

DATA ANALYTICS: JOURNEY OF THE NATIONAL GALLERY SINGAPORE

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With approximately 64,000 square metres of historic building space, displaying around one thousand artworks at any moment, and having welcomed the one millionth visitor just seven months into opening (“National Gallery Singapore welcomes” 2016), there is a plethora of visitor activities at the National Gallery Singapore (The Gallery) worth capturing, analysing, and understanding, so as to gain new insights into how this modern art institution could sustain itself through increased visitor engagement and optimised business efficiency.

This paper shares the exploratory efforts of the Gallery in the realm of data analytics, as the institution leverages the digital data efforts in both front and back of house operations. It covers the design of visitor interactives and data collection for analysis; and ends with a call-to-action based on data insights. The key learning point involves how data analytics should be part the design process of any touchpoint as early as possible.

Now Open. Now What?

When the National Gallery Singapore officially opened on 24th November 2015, it did so with much public fanfare, drawing

approximately 170,000 visitors in the first two opening weeks (“National Gallery Singapore” 2015). While curiosity drove many Singaporeans to visit then, the challenge now, as with most nascent arts institutions, is in finding ways to sustain and grow public interest.

The current reality poses the following challenges:

1. While the Gallery pursues the “Blue Ocean Strategy” (Kim and Mauborgne 2005) of exhibiting modern art from Southeast Asia, most local museum visitors are uninitiated, first-time visitors, making the Gallery’s relevance to the general populace a challenge through art alone (63%, n=250) (“Business Consulting Presentation” 2016). In The Participatory Museum (2010), this sentiment was echoed as one of the top reasons why citizens shun visiting museums, namely how they felt that “[c]ultural institutions are irrelevant to my life”.

2. In addition, competition for the visitor’s attention now goes beyond the museum industry, and into the increasingly disruptive media landscape of online apps such as Netflix, YouTube, and Coursera, offering new means of entertainment and education on

demand. This instant gratification, coupled with micro-payment subscriptions, makes for unprecedented access to many different and competing lifestyle choices.

The Gallery’s strategic focus spans a creative tension between artistic excellence (i.e., thought leadership in visual arts) and national contribution (i.e., accessibility to the Singaporean public) (National Gallery Singapore 2016). While artistic excellence is addressed through the quality of our curatorial research, publications, and exhibitions, the national contribution in terms of public accessibility and engagement is a challenge that most museums face.

Given that the average Singaporean’s sentiment towards visual art appreciation will take time (even decades) to develop, the more immediate point of impact for museums, with measurable return on investment, is in the design of its interactive experiences as tangible exploratory touchpoints around art, supported by embedded visitor analytics processes. Digital, as opposed to analogue touchpoints, affords

inherent ability to track change. This is an important characteristic given how it is paramount for organisations to measure the success of key efforts for further investment or redevelopment of key initiatives, which ultimately impact visitor engagement and financial sustainability.

Hindsight. Insight. Foresight.

Established museums like The Metropolitan Museum of Art (The MET) generate volumes of digital activities, reaching millions of users through numerous interactive channels. MET’s Digital Media Analyst, Elena Villaespesa, explains that “[w]ith so many activities, it’s important to track the impact of each project in order to set priorities and allocate resources. This is where data can help, and one of the keys to establishing a data-driven culture within an organisation is to report the results internally” (2015). This led them to use Google Analytics to prototype their own Digital Analytics Dashboard as having a live data feedback loop helped The MET better visualise and respond to their visitors’ needs, as shown in Fig. 1.

