ISTANBUL TECHNICAL UNIVERSITY ★ GRADUATE SCHOOL OF SCIENCE ENGINEERING AND TECHNOLOGY

ISO 19650 COMPLIANT PROJECT INFORMATION PROTOCOL PROPOSAL FOR COLLABORATIVE WORKING AND BIM EXECUTION

M.Sc. THESIS

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Department of Civil Engineering

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JUNE 2019

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ISTANBUL TEKNİK ÜNİVERSİTESİ ★ FEN BİLİMLERİ ENSTİTÜSÜ

İŞBİRLİKÇİ ÇALIŞMA VE BIM UYGULAMALARI İÇİN ISO 19650 UYUMLU PROJE BİLGİ PROTOKOLÜ ÖNERİSİ

YÜKSEK LİSANS TEZİ

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Salim Burak Tezgiden, a M.Sc. student of ITU Graduate School of Science Engineering and Technology with student ID 501151167, successfully defended the thesis/dissertation entitled “ISO 19650 COMPLIANT PROJECT INFORMATION PROTOCOL PROPOSAL FOR COLLABORATIVE WORKING AND BIM EXECUTION”, which he prepared after fulfilling the requirements specified in the associated legislations, before the jury whose signatures are below.

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To my family,

FOREWORD

Construction industry have long been regarded as an environment with demonstrated high levels of inefficiency, resulting in excessive waste and delays on an average. This study have been conducted with the aim of achieving improved efficiency and collaborative working conditions in buildings and civil engineering works, through contributing to the project information management process.

I would like to thank to my thesis advisor Assoc. Prof. Dr. Deniz Artan for giving me the countenance along the way. I am presenting my sincere appreciation to Mr. Marcel Ingenhoest, Mr. Christopher André, Ms. Miriam van der Putten, Mr. Behlül Kula, Mr. Burak Erçelen, Mr. Burak Biçkes, Ms. Teodora Kristitu, Mr. Mike dos Santos Freitas, Ms. May Winfield and all my colleagues from Royal HaskoningDHV that have contributed to this thesis for their precious efforts. Very special thanks to Mr. Hasan Pamukcu, Mr. Mehmet Oner and Mrs. Bilge Muhurdaroglu for always being there when I needed during this study. Finally a particular thanks to my family, I have always been grateful for their guidance and support.

June 2019 Salim Burak TEZGİDEN

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ABBREVIATIONS

AFNOR **:** French Standardization Association
AIA **:** American Institute of Architects
AIM **:** Asset information model
AIR **:** Asset information requirements
BEP **:** BIM execution plan
BIR **:** Building Information Council
BIM **:** Building Information Modeling
BSI **:** British Standards Institution
CAD **:** Computer-aided design
CDE **:** Common data environment
CEN **:** European Committee for Standardization
CIC **:** Construction Industry Council
CIOB **:** Chartered Institute of Buildings
COBie **:** Construction Operations Building Information Exchange
DEVB **:** Development Bureau of the Government of the Hong Kong
EIR **:** Exchange information requirements
EN **:** European Norm
FC **:** For construction
FIDIC **:** International Federation of Consulting Engineers
GSA **:** USA General Services Administration
HVAC **:** Heating, ventilating and air conditioning
ICT **:** Information and communications technology
IFC **:** Industry Foundation Classes
ILS **:** Information delivery specification
ISO **:** International Organization for Standardization
JCT **:** Joint Contracts Tribunal
LOD **:** Level of definition
LOD **:** Level of detail
LOD **:** Level of development
LOI **:** Level of information

LoIN **:** Level of information need

MIDP **:** Master information delivery plan

NBIMS-US **:** National BIM Standard - USA

NBS **:** National Building Specification

NEC **:** New Engineering Contract

NEN **:** Netherlands Standardization Institute

OGC **:** Open Geospatial Consortium

OIR **:** Organizational information requirements

PAS **:** Publicly Available Specification

PBS **:** Public Building Services of the GSA

PIM **:** Project information model

PIR **:** Project information requirements

POW **:** Plan of work

PTNB **:** Digital Transition Plan for Buildings

RIBA **:** Royal Institute of British Architects

TIDP **:** Task information delivery plan

UAE **:** United Arab Emirates

USA **:** United States of America

USO **:** Uniform Savings Statement

UK **:** United Kingdom

SYMBOLS

CO_2 **:** Carbon dioxide

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ISO 19650 COMPLIANT PROJECT INFORMATION PROTOCOL PROPOSAL FOR EFFECTIVE COLLABORATIVE WORKING AND BIM EXECUTION

SUMMARY

Construction industry is in a digital transformation. Introduction of new technologies and adoption of new ways of working brings together valuable benefits to the industry. There is an ever-accelerating orientation towards trying and adopting what is new and this is somewhat an outlander behaviour to an industry that is traditionally not very innovation-inclined. There is an accelerating shift from the physical to the digital environment.

BIM is one of the developments indicating where the industry moving forward, enabling parties work in a more efficient and collaborative way and leaving lesser space for mistakes and waste. Being an unarguable potential for a tremendous change in the definition of waste and inefficiency throughout the industry, BIM and digitized information have been welcomed across the industry.

Adoption of BIM and the use of digitized information also brings together the requirement of new ways of legal governance as the traditional ways of doing business in construction scenery are not capable of covering essential aspects of the management of digital information. It is not known where the digital transformation is taking the industry standards towards, but at the moment ways of adopting a legal consideration around information management are arising around amending contracts with documents consisting of additional provisions and relevant information. An information protocol is a common way of incorporating additional information management related provisions into contracts.

