operations could not be conducted and sent to Avvir. Hence, rendering Avvir's product not viable during the period of construction shutdown.

The lack of revenue generation would mean that Avvir had to keep itself afloat until the construction project resumes. Raffi and the management team had no choice but to resort to the trimming of the company size and a team as lean as possible to tide Avvir through the crisis until construction projects resume. After letting go a few employees, the company size of Avvir stood at a total of 18 by the end of April 2020.

Long Term – Lack of innovation funding from customers

Before Covid-19 struck, the General Contractors in the construction industry, who formed the bulk of the customers of Avvir, have had to rely on the innovation funding of the project sum or company to invest in a contract with Avvir. Even after construction projects resume, Raffi and the management team speculated that there might be a lack of innovation funding since there would be an increase in project costs due to manpower issues and safety enforcement regulations. For instance, additional time and money might be required to ensure sufficient ventilation on construction sites which require time and money. In addition, workers might require a higher medical coverage which might have to be borne by employers as well.

Hence, until the entire Covid-19 pandemic is over, Avvir might very well be less desired by potential and existing customers. Nonetheless, Raffi and his management team were assured by the fact that because construction projects have always a key driver of most economies, especially in New York where there was still $409 billion worth of construction project pipeline, everything would be fine once the Covid-19 situation improves and the construction shutdown is eased. They knew that construction projects would always exist.

"Construction Projects will be here to stay." – Raffi Holzer, CEO Avvir

The concerns then were to tide through the crisis until construction projects resume in the short run and how Avvir can continue to stay desirable to its potential and existing customers after the construction projects have resumed in the long run. After all, they still had to boost their revenue and continue to work on its product in order to garner a good amount of funding for Series A by the end of 2020, which was only less than 9 months away then.

The odds were stacked against the favor of Raffi and his management team. Raffi and his team got to answer this concern as soon as possible before the financial runway of approximately 15 months runs out: "What features should Avvir prioritize in the next few months for it to stay desirable after the resumption of construction activities?"

Construction Project Shutdown

During the shutdown of construction projects in the United States, Raffi and his management team decided to prioritize the development of Autodesk Forge and Photograph Product, and shelve the development of the algorithm accuracy in the meantime.

Raffi and his management team saw the importance in ensuring a pleasant user experience journey. They felt that the needs of the customers should be more important than the Operation Team's. Hence, the decision behind prioritizing the development of Autodesk Forge over the algorithm accuracy.

The attractive potential of the Photograph Product in increasing the adoption rate of Avvir's product was too irresistible. In addition, it was realized that photographs sent by customers would not require as much processing against the BIM model if the outcome for the photograph product was narrowed to progress and cost analyses without deviation analyses. For deviations to be identified through the comparison between photographs and BIM models, it would require heavy computer vision and machine learning algorithms and development. Hence, the

development duration could be shortened if the photograph product was only extended to progress and cost analyses.

Resumption of Construction Projects

In June 2020, after 3 months of shutdown of construction projects, many construction projects resumed operations as there were signs of positive recovery from the impacts of Covid-19. In addition, the government had to strike a balance between the economy and the impact of Covid-
19. To prevent the economic impact from worsening, economic activities such as capital projects were among the few to resume its activity in North America.

However, Covid-19 had already left a permanent delay in the end date of construction projects. The safety regulations which specified a maximum number of construction workers on construction sites meant that lesser manpower could be present to help facilitate the completion of these construction projects, resulting in a further delay in construction progresses. This further led to possibilities of completing construction projects at the expense of the construction quality. This meant that construction mistakes might happen more often and there might be a greater need for construction stakeholders to capture potential construction deviations. As such, this led to a burgeon in sign up rates with Avvir coupled with the change in marketing strategy which allowed for the sales cycle to be shortened.