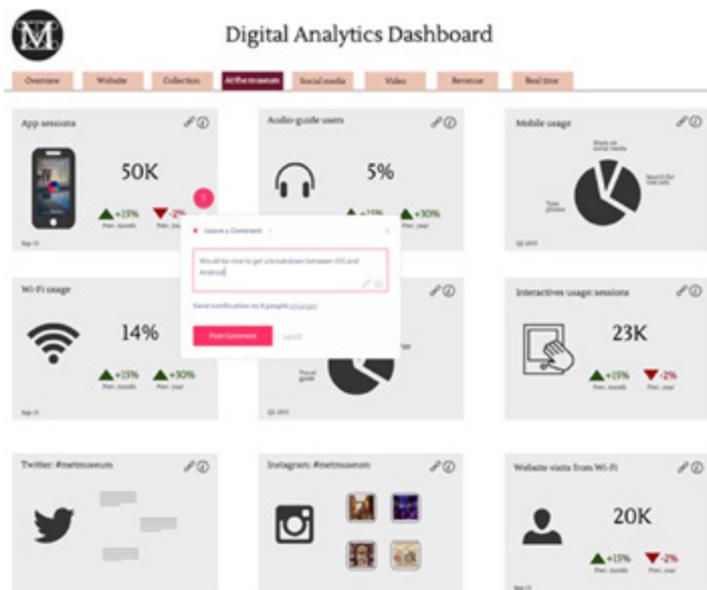


Fig 1. Screenshot of The MET’s interactive mock-up with comments from staff members, 2015.

Image courtesy of Elana Villaespesa of The MET.

The Three Stages and Six Steps of Quantitative Analysis

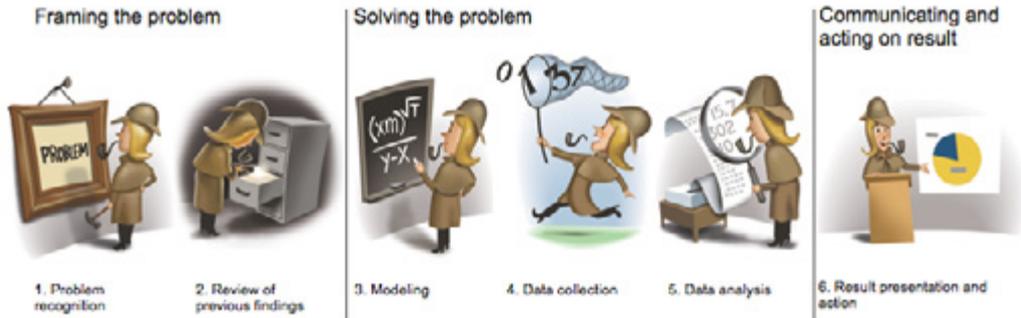


Fig 2. Illustration of analytics as a creative process, particularly in framing and communicating the result. Taken from T. H Davenport and J. Kim, *Keeping Up with the Quants: Your Guide to Understanding and Using Analytics* (Boston, Massachusetts: Harvard Business Review Press, 2013).

A common oversight, precursor to developing such analytics dashboards, is the necessity of embedding analytics needs within the design of interactive touchpoints, such as automated data reporting. To consider why and what is required, one of the “Big Four” consulting firms, Deloitte, broadly explained data analytics on their website as: “[The] practice of using data to drive business strategy and performance. It includes a range of approaches, from looking backward to evaluate the past, to looking forward to do scenario planning and predictive modelling” (Data Analytics 2016).

At the Gallery, we employ a mixed bag of data analytics approaches, with the ability to ramp up competency on-demand, thanks to our partnership with Accenture, such as predictive crowd simulation to prepare for the opening of the Gallery in November 2015. In most cases, there are two typical approaches in which the data analytics process is set up for organisations:

1. Traditional Research Approach

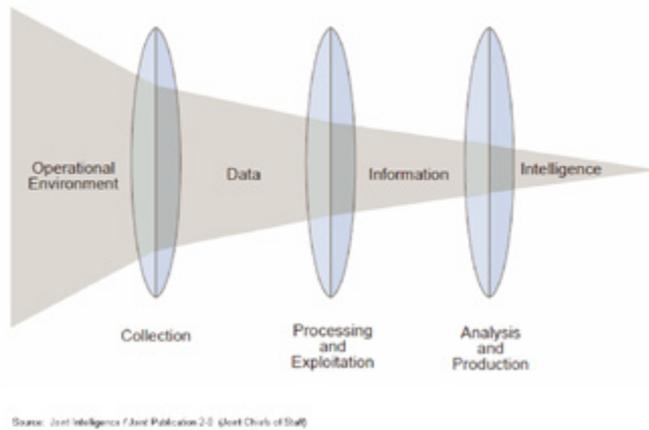
For organisations dipping their toes into analytics, it is common to start with a question

in mind to solve a distinct problem, as illustrated by Thomas Davenport and Jinho Kim in their book *Keeping Up with the Quants* (2013), as shown in Fig. 2. This is purpose-driven and familiar with most of management, largely addressable through traditional research methods (e.g., surveys, interviews, focus group discussions). The downside of this approach is that it typically limits the omnipotent picture which a larger set of ready data points can help present. The data set would be limited to what is readily available, as considerable effort would have to be established early on to collect data across multiple sources to be observed over time.