This study is aiming to achieve improved efficiency and collaborative working conditions in buildings and civil engineering works, through contributing to the project information management process. A project information protocol form that is in compliance with the ISO 19650 standards is proposed as a way to incorporate relevant information management provisions into agreements for buildings and civil engineering works, by altering the de-facto industry standard CIC BIM Protocol. By doing so, the envision behind is advancing the ability to draw a more visible legal framework than what has been done up to date and thus enabling parties to work within a more efficient and collaborative environment through BIM.

In order to achieve the vision, first a literature survey is undertaken. Various publications that concerned around barriers hindering the adoption of BIM and collaboration, the legal governance of information management, digitization of information in construction industry and BIM process are went through and the outcomes in relation with this study have been utilized as reference points to both determine problems within the information management process and propose appropriate solutions by synthesizing their relevant approaches, and also for benchmarking purposes.

The information management process during delivery is further examined in detail to provide understanding of the adopted approach for the information management

process as per the ISO 19650-2. Afterwards, a detailed definition is set out for a project information protocol with the help of the existing literature. Following the definition, an investigation on the status of BIM adoption around the world is undertaken with an attempt to demonstrate the existing situation around handling digital information management and BIM processes at the moment and where the leading industry standards are moving towards.

After providing a clear understanding of the background of information management process, the information protocol definition and having a glance at the current development of BIM applications within the construction world, a discussion on the existing ways of providing legal framework for information management and BIM within construction projects takes place. Different approaches from various organizations in terms of legal governance of information production, use and exchange are summarized. A number of legal risks arising from BIM adoption are presented and on the basis of mitigating these risks, the CIC BIM Protocol's second edition is benchmarked in comparison to findings on best practice approaches adopted by previous legal forms.

After the literature study explained in the overview chapter, the theoretical framework of the study is set out in the third chapter. Definitions of new terms adopted in the information management process with the introduction of new ISO 19650 standards have been described. The concept that have been shaped the study towards setting out the proposed project information protocol together with the intended scope are also presented within the theoretical framework.

During the main discussion of this paper, the proposed structure of the project information protocol is set out. As a reference point, the CIC BIM Protocol (second edition) which is a widely accepted, de-facto industry standard is adopted. Each provision that is determined to be essential and intended to be provided within the information protocol is explained within the extent supported by appropriate evidence. Provisions are taken from the CIC BIM Protocol and altered to satisfy ISO 19650 requirements. These alterations are based on the literature survey as given in the second chapter of this study, ISO 19650 examinations and expert reviews with professionals from the construction sector involved with experience.

In the sequel of the main discussion, the proposed information protocol is evaluated. An initial evaluation is undertaken to assess how the protocol is capable of mitigating legal risks arising from the adoption of BIM. In sequel of ensuring the information protocol being sufficiently capable of mitigating potential legal risks, the second evaluation took place indicating how the information protocol is contributing in overcoming various barriers hindering BIM adoption and collaborative working. Findings of the evaluation indicate the potential significant progress promised through the establishment of a clear legal framework with the incorporation of the ISO 19650-compliant Project Information Protocol into contracts.

Final summary of the study and discussion on findings and results are given in the Conclusion chapter. Considerations on how this study can be enhanced, thoughts and envisions on how this paper may contribute to further ideas for potential new studies are presented as the round out.

İŞBİRLİKÇİ ÇALIŞMA VE BIM UYGULAMALARI İÇİN ISO 19650 UYUMLU PROJE BİLGİ PROTOKOLÜ ÖNERİSİ

ÖZET

İnşaat endüstrisi dijital bir dönüşüm süreci içerisindedir. Müteahhitlerden, tasarımcılara ve üretim alanında faaliyet gösteren firmalara kadar endüstriye katkı sağlayan bir çok aktör, dijitalleşmeyle beraber gelen yeni teknolojilerin hayata geçmesi ile oldukça pozitif sonuçlar elde edebilmekte ve daha verimli çalışma yöntemlerine adapte olabilmektedir. İnovasyon kültürü açısından değerlendirildiğinde zayıf olarak görülebilecek olan bir sektörde, bugüne gelindiğinde görülen yeniliğe adaptasyon çabası ve hızla gelişen dijitalleşme rekabeti oldukça dikkat çekicidir. İnşaat sektörü dünyadaki en geniş sektörlerden birisi olmakla beraber aynı zamanda verimlilik olarak da dünyadaki en düşük ortalama verimlilik oranına sahip sektörlerin de başını çekmektedir. Teknoloji adaptasyonu ve dijitalleşmeyle gelen verimlilik, kayda değer oranlarda artan pozitif üretkenlik de aslında sektördeki değişime olan bu ilginin temel nedenlerinden biridir. İşverenler, farklı sektörlerdeki yeniliklerin de hızlı bir şekilde yayılması ve gelişen teknolojinin kolaylıkla takip edilebilmesi ile taleplerinde daha belirgin, daha zorlu ve daha yüksek verimlilik arayan şartlar ortaya koymakta, mühendislik ve yapım firmalarını bu zorlu şartlar altında gelişen rekabet ortamı ile teknolojik yenilikleri benimsemeye mecbur kılmaktadırlar. Gün geçtikte hızlanan bir ivme ile inşaat dünyası fizikselden dijitale doğru yer değiştirmektedir.