The development of Autodesk Forge was also on a pace Raffi and the management team was satisfied with. However, the development in the photograph product did not seem as promising as planned albeit a few positive findings. With the positive sales outlook and development of product features, especially in the integration of Autodesk Forge, over the past 3 months, Raffi and his management team could very well try to secure a rewarding funding round for Series A by the end of 2020.

However, trying would not be enough. Do or do not, there is no try. Time is ticking before the next funding round due the end of the year. Raffi and his management team were left with yet

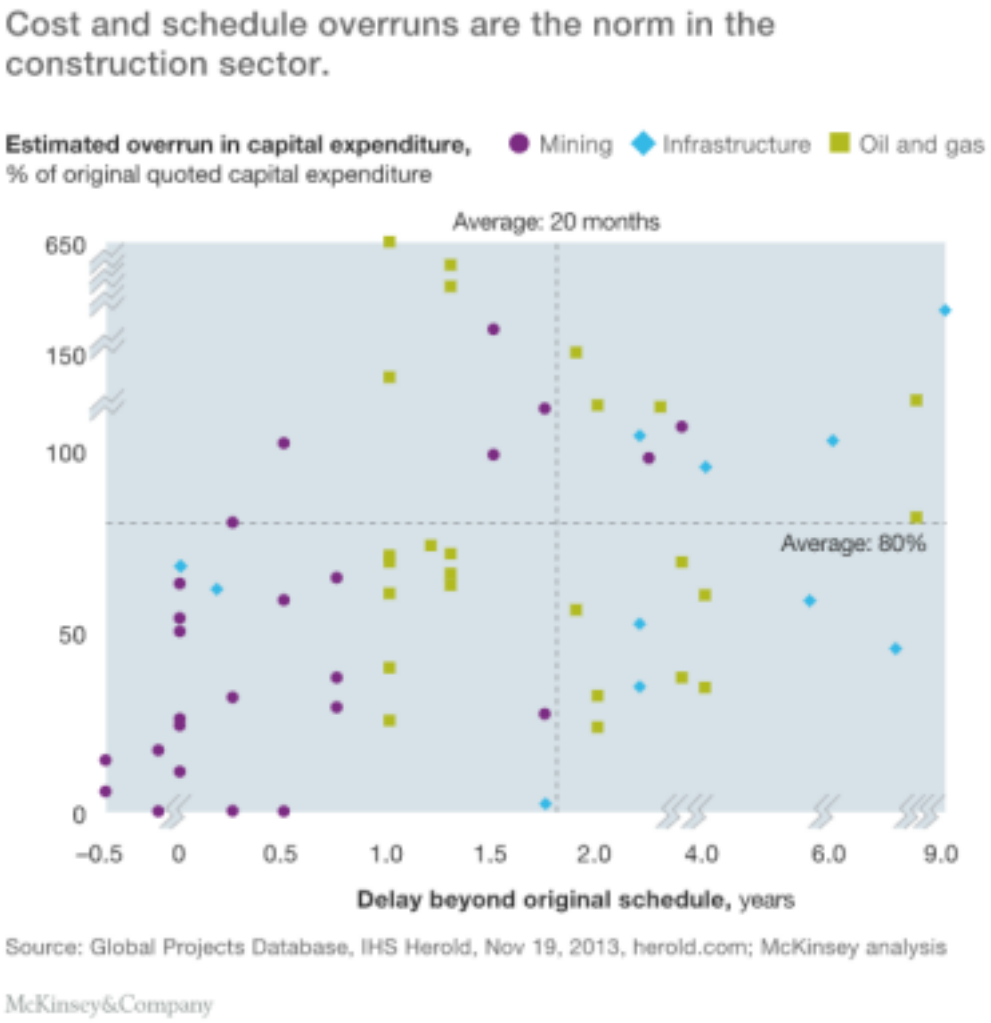
another dilemma: “Should resources continue to be injected into the development or should the plug be pulled on the photograph product for other developmental plans, i.e. algorithm accuracy, to be focused on?”