2. Big Data Approach

The Big Data approach starts with data collection first, not necessarily aimed at resolving specific problems, in order to discover new insights and incremental areas of optimisation. Most large-scale enterprises do this as they can leverage their massive array of data sources for greater economies of scale. The U.S. Joint Chiefs of Staff developed phases of the intelligence cycle used to convert raw information into actionable intelligence (2013), as shown in Fig. 3.

Relationship of Data, Information and Intelligence



Source: Joint Intelligence / Joint Publication 2-0 (Joint Chiefs of Staff)

Fig 3. Conceptually similar to the phases in data analysis, this diagram illustrates the phases of the intelligence cycle used to convert raw information into actionable intelligence or knowledge.

Taken from Joint Chiefs of Staff, Joint Intelligence / Joint Publication 2-0 (USA, 2013), 2.

In the Gallery's pioneering work to develop a data analytics workflow, Accenture and Gallery analytics teams embarked on interviews with key Gallery stakeholders, including directors and above, to discover the key business questions arising from their roles and responsibilities. This exploratory effort was partly useful in validating key concerns, but it naturally could not leverage the full potential of data analytics given that most organisations lack sufficient understanding of the paradigm of analytics in terms of function and delivery. This is a more common challenge than most realise, as validated by consultancy firm McKinsey & Company, citing how:

CEOs and other top executives, the only people who can drive the broader business changes needed to fully exploit advanced analytics, tend to avoid getting dragged into the esoteric "weeds." On one level, this is understandable. The complexity of the methodologies, the increasing importance of machine learning, and the sheer scale of the data sets make it tempting for senior leaders to "leave it to the experts" (Mayhew, Saleh, and Williams 2016).

For data analytics to work for organisations, instead of the other way around, there has to be sufficient traction through investment of time and trust. That said, small incremental wins are necessary to keep the analytics effort afloat, such as delivering regular reporting on business intelligence and providing insights to a myriad of questions that aid various divisions in making informed decisions.

In terms of quick wins, while the Gallery held weekly operational meetings to discuss and improve organisational performance, effort was also made to leap ahead with a "C-Suite Dashboard", which is an abstracted information platform to aid management in strategic decision making. From the big data approach in Figure 3, the analytics team saw opportunity in collecting, cleaning, consolidating, and visualising data across relevant channels, to enable us to detect patterns and develop new insights which the Gallery might not have even realised as business opportunities. As our first foray into developing dashboards, Accenture generously provided their data experts to guide us through.

The purpose of the C-Suite Dashboard was two-fold: a) given the lean workforce, to help the analytics team automate information collection as much as possible, b) to help provide information visualisation and business insights for management and board members via a purpose-built information platform. If well executed, the dashboard would give users the ability to feel the pulse of the Gallery, allowing clearer assessment for decision and action.

From our internal user interviews, at least 30 key performance indicators (KPIs) were identified which the Gallery wanted tracked. Our design involved abstracting complex performance data onto three intuitive thematic dashboards -- namely Visitorship, Expenditure, and Revenue (see Fig. 4). Across fragmented systems, timed scripts are run to semi-automate data compilation, with critical data sources on-board first, including ticketing, people counting, finance, and Google Analytics for the website. Naturally, there are challenges associated with the data collection effort:

1. Each of these data sources are often little Pandora's boxes, containing a complex data schema with an array of data types, which at times require ingenuity as well as mutual understanding in cross-divisional processes to help derive specific KPI data. An example is the derivation of local versus foreign visitorship, on top of the haystack of diverse admission tiers such as complimentary, promotional, and exhibition type.

2. Much of this effort was also dependent on the maturity of the other data sources, such as our customer relationship management and social media tracking systems which was still under development. Incremental effort was required starting with data sources which were critical and readily available.