Yapı Bilgi Modellemesi (BIM), sektörün hangi yönde ilerlediğini bize anlatan, tarafların daha verimli ve işbirlikçi bir çalışma ortamı içerisinde çalışmasına olanak oluşturan, emek, hammadde ve zaman israfını azaltma hususunda önemli fayda sağlayan gelişmelerden bir tanesidir. Ayrıca BIM; şirketlerin bilgi birikimi yapmasına imkan sağlayan, ve bu sayede hem teknik bilgi birikiminin artmasına hem de alt ve üst yapı tesislerinin operasyonel sureçleri dahil tüm yaşam döngüleri boyunca daha verimli işletilmelerine yardımcı olan bir araçtır. İsraf ve verimsizlikle mücadele konusunda, inşaat sektöründe yeni bir sayfa açılmasına ışık tutan bu buluş, doğal olarak sektör genelinde büyük bir ilgi ile benimsenmeye devam etmektedir. Günümüzde oldukça popüler olan bir çok teknolojik yeniliğin inşaat endüstrisinde kullanışlı bir yer edinebilmesi için de yine BIM'in kullanımı bir zorunluluk halini almıştır. Bu yeniliklere sanal zeka, makine öğrenmesi, nesnelerin interneti, saha sensörleri ve giyilebilir teknoloji, sanal ve artırılmış gerçeklik ve benzeri teknolojiler örnek olarak verilebilir. Tüm bu ileri teknoloji araçlarının, çesitli inşaat faaliyetlerinde potansiyel kullanım alanları mevcuttur ve özellikle BIM süreci ile yönetimi kolaylaştırılan dijital bilginin mevcudiyeti bu araçların kullanımını mümkün kılmaktadır. Dijital bilginin kullanımı arttıkça, sektörün teknolojik gelişmelere adaptasyonu da hızlanmaktadır.

BIM süreçleri ve dijital veri kullanımı, aynı zamanda bu uygulamaların hukuki olarak düzenlenmesi ihtiyacını da beraberinde doğurmaktadır. İnşaat dünyasında mevcut süregelen geleneksel iş yapma yöntemleri dijital bilginin üretim, kullanım ve alışverişinin hukuki olarak yönetilebilmesi için gerekli olan temel olgulara haiz bulunmamaktadır. Günümüzde yaygın olarak kullanılmakta olan çesitli standart sözleşme formlarını yayınlayan kurum ve organizasyonlar, üretim faaliyetlerinin

idaresini sağlayan sözleşme formlarının yanısıra, dijital bilginin kullanımından doğan bu sözleşmesel düzenleme ihtiyaçlarına cevaben dijital bilgi kullanımını da yasal çerçeve içerisinde yönetebilmek için çesitli yöntemler benimsemektedirler. Kullanılan çesitli yöntemlerden en yaygın olanları, inşaat sözleşmelerini çesitli sözleşme ekleri ve bunlara yardımcı teknik dokümantasyon ile desteklemek şeklinde uygulanmaktadır.

Dijital bilginin yönetimi hususunda proje anlaşmalarında sağlanan hukuki çerçeveler, sözleşmelere eklenen ve çeşitli ek hükümler içeren belgeler ile oluşturulmaktadır. BIM protokolü bu amaçla en sık uygulamaya koyulan standart form tipleri için kullanılan uluslarası bir tabirdir. BIM protokolleri; sözleşmeye ek olarak anlaşılan bir doküman olup içerisinde taraflara özgü yükümlülükleri, fikri mülkiyet haklarını ve bilgi kullanımı ile alakalı mükellefiyetleri açıklayan hükümler yer alır. BIM protokolü ayrıca bilgi gereksinimleri ("information requirements"), iş ve uygulama planları, risk değerlendirmeleri, teslim planları ve benzeri teknik dokümanlar ile desteklenir.

Bu çalışma ile; inşaat işlerinde proje bilgi yönetimi sürecinin geliştirilmesine, ve bu yolla taraflar arasında daha etkin ve işbirlikçi bir çalışma ortamının oluşturulmasına katkı sağlamak amaçlanmaktadır. Bu bağlamda, gerekli bilgi yönetimi hükümlerini içeren ve inşaat anlaşmalarına sözleşme eki olarak dahil edilebilecek, yeni uluslarası ISO 19650 standartlarına uygun bir Proje Bilgi Protokolü ortaya koyulmuştur. Bu protokolün anlaşmalara dahli ile partiler arasındaki sorumlulukların daha keskin çizgilerle ayrılması ve yasal sınırların daha belirgin bir şekilde çizilmesi hedeflenmektedir. Bu şekilde yönetilen bir projede taraflar arasında daha iyi bir iletişimin sağlanması, israf ve zaiyatin daha büyük mertebelerde önüne geçilmesi, daha verimli ve daha kolektif bir calışma sisteminin kurulması ve bu sayede üretimin kalitesinin de artırılması hedeflenmektedir.

Yukarıda bahsedilen hedeflerin gerçekleştirilebilmesi için öncelikle çalısmaya kapsamlı bir literatür taraması ile başlanmıştır. Halihazırda geçtiğimiz 2018 yılının sonlarında yayınlanan ISO 19650 standartlarının oldukça yeni olması ve mevzubahis dijital bilgi yönetimi ve BIM konularının gelişen teknoloji ve sürekli değişen örnek uygulama yöntemleri ile konsolide bir gelişim göstermesi sebeplerinden ötürü literatürde yer alan yayınların bir çogu güncelliğini kısa sürede yitirmektedir. Bu sebeple yapılan literatür taramasında, konu özelinde temel değişimlerin yolunu açan bir takım çalışmalar haricinde genel olarak yalnızca son yıllarda ortaya koyulan çalışmalara yer verilmiştir. Yapılan tarama sonucunda derlenen veriler, bu çalışmaya hem bir başlangiç noktası hem de karşılaştırmalar için referans noktası olarak kullanılmıştır.