Exhibit A: McKinsey Global Institute Industry Digitization Index (2016)

Source: https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our insights/imagining-constructions-digital-future

Exhibit B: McKinsey’s Global Estimation of Cost and Schedule Overruns for

Infrastructure, Mining, Oil and Gas Industries



Source: https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our insights/imagining-constructions-digital-future

Exhibit C: The Sweet Spot of Innovation

Source: https://designthinking.ideo.com/

Exhibit D: Digital Twin and its TAM, SAM, SOM

Source:

Digital Twin: A digital twin is a digital replica of a living or non-living physical entity.

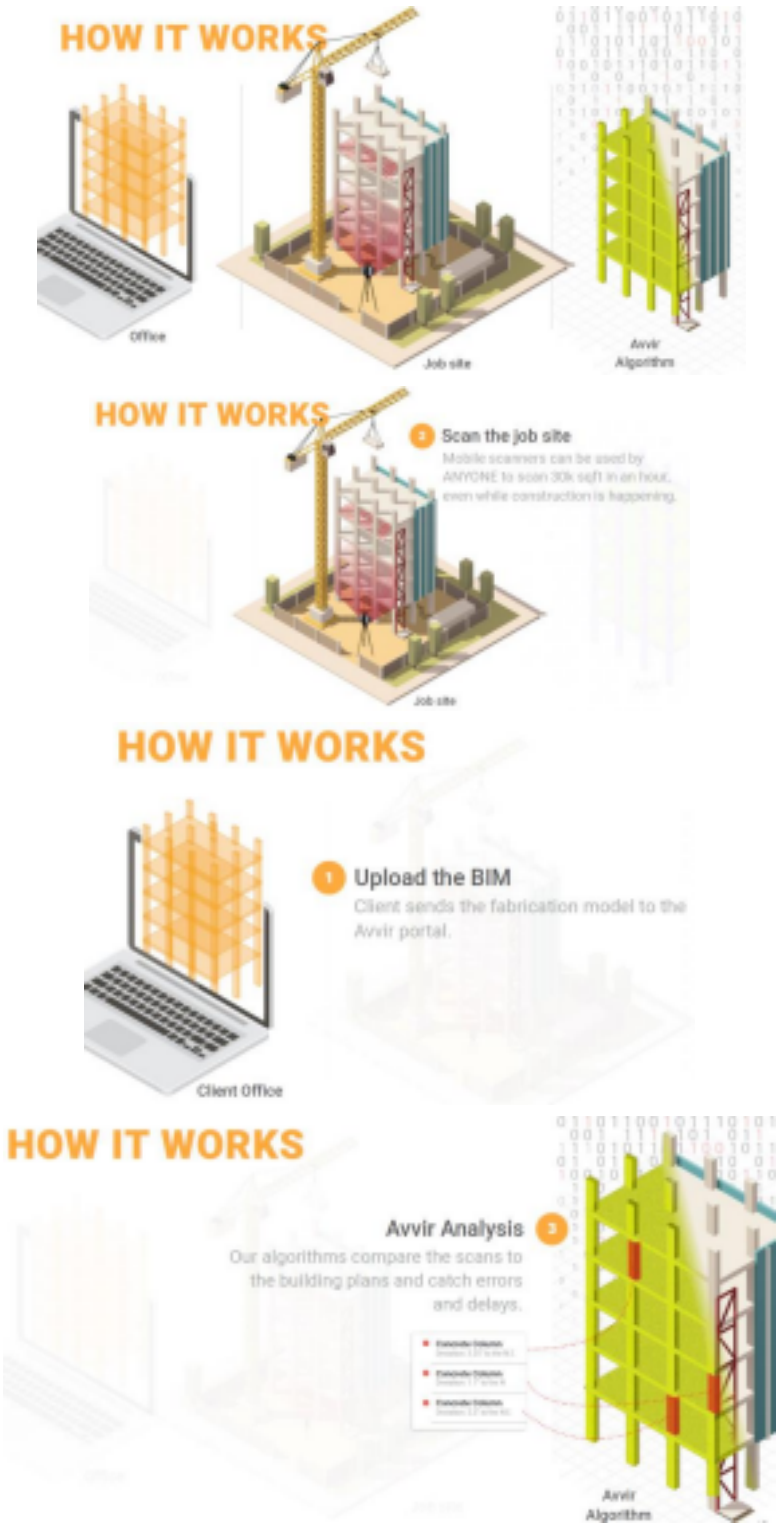
A top-down TAM (Total Available Market), SAM (Serviceable Available Market) and SOM (Serviceable Obtainable Market) forecast for the purpose of a quick way to rationalize the decision to enter the Digital Twin industry