3. In reality, the effort of automating data collection alone can be challenging, with some sources requiring further finesse through manual

data cleaning and consolidation by the relevant divisions, such as for ticketing (SISTIC) and financial data (SAP). This mundane work of preparing and cleaning data is what accounts for 80 per cent of a data scientist's time (Press 2016).

While these challenges reflect the growing pains of any organisation embarking on an analytics venture, it is natural for an organisation to also question whether the additional effort put in to maintain such a C-Suite Dashboard is worth the results it gets. In summary, the short term Return on Investment (ROI) may be low, but McKinsey's study of companies embarking on big data analytics indicates that much of the work involves longer term effort to reap productivity and profit gains at five to six per cent higher against their competitors. (Biesdorf, Court, and Willmott 2013).

Analytics as part of Design Process

With unparalleled level of attractiveness and accessibility in leveraging our visitors' mobile devices, considerable audience research had to be committed before the Gallery made its foray into offering digital proxies of itself through the web, social media, as well as mobile application. These were seen as a cautionary yet necessary step forward in engaging our connected era of visitors (one of several focus group discussions shown in Table 1), with visitor-based research continuing to evolve even today.

To help guide our interactive design roadmap, the Gallery adopted key concepts from Nina Simon's book, *The Participatory Museum* (2010). Currently practicing her craft as executive director of Santa Cruz Museum of Art & History, Nina's holistic framework on how museum interactives and data gathering could be cohesively developed is based on three fundamental humanistic theories:



Fig 4. C-Suite Dashboard visualises the Gallery’s data sources onto three key dashboards - Visitorship, Expenditure, and Revenue, 2016.
Image courtesy of Accenture.

Summarised Learning Points From Gallery’s Focus Group Discussion (5 th July 2011, $n = 40$)	
Feedback	Motivation
Seeks WOW factor <i>Youth & Young Adults, Students, PMETs, Tourists</i>	to share with friends, for bragging rights
Better artwork explanations <i>Youth & Young Adults, PMETs, Families with Young Children, Tourists, Active Agers</i>	most artwork captions feel insufficient; shows artist, year, medium, size
Recommendations on what to do Tourists, Active Agers, PMETs	to ease visitors into museums, which most locals consider an intimidating place
Better way to know what’s where Youth & Young Adults, PMETs, Families with Young Children, Tourists, Active Agers	to easily locate art highlights, activities, amenities and commercial offerings
Museum guide as mobile app <i>Youth & Young Adults, Students, PMETs, Tourists, Active Agers</i>	seeks convenience for looking up relevant information while visiting the museum

Table 1. The focus group discussion organised by the Gallery on 5 July 2011 involved 40 participants representing six key visitor groups, comprising graduate students, parents, retirees, teachers, business owners, and tourism industry leaders.

1. The idea of the audience-centred institution that is as relevant, functional, and accessible as a shopping mall or train station (Peniston 1999, Gurian 2006, and Lamb 2005).

2. The idea that visitors construct their own meaning from cultural experiences (Hein 1995, 21-22; and Falk 2009).

3. The idea that users' voices can inform and invigorate both project design and public-facing programs (McLean and Pollock 2007).

The Participatory Museum's approach is illustrated through the stages which visitors and museums could be mutually developed, thus turning the table from “me” to “we” in terms of the overall museum visit experience as shown in Fig. 5.

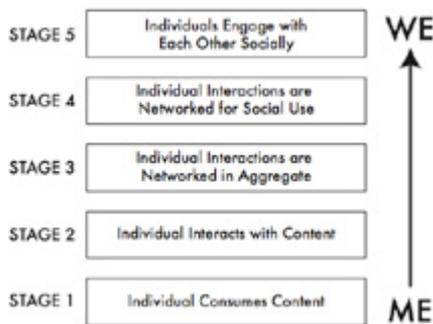


Fig 5. We to Me Design: Five Stages of Social Participation. Taken from N. Simon, *The Participatory Museum* (Santa Cruz, 2010).