Teslim safhasındaki bilgi yönetimi süreci, ISO 19650-2 kapsamında ele alındığı üzere, bilgi üretimi ve teslimi üzerinde genel bir bakiş açısı oluşturmak adına incelenmiş ve literatür bölümünde özetlenmiştir. Bilgi yönetimi sürecinde yer alan ön değerlendirme, ihale, mobilizasyon, bilgi üretimi, bilgi teslimi, onay ve projenin sonlandırılması iç süreçlerinde yer alan tüm aktiviteler hakkında bilgi verilmiş ve bu sayede okuyucunun süreç hakkında bir anlayış kazanması sağlanmaya çalışılmıştır.

Bilgi yönetim sürecinin ardından proje bilgi protokolü kavramı, literatürde yer alan çeşitli yayınlar yardımıyla ortaya konulmuştur. ISO 19650-2 kapsamında yer alan protokol gereklilikleri açıklanmış ve bunun yanısıra etkili bir BIM sürecinin sağlanabilmesi için önem arz eden faktörler, etkili bir yönetime olanak sağlaması

hedeflenen bilgi protokolünün tanımlanmasında rol oynaması amacıyla ortaya koyulmuştur.

Protokol tanımının peşinden dünya genelinde mevcut BIM adaptasyonu ve bilginin dijitalleşmesi hususunda gelinen noktayı anlamak ve içinde bulunulan durumun tahayyülünü güçlendirmek adına çeşitli örnekler verilmiştir. Bu sayede dünyada inşaat dünyasının BIM anlayışının idrak edilmesi ve çalışmanın takip eden bölümlerinde göz önünde bulundurulması amaçlanmıştır.

Proje tesliminde bilgi yönetimi süreci ve proje bilgi protokolü tanıtıldıktan ve dünya genelinde inşaat sektörünün BIM ve dijital veri adaptasyonu incelendikten sonra, son yıllarda standart inşaat sözleşme formlarında veya bu formların benimsediği BIM protokollerinde, dijital veri ve BIM'in nasıl değerlendirildiği ve bilgi yönetimine ne gibi hükümler ile yasal sınırlar çizildiği incelenmiştir. Günümüzde pek çok BIM protokolü örneği mevcuttur. Bunların bazıları, şirketlerin belirli projeler özelinde hazırlamış olduğu, ve bu kapsamdaki hususları ele aldıkları protokollerdir. Bazıları ise çeşitli kurumların yayınlamış olduğu ve tüm inşaat projelerine uygun şekilde düzenlenebilmesi amaçlanmış esnek standart formlardır. Bu çalışma kapsamında, en yaygın şekilde kullanılan iki standart BIM protokol formu, CIC BIM Protokolü ve AIA'in E203-2013 Yapı Bilgi Modellemesi ve Dijital Veri Eki incelenmiştir. E203-2013 bir tip sözleşme eki olup, BIM ve diğer dijital veri konularını ayrı ayrı ele alan iki adet protokol hazırlanmasını öngörmektedir. CIC BIM Protokolü (2. Sürüm, 2018) ise bu çalışma için temel referans olarak kabul edilmiştir. Son olarak literatürde yer alan bir başka çalışma içerisinde ele alınmış olan, BIM'in projelerde uygulaması ile ortaya çıkan hukuki riskler ve sektörde kabul görmüş olan çeşitli legal formlar ve bu formların mevzubahis riskleri ele alış ve önleme stratejileri arasından derlenerek önerilen örnek uygulama stratejileri bu bölüm kapsamında paylaşılmıştır. Bu stratejiler her bir risk bazında CIC BIM Protokolü ile kıyaslanmış ve sonuçları bu protokolün referans olarak seçimine destekleyici bulgu olarak sunulmuştur.

Literatür çalışmasının ardından çalışmanın teorik altyapısı üçüncü bölümde anlatılmıştır. Burada öncelikle çalışma içerisinde yer alan ve yeni ISO 19650 standartlarının yayınlanmasıyla ortaya çıkmış olan yeni tanımlar açıklanmıştır. Ardından calışmanın sonucunda hedeflenen dokümanın kapsam ve içeriği özetlenmiştir.

Çalışmanın dördüncü bölümünde ise, proje bilgi protokolünün içeriği, yapısı ve hükümleri detaylı olarak ortaya atılmıştır. Bilgi yönetimini sağlamak amaçlı hazırlanan bu hükümler; yapılan çalışma sonucunda derlenen literatür bulguları ve kişisel uzman görüşmeleri ile savunulmuştur. Bu doğrultuda, çalışma için temel referans kabul edilen CIC BIM Protokolünün koşulları ve ekleri ele alınmış ve bu koşullar ile ekler ISO 19650 standartları, literatür bulguları ve BIM süreçleri içerisinde tecrübe sahibi olan uzman profesyöneller ile yapılan kişisel mülakatların ışığında tekrar düzenlenmiştir. Elde edilen sonuçlar çerçevesinde hazırlanan yeni koşullar CIC BIM Protokolünün ilgili koşulları ile karşılaştırmalı olarak kıyaslanmıştır.

