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Part A

In this article “How Digital Information Transforms Project Delivery Models” Jennifer Whyte describes how the rise of digital systems and analytics can contribute to the transformation of project delivery models. It discusses the employment of fast-growing innovation and computation ability to project management that empowers project models and impacts all aspects of a project; supply chains, relationship with owners and end users, and operators.

The paper goes on and sets a background by looking into empirical studies focusing on megaprojects to show how digital transformation and innovation changes the landscape of project delivery models. This phenomenon in the infrastructure delivery model enables the actors in the project to easily expand the network. The example given by scholars shows the execution of progressive design approach that deals with risk and flexibility, influence of digital information on operation and the impact innovation has on Crossrail throughout the London megaproject ecosystem. Inadequate employment of digital information that includes system integration in project delivery models was also examined.

The other matter discussed in the journal is the system integration and integrated solutions. Davies and Mackenzie’s study shows how megaproject changes its relationship with stakeholders as the project’s deliverable and objectives changes. Projects and its players can go beyond the only project duration and can integrate into other areas of business such as; finance, design, construction, maintenance, etc. This section also refers to an integration solution as the extension of project deliverable beyond products and adds services as an outcome. Although, one of the industry experts suggests that there has been a significant deficiency in implementing such techniques.

The author drives on knowledge codification in project delivery and digital information transformability - which is identified as essential to organizing - by expanding on revolution that is occurring from hard printing of the codified knowledge to digitalisation and personal computation of it.

To explain project deliveries that are influenced by digital innovation, the author discusses the definition of such projects and their characteristics. In such projects - that are outlined as information processing systems – information is digitalised and organised by an information management system in a firm which generates a variety of data such as; digital records, drawings and geographic data that are kept in a database. Given this digital shift in the project delivery ecosystem - which according to this journal is correlated to upswing of professionalism and a new fashion of accountability in this area of work – the characteristics of digital information are underlined as shareable, remotely accessible, searchable, and updatable.

Evolving digital ecology enabled by general-purpose technology creates a steadfast change that impacts all sectors. Then, the consideration is how industries with lower rates of adaptability and adjustment

would handle such wild and fast changes. Kane, Palmer, Nguyen-Philips, Kiron and Buckley state that stakeholders must “Systematically prepare to adapt consistently” as a way for organisations to gain digital maturity. This assessment then raises a new set of questions about the project's development, integration, outcome, and stake-holder’s interactions within this fast-growing digital information ecosystem.

The author has also looked at the method used for London’s megaproject research, identified as the forerunner of digitally enabled project ecosystem, with focus on 15 years of organising and connection practices and experience in developing projects that are embedded in digital information technology. It includes reviewing the areas such as; research design, data collection and data analysis and concentrates on two segments: the industry/government initiative and the infrastructure megaprojects. The data collected through a set of projects focusing on first; environments where a single digital model is used such as Heathrow T5, and second; world-wide projects that used technology. Additionally, the data analysis is identified as iterative and constructed upon a profound engagement with the dataset and context of interconnection between digital initiatives and megaprojects.

The findings in the journal focus around the three industry/government initiatives that describe the evolution of digital innovation in megaprojects ecology and the learning about digital delivery and its link to digital maturity. The finding includes Avanti Programme, a £5 government initiative, that enhanced consistency of data development in design by creating information standards and became the lead for UK BIM Agenda, which was another initiative by the UK government that was employed to modernise the sectors aimed at creating new procedures of digital delivery. In doing so the following are executed; ‘incentive structures’ implemented by government and ‘procurement methods’ which tasked a group of professionals to create new strategies. The ‘stage-gates in the process’ implied there was responsibility for rationalising and standardising the stage-gate model across the industry, creating a new set of standards for using the digital information and digital communication across supply chains. All these programmes were initiated under the “Digital Built Britain”.

The next part of the paper discusses accessibility of project managers and engineers to use digital tools such as digital dashboards, analytics, and multi-functional devices that are now available due to growing computational abilities and technology advancement. To showcase this revolution, the author looks into Heathrow T5, London 2012 Olympics, Crossrail, and HS2 projects which are the four major infrastructure megaprojects in London where increasing interconnected technology along with hardware such as sensors and drones were employed. Due to integrated software solutions among projects, a massive amount of data is generated which creates challenges when it comes to sorting, analysing, and retaining information.

The fast-growing rate of change in the megaproject ecosystem forced project managers to not only comprehend the transition and direction of this rapid change, but also forced them to absorb, adapt, apply and customise the pervasive digital information in the light of attaining digital maturity. Expanding on achieving digital maturity, the journal introduces the notion of “thinking into the future” which addresses

the different emergent pace of project delivery and digital innovation that project managers are left to deal with. It is specified that project managers are challenged to recognise, take opportunities and learn on how to consistently and rationally adapt, engage and implement the advanced digital technologies throughout megaprojects.