From Stages 1 and 2 in developing the Gallery's interactive touchpoints, while the primary function was to produce and present relevant content to support exhibitions, pre-planning in terms of modular design was already needed so as not to simply utilise interactives as one-way devices to passively educate or entertain visitors. Most establishing museums are at this early phase, and can look to scale up to establish a dialogue between visitor and museum, in order to reap higher returns on investment in terms of visitor intelligence and shared content generation.

To realise Stages 3 and 4, the Gallery had to develop interactives not in silo, but as part of a larger network of communicative interfaces, allowing us to learn from the digital activities of their visitors, either through direct feedback (e.g, preferences via visitor services' feedback kiosks), or through actions committed via these digital platforms (e.g, behavioural traits via liked artworks on mobile app, selecting e-postcards via interactive table). Part of this involves a feedback loop, where visitors in turn get to see the results of their collective impression of the artworks on display. An example for this is the display of the “most liked” artworks on the home page of the Gallery Explorer app.

Stage 5 represents the epitome of participatory museum design where, further in the future, experienced designers could explore visitor-to-visitor interactions, thus transforming the Gallery into a facilitator of artistic discourse and enabling a more sustainable content development outlook. A metaphor for this could be seen in how Facebook does not primarily produce content on its own, but facilitates sharing of user-generated content and packages them in an ecosystem of users and their community groups. Aside from the economic benefit of crowd-sourced content production, the socialisation of visitors around artistic discourse also promotes constructivist learning of visual art, in which visitors construct meaning and knowledge for themselves as he or she learns (Hein 1991). This intent of inspiring and enlightening our visitors, particularly through self-realisation, is an essence of what art museums such as the Gallery aspires to embody.

Two real-world examples of Stage 5 in action are Museum Hacks (2013) and School of Uncommon Knowledge (2016). With museums like The MET providing the space, content and authority, the Museum Hacks start-up organises “renegade tours” through exhibition spaces, which range from public “Un-highlights”, to “Badass Bitches of the Met” that celebrates female art and artists. A Singaporean equivalent is the School of Uncommon Knowledge, where

poet/activist Ng Yi-Sheng conducted tours (18 and 19 November 2016) of the National Gallery Singapore through the lens of Southeast Asia’s queer art history (“Painted Shadows” 2017).

Use Case 1: Data-Driven Design for Individual Touchpoints

In 2013, Apple introduced iBeacons (example shown in Fig. 6), a system of low-energy Bluetooth transmitters and application protocols to geo-locate visitors with smartphones indoors and outdoors, and allow for the triggering of specific actions such as push notifications upon entering specific areas. This technology enabled retailers to explore new realms of the shopping experience, by allowing them to track customer movement in a given space, and if systematically linked, could be correlated to deliver specific offers based on a customer’s demographic data. Learning from the retail sector, iBeacons have been deployed in the arts, where established institutions such as The MET and the Louvre have explored this tool to enrich the viewing experience and gather visitor analytics (Chun 2016).

While an easy, safe bet would have been to locate a technology development vendor with an existing iBeacon-ready application framework to produce the Gallery’s mobile app, the bold decision was made to develop the application from ground-up, implementing new interactive technology as we saw appropriate based on our innovation and engagement values, rather than to be locked down by what external vendors were willing to provide. Such interactive technology has always been an ever dynamic playing field, which made it prudent to invest in the short run to evolve eventually to something truly stable and unique for the benefit of our Gallery visitors and staff alike.

A sustainable approach came in the form of a partnership with Accenture Singapore, where a shared vision of developing innovative experiences and organisational excellence allowed us to forge new ground through the Gallery Explorer app (see Fig. 7). Learning from the mobile app development experience with Accenture Mobility, the constant challenge has been in delivering hygiene factor needs (e.g, app usability, stability), while balancing innovations



Fig 6. iBeacons offer potential of indoor navigation and trigger-based interaction. Image courtesy of Accenture.



Fig 7. This illustration quantifies the development effort for the Gallery Explorer app which leverages iBeacon technology, November 2015. The app was developed in partnership with Accenture. Image courtesy of Accenture.

the Gallery sought as game-changers in a bid to be a thought-leader in this field (e.g., iBeacons, non-linear audio-guide, augmented reality, and virtual reality). To this end, the cross-institutional team is constantly learning and evolving our development practice.