Source:

https://www.globalinfrastructureinitiative.com/article/digital-twins-taking-modular-construction-next-level

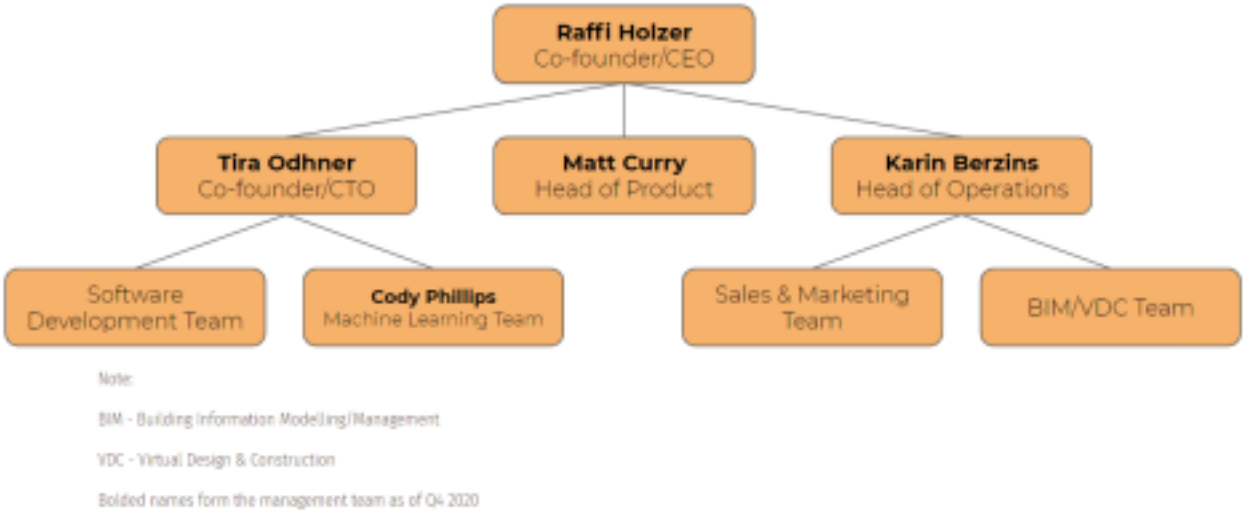
https://www.gminsights.com/industry-analysis/digital-twin-market