Then the journal follows the three generations of integrated solutions identified by combining the literature and empirical study of Bradly et al, and how these relate to the project deliverables (that are now not only physical but also digital assets), project's stakeholders and also the digital information. These are model1; Owner-Operator, Model2; Pop-Up client and model 3; Integrated Pop-Up client. The methods, standards and structures embedded in these solutions are gained through industry/government initiatives to address substantial challenges arising from the integration of digital information.

This paper concludes by revisiting on the impact of fast-growing pervasive digital information and accessibility to inexpensive and smaller devices on project delivery models and how these changes have been transforming the deliverables itself as well as the ways of delivery. It also suggests the need for new ways of researching as digital innovation evolves and gains more maturity. It stresses how further research due to the exponential rate of computational power increases the amount of data collected which provides scholars with new distribution techniques that enable thorough simulations.

Part B

This research is valuable as it illustrates ongoing and profound movements of digitally enabled project delivery models. Movements include the development of three new generations of integrated solutions, changes in supply chain and relationships between practitioners, growing recognition for the importance of digital and analytics. The five megaprojects analyzed have gained global reputation and great success with digital innovation in delivery models, making the results reliable and acknowledged.

The digitally enabled project delivery models of five megaprojects in London are classified into three generations. This enables practitioners to study and gain heuristics from others' experience. By referring to the classification of new integrated solutions, practitioners are able to decide which generations their behaviours belong to by estimating internal circumstances. With both external references and internal evaluation in mind, they can flexibly make changes in workflows. To address any bottlenecks, manners identified in the new integrated solutions can be considered. However, project managers shouldn't just focus on the benefits of digitally innovative models but also consider potential risks generated. As a trade-off to develop innovations, the megaprojects in London spent a large amount of capital and manpower where Heathrow Terminal 5, London 2012 Olympics, Crossrail, High Speed 2 funded £4.2 billion, £6.7 billion, £14.8 billion and £24.3 billion respectively. This might not be acceptable for all project sponsors. Therefore, when taking the three generations of integrated solutions as references,

project managers should pay great attention to project risk management. For example, they should think about “Are technical equipment stable enough to support innovations?”, “Is the digit system reliable? Will it cause information leakage?”, “How reliable are the cost estimates?”, ect.

In the latest year, it has been a global trend of digitalization. In order to help entities getting a firm foothold in the growing competitive markets, practitioners have to be sensitive and react quickly to the new generations of digital devices and built-in software. Otherwise, they will be ruled out by markets. For instance, if a supplier does not accommodate new digital innovations in the workflows, it would have lower competitiveness and bargaining power when peer competitors are familiar with the new digital technologies as the nature of markets is survival of the fittest.

Besides the external motivations of adapting new digitally enabled project delivery models, digit information itself can help practitioners to deal with tasks much more effectively and efficiently. Since four characteristics of digital information are shareable, accessible remotely, searchable and updatable which bring great advantages to the development of entities. With these characteristics, digitally enabled project delivery models help reduce transaction costs as well as cross-boundary corporations. Especially, with significant influence of the COVID-19 outbreak, a remote design office and real-time operating system have a great contribution to enable regular workflows. Furthermore, the shareability of digital information makes information transparent across supply chains during delivery and across stakeholders. Building information models works as a catalyst for potential partnerships as well as enabling the success of asset management. By understanding how shareable digital information changes the relationships between contractors, practitioners can find the best practices to enhance trust and close the relationships with their partners.

With the importance of digital information in mind, practitioners are able to discover and take advantage of new opportunities derived by the increasingly popular and widely used digital information. For example, with the given changes in digitally enabled project delivery models through three generations, practitioners are able to observe the potential patterns and further develop innovative models by seeking for new incentive structures, procurement methods, standards and client communications. This could be a great chance for the entity not only for its internal development but also helps it to possibly become the initiative of a new generation, just like the five megaprojects in London. Although a new opportunity is beneficial to an entity, it can always derive risks. A concern in this case is that digitalization has already reached relative maturity in industries currently. It might be harder than ever to create breaking innovations. It is possible that practitioners try to break through the bottleneck of development by putting in abundant effort but end up no remarkable contribution. Again, practitioners need to carefully estimate and control potential risks when encountering such an opportunity. Looking at the other side, if practitioners are able to overcome the risks and effectively reduce the cost, they could contribute to a great forward step in the development of digitally enabled project delivery models. This enables them to gain a reputation over industries and earn more profits.

In conclusion, the results of the article are valuable as it provides insights about practices of innovative digital enabled project delivery models. By identifying changes of models, including relationships between contractors, growing recognition of importance of digital information as well as the transformation of integrated solutions, it provides reliable references for practitioners, allowing flexible adjustment for their project delivery models. Moreover, it helps practitioners to identify and benefit from new opportunities derived from increasingly influential digital information. To refer and apply these results in their own practices, project managers need to carefully consider project risk management, especially the cost estimate, feasibility and sustainability of the project. However, there has been a limitation that the result is only regionally presentative. It well described previous manners of megaprojects in London, but it could be inappropriate to apply the results to other regions, such as Asian countries. This is because markets are largely different in various areas. When referring to the results, practitioners should also adopt corresponding customised measures which best fit the regional markets.