To serve the visitor, some of the key features of the Gallery Explorer currently include indoor navigation to locate artworks, self-guided audio tours, and the ability to like, comment and share artworks on social media (as shown in Fig. 8), with more experimental features to come.

To serve the Gallery as a behavioural data reporting foundation, the way visitors use the mobile app is tracked via Google Analytics. We are able to determine data points with regularity, such as the most liked artworks, most popular tours, and where users pick up and stop using the app. Google Analytics allows the team to see the general user journey, determine problem areas, and improve the UX (User eXperience) design as we release new versions of the Gallery Explorer app. Aside

from improving the mobile app experience, this consequently helps the Gallery’s overall visiting experience as well.

Use Case 2: Data-Driven Design across Multiple Touchpoints

The Art Institute of Chicago leveraged its three hundred beacon network (after users connect to their wifi) to increase paid attendance from \$14.8 million in 2015 to a projected \$19.9 million the following fiscal year. Citing Artsy’s editorial, “Can Big Data Make for Better Exhibitions?”,

To accomplish this, user data is crunched to produce coveted analytics like “heat maps” (a visual representation of the total number of interactions with an exhibit), travel paths (where people walk) and dwell times (how long they stand in a gallery).

When a small Edgar Degas show at the museum was an unexpected hit, the red-hot heat maps and killer dwell times

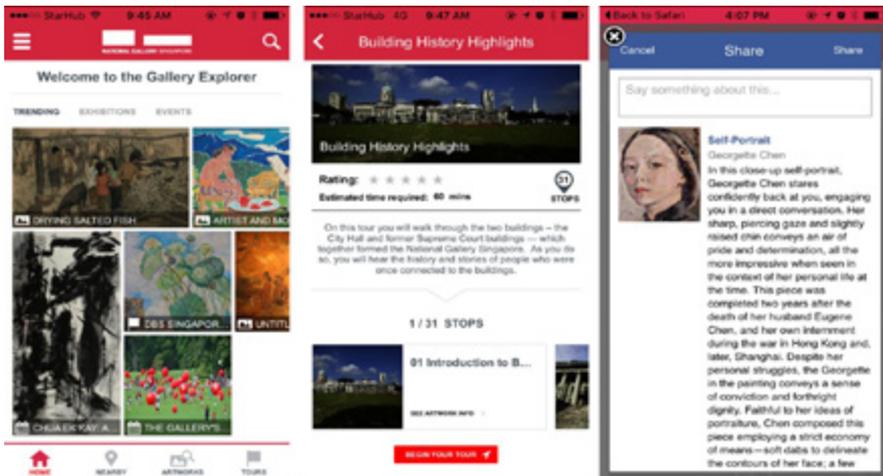


Fig 8. Left to Right: Gallery Explorer’s Trending Homescreen, Building History Audio-guide, Artwork Sharing on Social Media. Images courtesy of Accenture.

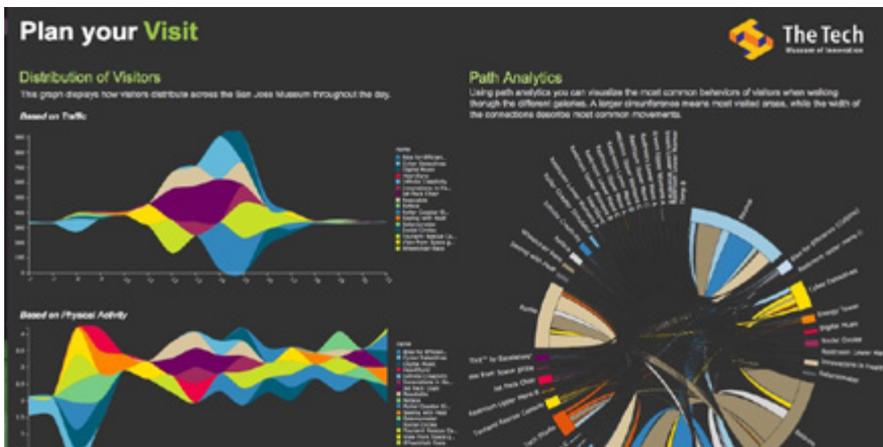


Fig 9. Sample data from the Tech Museum of Innovation, 2016. Image courtesy of the Tech Museum of Innovation.

it generated (more than two times the baseline) indicated that promoting it could drive ticket sales.