Exhibit E: Overview of Avvir's Product Offering



Source: Avvir

Exhibit F: Avvir Organizational Chart

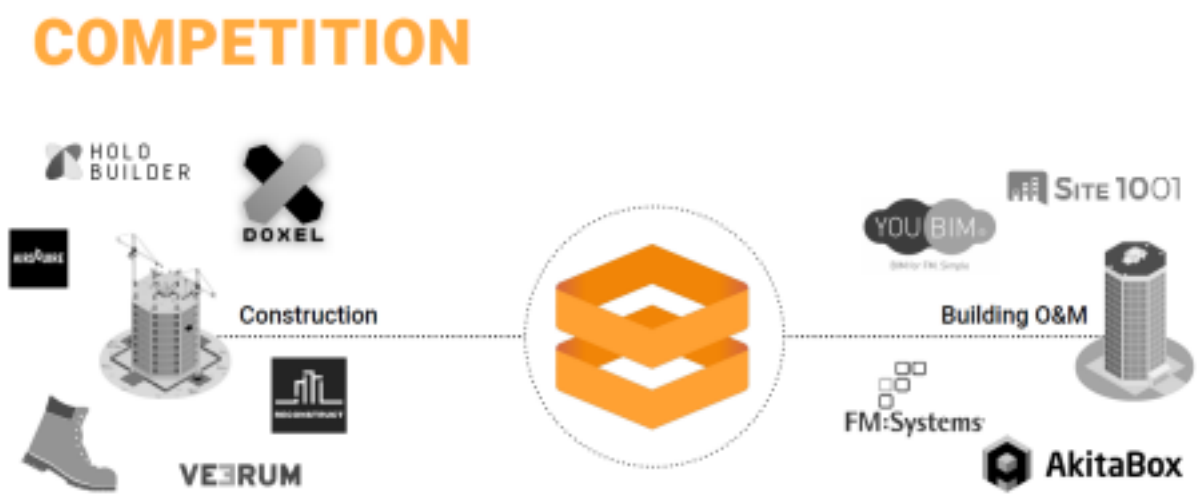


Source: Eugene Lee

Exhibit G: Deviation Analysis (3D) Product Feature

Source: Avvir

Exhibit H: Competitive Analysis



Source: Avvir

Features	HOLO BUILDER	RECONSTRUCT	Bentley	AVVIR
Progress (4D) monitoring	✓	✓	✓	✓
Cost (5D) monitoring			✓	✓
Digital Twin Model	✓	✓	✓	✓
Photograph product	✓	✓		
Identify + Analyze mistakes/deviations (3D)				✓

Source: Eugene Lee

Exhibit I: Progress Analysis (4D) Dashboard

Source: Avvir

Exhibit J: Cost Analysis (5D) Dashboard

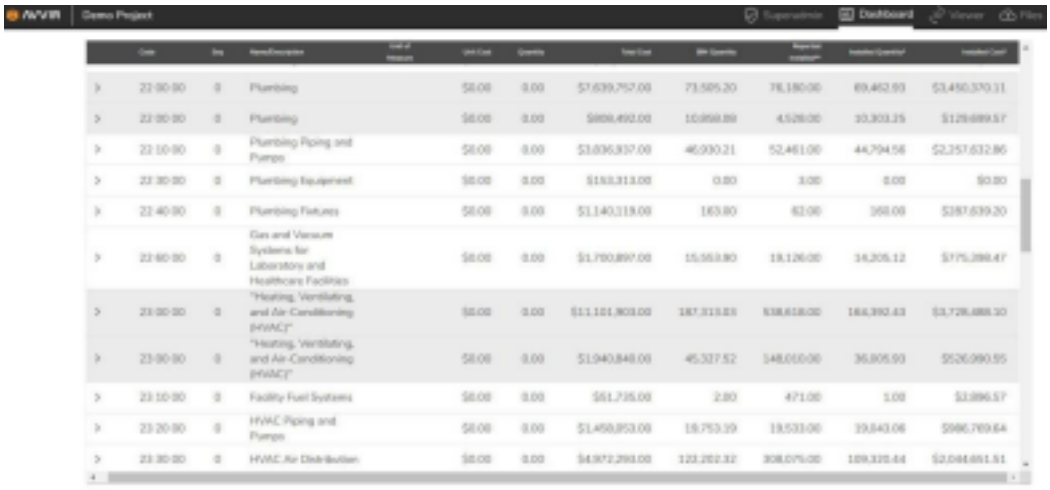


Exhibit K: Market Analysis of Digital Twin Market

Source: https://www.marketsandmarkets.com/Market-Reports/digital-twin-market225269522.html

Avvir