Değerlendirme bölümünde önerilen proje bilgi protokolü iki farklı kıstas çerçevesinde incelenmiştir. Öncelikle protokol, literatür taraması esnasında sunulan ve BIM kullanımı ile ortaya çıkan hukuki risklerin önlenmesi hususunda değerlendirilmiş ve bir başka çalışma kapsamında, farklı legal formların benimsediği stratejilerden derlenmiş olan örnek uygulama stratejileri ile kıyalanmış ve bu risklerin önlenmesi hususunda yeterli potansiyeli taşıdığı ortaya koyulmuştur.

Ardından, yine literatür taramasının bir parçası olarak derlenmiş olan BIM uygulamaları ve işbirlikçi çalışmaya engel teşkil eden çeşitli faktörlerin ortadan kaldırılmasına yönelik potansiyeli, bu faktörler kapsamında yapılan değerlendirme ile ortaya koyulmuştur. Bulunan sonuçlar önerilen ISO 19650 uyumlu proje bilgi protokolünün bir çok mevzubahis hususun önlenmesinde, direkt veya dolaylı şekillerde, önemli katkılarının olabileceğini ortaya koymaktadır.

Sonuç bölümünde çalışmanın sonuçları özetlenmiş ve ileriye dönük değerlendirmeler yapılmıştır. Çalışmanın, bu sürecin devamında nasıl geliştirilmeye devam edilebileceği ve bu calışmanın farklı çalışmalara nasıl katkıda bulunabileceği değerlendirilmiş ve bu kapsamda üretilen fikirler sunularak çalışma tamamlanmıştır.

1. INTRODUCTION

Information is a phenomenon formed in individuals' minds but is something that needs to be moulded into a figure in order to be of used and shared with others. The need of forming information into a usable and shareable figure is no different in a built environment than any other ground in life. This figure used to share an information about a construction work can be of any format such as a word in any language, a gesture or an illustration such as a drawing or a model object. There are commonly used figures to form and share information have been evolved through ages, and nowadays people are investing in forming information into digital figures as these are the most efficient solutions found to date. In the construction world, these digital figures are likes of computer aided drawing files, digital 3D models of the built environment, digitized documentation of planning and procurement information, and so.

The construction industry worldwide is entering the digital age. The industry is in an accelerating reformation. There is a need of change to more digitized environment and the pressure coming from a range of perspectives [1].

Client expectations are evolving. Clients are impressed by rapidly changing world and other markets with adaptive and competitive conditions (with offerings of tailored products and high class service levels) and look forward to have more technologically "connected" buildings and infrastructures. Client requests are rapidly increasing and becoming more complex everyday with expectations are more getting on the usage rather than the end product itself.

Rapidly developing technologies and increasing capabilities of endless possible solutions are another factor pushing industry actors. Costs are decreasing for various software and this opens new horizons for new capabilities. High level of competency makes obligatory companies to keep pace with these new capabilities. This means higher energy and constant move towards latest trends.

Built industry has been traditionally more resistant to change than others, but discerning and keeping up to date with technology is now expanding in the industry. Digital tools are getting more and more into use. Universities investing in tech savvy young generations by adopting innovative curriculums. New job families and new opportunities are arising as a result in the digital transformation. Actors in the industry are challenged with foreseeing a future behind fast-changing horizons. Apart from big and rooted actors which have been leading the sector across the world, also new start-ups are now entering the market and taking advantage of enhancing technologies by filling gaps with their high added-value products. Technology is changing the environment all-over.

Governments also another key factor pushing the industry towards adopting new solutions with their challenging mega projects and high-expecting regulations. Governments around the world are launching more and more mega infrastructure projects which dramatically increases market needs and competency between industry actors and heats up the race towards shattering barriers towards adapting technology. Also they are setting out new regulations that are abreast of higher society needs, which are expanding from environmental orders such as CO_2 and energy efficiency targets to information management requirements such as adopting BIM in public construction projects to achieve high level asset life-cycle cost savings. Also requirements for copyright protections and cyber security concerns are being heightened as a consequence of increasing importance of intellectual property [1].

“Building information modelling (BIM) should be regarded as the backbone of the new way of working triggered and targeted by the digital strategy given that different elements (such as various software, drones, construction engines, building and infrastructure equipment) should ultimately be connected to it” says Kaufman et al. (2018) in their report about digitalization in the construction industry. Here, the term BIM should be considered not only a information-containing 3D model, but it is a purposeful information management all along the lifecycle of an asset [2].

As the information transforms into digital figures, the way to manage and organize it also changes. Building Information Modelling (BIM) is where this change bring the construction world today. Utilising Building Information Modelling is one of the ways to manage production, organization and sharing of digitized information in a

construction project. While the production and exchange of information is being managed in a number of ways including BIM, it also requires a legal governance in order to establish a ground where parties are binded with clear boundaries of responsibilities. In a construction project, a legal governance is established with the use of agreements between contracting parties which will also produce, use and exchange the information. There are many different types of these legal agreements used in construction works across the world, including a number of widely accepted special construction contract forms such as the ones published by FIDIC. These govern the procurement of construction works but their governance area may also cover the entirety of commercial relations between parties including matters such as copyrights of intellectual property.

1.1 Problem Statement

According to the findings of the comprehensive literature survey undertaken part of this study, there are various hinderances towards enabling efficient and successful information management employing BIM and collaborative working. These barriers are collected, refined and re-structured to provide a good and clear understanding of key issues and are categorized into four topics as follows:

- Technology and technical feasibility related barriers
- Culture and people related barriers
- Management and organization related barriers
- Legal barriers.