Part C

At the beginning of the article, the author mentioned that Moore's Law predicted the exponential but non-linear growth of computing in the past 50 years correctly. However, Moore's Law slows down sharply in recent years. When smaller nodes reach the limits of physics, the power efficiency gain will gradually reduce, and the current processor core performance is expected to double only every twenty years (Triggs, 2020). So far, due to technical and economic reasons, Moore's Law has become more and more challenging to maintain. The direction of future development and technological speed of growth are likely to be very different from before. Moreover, the development of science and technology is actually close to the bottleneck and tends to be saturated. As a result, the assumptions of Moore's Law might become increasingly inapplicable in the current technology and market environment. Thus, if the author can take the maturity of technological development and the potential moderateness trend in the future, it can make this article far more reliable.

In terms of the methodologies, the research analyses initiatives and megaprojects in London across 15 years to explain the digitally enabled project delivery models which are changed by pervasive digital information. The study only selected a few initiatives and megaprojects in London as the research objects, and projects in other areas or countries were not taken into consideration. However, the actual environment of each place always has a certain degree of difference(e.g. the level of technological development). Therefore, the results could only be accurately applied to the sampled area and may not be concluded as universal for other places which are not involved in the research process. We should acknowledge that London has already become a developed city in a highly developed country where megaprojects can be carried out by high-end managerial elites in a relatively orderly manner. However, in places such as Africa or Asia and all the other countries with a market environment totally different from

that of Britain, the same impact of the digitally enabled model on project delivery might not be observed in the same way. The sample size for the research is also quite small, namely, it only includes three industry or government initiatives and five infrastructure megaprojects in London. Thus, the models and conclusions obtained based on the analysis of these samples may be ill-considered, not accurate enough and have certain defects. More cases may be needed to support the universality of the models, both in terms of quantity and breadth of scope.

This article embraced interpretive approaches in the process of selecting cases, collecting data and analyzing the data. By utilising this method, researchers mainly deepen their understanding of the phenomena as well as its complexity under specific circumstances, rather than generalising the understanding for the entire population and other contexts (Creswell, 2007). Thus, the research does not have a scientific procedure to verify the validity and practicality of the results (Pham, 2018). Another limitation of this method is that the views generated tend to be subjective. The personal opinions and values of researchers would affect the process of data selection and analysis, which might contribute to the unreliability and unrepresentativeness of the data. At the same time, the results produced by the research would also be impacted to a certain extent, it may lead to biased interpretations due to the researcher's own thinking style or cultural background (Pham, 2018).

The result presented by the author in this article also has some deficiencies. The issue which our group is most concerned about is the risk management issue driven by the growth of the integration of the digitally enabled model into project delivery. Since this article aims to analyse how digital information transforms project delivery models, its readers and potential readers should have expected a more objective and comprehensive analysis. However, as far as our group is concerned, the author presented a screening of non-objective research results and an overly optimistic vision. Too much attention was paid to the advantages of the digitally enabled model for project delivery, neglecting the risks associated with it, thus forming a certain degree of misleading. Although the author did mention that 'such integration of project information opens new opportunities for value creation, and also raises new challenges (p.187)', she did not elaborate much on this point. Our group believes that it is necessary to add risk-relevant analysis into such an analytical article. First of all, although the digitally enabled model facilitates information sharing to a more convenient and transparent stage, it also increases the risk of information security. A great amount of capital investment is needed if the system security needs to be guaranteed. On the other hand, if the tangible files and documents are transferred entirely online, the requirements for internet stability and online storage are very high. Once the internet runs down or the online storage space is damaged, it will bring a significantly negative impact on project management. Moreover, as we mentioned previously, the subject projects selected by the author are very limited in terms of their characteristics. Perhaps for some megaprojects that are not considered in this article, due to their own situation, the disadvantages caused by the use of the new digitally enabled model might overweigh the advantages. In such a scenario, a more comprehensive solution should be further discussed. If appropriate risk analysis and corresponding managerial methodologies can be integrated into this article, a more objective result can be presented, and

the impact of the digitally enabled model on project delivery and management can also be understood more clearly by the readers.

It should also be noted that the author's interpretation of the advantages brought by the digitally enabled model in the presentation of results is not detailed enough and too general to reflect its specific impact on megaprojects. Clearly, in this article, the author wanted to focus on how the development of digital information affects the delivery of megaprojects. However, in describing the detailed advantages and changes brought by the digitally enabled model, although the author provided readers with very helpful models, this article does not reflect the specific impact of the development of digital information on megaprojects. In other words, in the design of research and analysis, the author only considered the field of megaprojects but as results he only obtained a relatively general conclusion, which makes it difficult for readers to understand what unique advantages megaprojects can obtain under such information development compared with other ordinary or small projects. If the author can take more the detailed impact of the digitally enabled model on megaprojects and more specific advantages into account, she can surely make more contributions to the guidance of megaproject management in terms of achieving better scheduling and resource distribution.

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