“We were able to dramatically grow our revenue with minimal additional investment by responding to this data,” says Andrew Simnick, vice president of finance and strategy. “Now we can supplement and crosscheck this

knowledge with new insights, and run experiments against these assumptions to grow our attendance even more”. (Chun 2016)

As an example of data visualisation, Fig. 9 shows how The Tech Museum of Innovation in San Jose, California presented their visitor traffic flow.

From a big data perspective, comprehensive insight into visitor traits and preferences can be inferred from when we correlate relevant data points across supporting visitor-facing systems. The ground-up development of the Gallery Explorer app means that we can add a backend dashboard to collect and display iBeacon location data points based on visitor movement through building spaces, which can be further enhanced if users register or sign in (technically linking with our Customer Relationship Management system), allowing the Gallery to link location movement data with their personal profiles to derive personalised insights.

While data visualisation appears fun and interesting, Mr Leong Yeng Wai, a Masters Student at Hyper Island Singapore, shared that all of this rests critically on the reliability and validity of the data source. A Forbes Magazine survey found that for data scientists, data preparation and cleansing are the least

enjoyable parts of the task, yet take up around 80 per cent of their time (Press 2016). To add rigour to Gallery’s insights, the aspiration is to utilise both iBeacon and Wifi location data to compensate for shortfalls in the accuracy of either data source. Further validation could be made by comparing against ticket transactions for specific time periods.

Fig. 10 shows the Gallery’s experiments with various ways to visualise visitor flow using log files from the buildings’ Wifi Access Points (AP). As Leong pointed out, in our age of instant gratification, there needs to be an understanding of the challenges behind the scenes. Some of the learning points were quite similar to our iBeacon deployment, including how a) Wifi signal is subject to AP placement within physical space layout, where line of sight often overcomes proximity, b) Wifi systems vary in ability to “handover” device connections accurately from one AP to another.

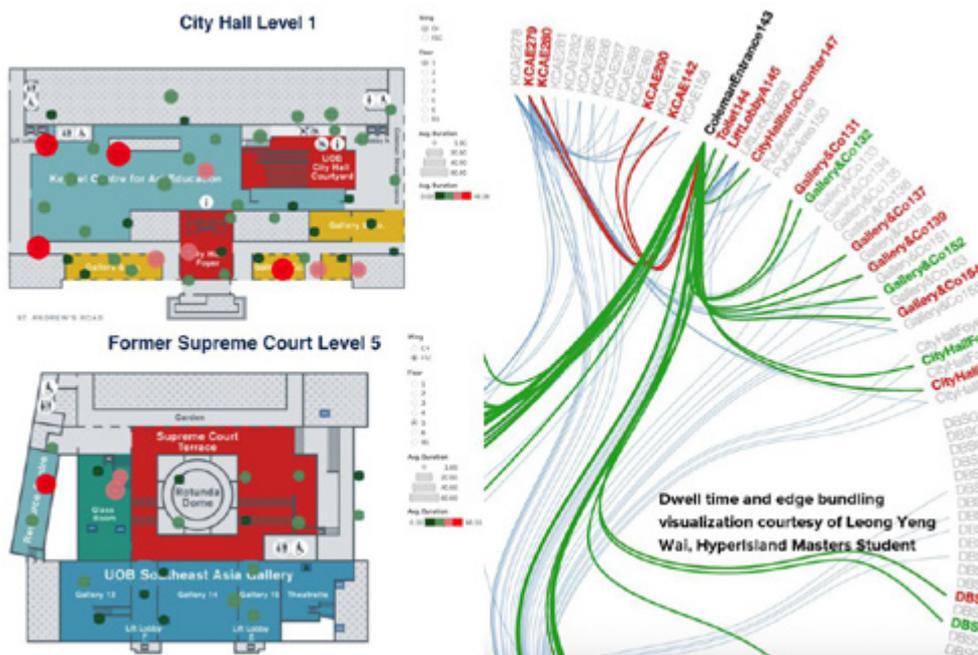


Fig 10. Dwell time and edge bundling visualisation, 2016. Image courtesy of Mr. Leong Yeng Wai.