Findings suggest that these barriers are significant issues hindering the effective use of digitized information in the industry and it is indispensable to address these issues in order to establish a ground for practicable and reliable BIM execution. Addressing these barriers require various aspects to be considered in terms of legal governance, technology management, standardization, people management, education, cultural changes. Inadequate standardization and legal considerations are key issues to be surpassed in order to increase efficiency and collaboration towards the success of the project, based on findings of the literature survey. Adopting a way of legal

governance with appropriate international standardization may also contribute to other categories of barriers in different ways.

Legal governance is typically established with a written agreement between parties. While the main consideration in a legal agreement for a construction project arises around procurement of construction works; the governance of production, use and exchange of information is not always covered in the scope of construction contracts. On the other hand, with the developing technologies enable new ways to enhance information production, the governance around the digitized information management becoming more and more essential for a smooth and sustainable built environment throughout the asset lifecycle. This issue brings up several solutions to incorporate developments for legal governance of digitized information management which are being implemented by various entities around the world, of which engaged in legal and administrative aspects of construction works or regulating ways and standards of creation, use, sharing and digitization of information such as FIDIC, NEC, JCT, CIC, NBS, ISO, BSI, and also private law firms, national and international civil engineering and architecture societies.

As mentioned above, most of the contract forms do not directly govern information management and use of digitized information within its general and special clauses. Information management rather not governed in detail at all or this is done by additional documentation. This is mainly because these contract forms generated for the use of a wide range of projects and with a more focus on the procurement, while not always these projects are realised based on digitized information. Today, it is not considered essential to govern the information management in the main contract form of a construction project as it is more a technical input and required to be flexible in a way to enable technically responsibles parties. Thus production and management of information are governed by contract addendums of related content.

A BIM protocol does establish a ground to create a consistent connection between information requirements and appointed party’s response in those requirements. It is a standard legal agreement that supports the appointment by enabling information model production at defined stages of a project and enabling collaborative working by setting common standards and drawing clear legal boundaries [4]. With the inclusion of this amendment, additional rights and responsibilities arise for both appointing and appointed parties. There are a number of BIM protocols available in

the literature to help govern digitized information management. These protocols are created by different public and private organizations either as a standard document form that is an open-source or paid service, or a project-specific document that prepared by or on behalf of an appointing party for the use in a specific project or a specific facility or various projects in a specific knowledge area. This can be a confidential or an internal document and not necessarily be open to public access. Scopes and intended coverage ideals are different per the protocol, as the creators of these protocols ranging from legal counsels to technical responsibles for data management. The broad differences between BIM protocols that published by different bodies also gives the impression that the term does not mean the same to everyone involved in BIM processes. A protocol form may simply cover the legal liabilities and obligations of parties and leave the flexibility for further decisions by their technical specialists in terms of technical governance of information management. On the other hand another example of a protocol form may cover much extensive technical details from 3D object definitions to CAD standards (where all these details might also be covered in a different way as per ISO 19650-1:2018 requirements) as the point of view of the owners are more technical-oriented. It is intended for this study to adopt the CIC BIM Protocol's second edition (2018) as a reference point for the proposed new protocol. It is a widely accepted standard form, considered as one of the eight pillars of BIM in the UK and everywhere embarking on complying with PAS 1192 standards, which can be interpreted as the CIC BIM Protocol being as the de-facto standard in various geographies. Further explanation on selection of the CIC BIM Protocol as the reference point provided in Section 2.5 of this study.

It is intended with the use of a protocol form to govern the legal aspects of the information management process with BIM. While the information protocol covers the legal aspects of the process and interaction between parties, it stands on the foundations of the information management process that is embarked on by the project team. It is important to standardize the information management process in order to provide a common understanding for all parties which they are all familiar with. Standardization will bring together a better collaboration environment, efficient execution of the information delivery process and significant decrease in the waste of labour and resources. The standardized information management process will

establish a common language between parties. It is then essential for an information protocol form to comply with the standard and provide on point guidance to the same language adopted by contracting parties in order to avoid clashes, conflict of interest and waste of time and effort by parties in dealing with the syntonising the standard form with the applicable information management process.

In late 2018, a new standard for "Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) – Information management using building information modelling" drafted and published by ISO as the ISO 19650 family, currently in two parts (as the first one is being the concepts and principles and the second is defining the delivery phase of assets) and more on the way in drafting. Most of the existing protocols and other tools aiming governance of digital information management and exchange for particular construction projects are either in compliance with the existing BS PAS 1192 series or not in compliance with any national or international standards. Although the new ISO 19650 standard family is formed in the light of the existing PAS 1192 series, there are a number of differences especially in the definitions of several processes and their definitions, and respective glossary. Some definitions are suggested in different naming and also with either sometimes a larger, narrower or a different context as well as some relations between these defined matters and processes are also handled in a different way. There are revised devices and approaches particularly to enable the use of this standard globally, considering the fact that the PAS 1192 series are intended to be used in the UK and uses the glossary and understandings of the UK construction environment and culture. While the new standard is based on a concession of views, acceptances and approaches of a wide range of national standard institutions from across the world [5].

Levels of maturity have usually been the way to define to what extent the BIM process adopted in a project. These levels are described as from BIM Level 0 up to BIM Level 3. Existing PAS 1192 standards were aiming to achieve a BIM Level 2 implementation across the asset lifecycle for any construction project, which was required by the UK Government mandate specified as "fully collaborative 3D BIM (with all project and asset information, documentation and data being electronic)". This requirement was a part of Government Construction Strategy published in May 2011 and widely accepted as to correspond to minimum of BIM Level 2 adoption

and this is what PAS 1192 is aiming to achieve through its adoption by project participants [6] (p. 10). Now with the introduction of ISO 19650 standards, the term BIM Level 2 is exchanged with the new term “BIM according to ISO 19650”. The adoption of new standards family envisions the same outcome in terms of achieving fully collaborative and digitized information management process while addressing to a wider audience with more globalized practices and a more flexible structure. Currently, adoption of the BIM according to ISO 19650 have not yet been pursued widely in terms of legal coverage and governance within projects as the standards are quite new to the world.

1.2 Purpose of Thesis

This research aims improved efficiency and collaborative working conditions in buildings and civil engineering works, through contributing to the project information management process. The desired outcome of this paper is setting out a standard project information protocol (a replacement to the term BIM protocol) form containing additional provisions to draw a legal framework for the information management process, which further to be completed as per requirements of a specific project and to be incorporated into a construction contract through an amendment. Utilization of the information protocol in projects is expected to contribute in clearing various barriers (as identified in Section 2.1) to collaboration and adoption of BIM.

An example to an information protocol is the CIC BIM Protocol which is published by the Construction Industry Council in the UK in 2013 and since then it has been widely accepted and became a de-facto standard where it is desired to incorporate a BIM protocol into an agreement, mostly in the UK, Europe and the Middle East. Per this study, the CIC BIM Protocol is adopted as the reference example of an information protocol, and its clauses and appendices altered and amended where necessary in order to transform its structure into a protocol form that is in compliance with the ISO 19650.

Specifying utilization of BIM as a requirement by a client is far away from being clear in what is actually wanted as BIM should not be considered only a 3D model that is used for clash detection or a tool for making a nice looking render. Specifying

maturity level is a development on the beam, as this incorporates a relatively tangible definition which enables to measure requirements to some extent. However even with a given maturity level, the definition of the level and BIM and the information management process, methods and practices requires further assessment per every project in order to enable project participants to agree in terms of risk allocation, scope and liability concerns to avoid potential disputes [6] (pp. 10-11). This study aims to enable all project parties to agree on the same consistent framework by adopting ISO 19650 vision for information management and BIM activities, through the use of a project information protocol over the course of project lifecycle. Once agreed on a project information protocol, it is targeted to have all parties to the project to possess the same understanding of information management process, BIM and collaborative working.

What is also intended to achieve with this study, is a project information protocol that is suitable for construction projects globally by conforming with the new ISO 19650 standard family. By having such compliance the form is expected to be an up-to-date solution for digital information management governance that follows up the newest developments in the market to the convenience of the industry.

As a result from the 2015 NBS National BIM Survey in the UK, more than half of the answerers concluded that BIM is "all about real time collaboration" [7]. Another objective of this thesis is to analyse how to contribute to collaborative working in construction projects from the contractual framework and setting out a new ISO 19650-compliant project information protocol. With the prospective use of the intended protocol, breaking more barriers for an efficient BIM-adoption and advancing in digital information management in today's ever-changing technologic environment are key objectives in contributing sector's collaborative working desires. The project information protocol is intended to be a contract addenda between contracting parties, for many types of awarding including consultancy and design agreements, traditional design bid build contracts or design and build contracts. By having such information protocol agreed in projects, it is aimed to achieve a better rounded legal control and a more comprehensive technical responsibility and risk distribution between parties in terms of digital information management. This may provide a clear view of responsibility boundaries for parties, which brings together better communication, increased efficiency, less number of

disputes and lower legal costs, and all together a smoother and effective development during the entire lifecycle of the asset. In other meaning, the intention is simply achieving a better collaborative working environment for all parties and increased efficiency throughout the life of an asset.

1.3 Method of Thesis

An initial literature survey is conducted as the start point of this study within the overview of current development section. During the literature survey, an examination of previous studies providing various hinderances towards efficient BIM execution and collaboration is conducted and findings are presented in this section. Also a number of publications, including the new ISO 19650 standard family, are went through in order to describe the background of the information management process and to get across the need for a project information protocol in a construction project.

Current status of digitization of information in construction industry and adoption of BIM around the world are also summarized in the same section to provide an understanding of the situation around the existing developments and a vision for potential future of information management in the industry. Examples furnished indicating global progression around the topic including governance of information management, initiatives of standardization of use and exchange of digitized information and public imperatives to enhance the use of BIM.

Further an overview of existing BIM and information protocols in use and ways of governing BIM and digitized information management up to this date are examined and analysed in respect to the vision of this thesis. Selection of the CIC BIM Protocol as the reference point is explained through its prominent features and findings on the basis of a previous study defining legal risks related to BIM adoption and comparison of several legal governance options in terms of addressing legal risks.

After the literature overview, a list of definitions as part of the theoretical framework section takes place in order to enlighten the rest of this study where a language is used in alignment with the new ISO 19650 standard family. Subsequent to definitions, the scope and context of the prospective information protocol is set out to

answer the questions of how the related aspects of the information management process of a project is being covered and in what order and to what extent, with the potential protocol form.

In the Section 4, general clauses of the project information protocol form are covered in detail. Obligations of contracting parties, coordination and conflict resolution between the parties, use of information, liabilities, interoperability of digitized information, and termination process of the provisions of the information protocol are revealed within this section. The outcomes of this section are based on the CIC BIM Protocol's clauses as well as literature findings, consultation with technical experts and legal councils from the industry.