Fig 11. Questions answered by research methods across the landscape, by Christian Rohrer. Taken from Christian Rohrer, 12 Oct 2014, “When to use Which User-Experience Research Methods,” <https://www.ngroup.com/articles/which-ux-research-methods/>.

The bottom line is that anyone who develops or critiques analytics insights should do so with an understanding of the challenges which are inherent to each data source.

Knowing the What, Understanding the Why

Data alone is rarely enough to call for action, as well-researched storytelling is needed for an audience to rationalise and connect new insights. While data analytics derives insights from large-scale quantitative trends (the *What*), this could be validated through context by understanding the motivations (the *Why*) behind these behaviours, which could be derived through the qualitative methods of surveys, interviews, focus group discussions, and insight communities. Planning for resource allocation towards this helps ensure a holistic perspective of new insights. Christian Rohrer (PhD), Vice President of Design, Research and Enterprise Services at Capital One, developed a succinct chart to explain when to apply each type of research method, as shown in Fig. 11.

Insight. Decision. Action.

In sharing the data analytics journey of the National Gallery Singapore, this paper has covered:

1. Setting up of data analytics approach, based on an organisation’s readiness level.
2. Design of visitor interactive touchpoints, incorporating performance data tracking.
3. Reliability and validity of data, through diversity of data sources.
4. Storytelling of insights, through qualitative research methods.

The fifth and final step involves work culture, and is what McKinsey partners call “Adoption”. This reflects how companies must embed analytics in operating models of real-world processes and day-to-day work flows.

While organisations can amass more data than ever, deriving meaningful insights from data, and deciding with clear action, is easier said than done. A McKinsey global survey on the topic showed that most executive leaders expect their analytics activities to have a positive impact on company. Yet, to date, respondents report mixed success in meeting their analytics objectives. The reason is not due to a lack of strategy or tools, but the a) lack of leadership support and communication, b) ill-fitting organisational structures, and c) trouble finding -- and retaining -- the right people for the job (Sept 2015, $n = 519$) (Brown and Gottlieb 2016).

To address a) leadership and communication, the analytics team of two directly reports to the CEO, as well as the Museum Director, and more recently, is supported by the Chief Marketing Officer (CMO), who is a major proponent in adopting insights about visitors to enhance the Gallery's marketing campaigns. Championing an internal campaign to "Know Your Visitor", the CMO helps drive collaboration across the institution with the aim of educating, gaining buy-in, and enhancing divisional performance through the adoption of meaningful analytical insights.

To address b) ill-fitting organisation structure, the analytics team (a role within Co:Lab X – an innovation lab for the Gallery) is positioned as a lean, cross divisional unit working between key divisions with direct reporting to the top. As an experiment in work culture, Co:Lab is short for Collaborative Laboratory, which highlights the organic nature of the team, with the ability to co-opt ad-hoc members from relevant divisions, depending on the specific task at hand.

On c) finding and retaining the right people, Co:Lab X is still in infancy with about six months since our formation. We still need to establish data architecture across a broader range of business systems, and this being the first year since the Gallery's opening, we lack

sufficient longitudinal data to work with. Managing risk with a small team of two, the idea is for management to determine if this initiative works with a viable roadmap, before further investment is made into the team.

Currently, as an operating procedure, the analytics team works collaboratively with key divisions (e.g., Marketing, Visitor Experience, Strategic Development) to develop and share insights which would typically be leveraged across the organisation. Broader insights are shared at our regular meeting platforms such as our weekly operations, exhibition coordination, or management committee meetings. More specific insights are shared directly with relevant divisions. As an example of turning information into action, data from observed visitor traffic flows inform curators about responsive exhibition design, contribute ideas about potential merchandising opportunities to business development leads, and enable the visitor services team to strategically deploy front of house staff. Moving forward, most efficient organisations have their divisional staff trained with data visualisation tools (e.g., Tableau, Qlik) so they can "self-serve" by seeking answers to their own questions.

For the Gallery, measured investments have been made into the analytics effort, and while it is exciting to see this venture grow, the most important takeaway is how it remains as an incredible learning journey for everyone.

Acknowledgements

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