An extensive investigation through appendices of the intended project information protocol takes the next place in Section 5. The general clauses are to provide a framework for parties' mutual consent in terms of defining their obligations and process related procedures such as conflict resolution. They are intended to be generic provisions and can be appended to any construction contractors' or consultants' contract forms. There is also a need for detailing such provisions concerned with parties' obligations and information management activities. Per each project and per each appointment, parties need to define the distribution of obligations and information management functions, standards that the appointing party requires the delivery team to comply with, delivery team's correspondence to satisfy the organizational, asset and project information requirements (OIR, AIR and PIR) through the exchange information requirements (EIR) in the production and delivery of information and likes.

Along with the provision of these appendices, the intended information protocol is expected to satisfactorily cover the information management process for a specific appointment within a specific project through a mutual consent of parties. Detailed explanations and incorporation purposes of each appendix provision are provided within this study. The appendices are to provide detailed information and set out the framework for particulars such as information management functions and assignment matrix, exchange information requirements, project's information standard, delivery team's BIM execution plan, master information delivery plan, methodology for resolving inconsistencies. The study for appendices have also been undertaken in the light of primarily the CIC BIM Protocol, and alterations to the considerations by the

CIC BIM Protocol to satisfy ISO 19650 requirements have been done based on literature findings as well as consultation with technical professionals from the industry who are responsible for digital products and building information modelling.

The validation of undertaken revisions to the CIC BIM Protocol and new considerations towards compliance with the ISO 19650 is established through expert reviews. Table 1.1 presents interviewee experts and their backgrounds, and their contribution (considering which provisions of the information protocol are reviewed/supported) per the validation of the study.

Table 1.1 : Summary of expert contribution.

Expert	Role	Company	Exp. (yrs)	Validation on
Christopher Andre	BIM Champion	NACO	10	• Scope • Context • Information Standards • Final Overview [8]
Mike dos Santos Freitas	BIM Manager	NACO	17	• Information Standards • Exchange of Information • LoIN • Defined Terms
May Winfield	Associate Director	BuroHappold Engineering & UKBIMA BIM4Legal	20+	• Contract Incorporation • Precedence of Appendices
Miriam van der Putten	Legal Council	Royal HaskoningDHV	15+	• Contextual Limitations • General Consistency Review [9] • Final Overview [9]

Table 1.1 (continued): Summary of expert contribution.

Expert	Role	Company	Exp. (yrs)	Validation on
Willem Berghuis	Legal Council	Royal HaskoningDHV	20+	• Final Overview [10] • Contract Incorporation • Order of Precedence
Teodora Cristitu	Information Management Expert	Royal HaskoningDHV	10	• Problem Statement • Contract Incorporation • Order of Precedence • Final Overview [11]
Yves Scholtes	Information Management Expert	Royal HaskoningDHV	10+	• Appendices Final Overview [12]

Following setting out and discussion around the clauses and appendices of the proposed information protocol, Section 6 presents the evaluation of the intended standard form. Two ensuing evaluations have been undertaken in order to provide understanding on how the expected outcomes are achieved through this study. First evaluation is concerned on how the proposed information protocol is capable of mitigating legal risks arising from BIM adoption in projects as presented in Section 2.5. Further ensuring the information protocol being sufficiently capable of mitigating potential legal risks, then the second evaluation took place indicating how the information protocol is contributing in overcoming barriers hindering BIM adoption and collaborative working as presented in Section 2.1. Resulting outcomes of these evaluations are summarized as indicative tables in Section 6.

Finally with the conclusion section, anticipated goals and achievements by this study, final remarks for targeted users (companies, information managers and task team members), and prospective further developments to achieve better information exchange management are set out.

The final version of the project information protocol form can be found attached as an appendix to this thesis.

2. OVERVIEW OF CURRENT DEVELOPMENT

In this section, findings of an initial literature survey takes place to set out identified barriers hindering the information management through adoption of the BIM process. In the sequel, the information management process and procedures are explained mainly as per the new ISO 19650 standard family. In the following, the project information protocol is defined in detail in the light of available literature up to date. Later on an overview of the status of BIM and digitization and management of information in construction projects in a varying range of countries summarized in order to provide an understanding of the current conditions of BIM adoption and digital information management across the world. The views in different countries stands out as an important input for the evaluation of legal governance of information management and BIM process as this understanding reveals the reality in adopting BIM and digitization of information at the time being. Following, a number of existing BIM protocol forms are examined in order to put forward an image of how a project information protocol is currently being covered by available documentation, especially by the CIC BIM Protocol, and how these can set a precedent to the intended information protocol form in this study.

2.1 Barriers Hindering Information Management through BIM adoption

Various studies are available across the existing literature that are defining a variety of factors hindering the adoption of BIM and correspondingly an efficient information management process and collaborative working environment.

As part of this study an initial literature survey have been undertaken to understand the key barriers to BIM adoption. Examined studies indicate a large number of factors are standing as barriers and they can be evaluated in a broad distribution of categories. Each study adopted a different strategy to evaluate these hinderances and thus grouped them into different category trees [13] [14] [15] [16]. Per this study,

these variety of categorization systems are refined and adjusted to make it easier to understand and evaluate. These barriers are listed in the Table 2.1.

Table 2.1 : Barriers hindering BIM adoption and collaborative working.

Category	Barrier	Main References	Supporting References
Technology and technical feasibility	Inadequate technological support: software and hardware limitations, complexity of usage requirements	[17] [18] [20] [21] [22] [23] [24] [26] [27] [30] [31] [97] [121] [122] [123] [157] [159] [164] [166] [171] [172] [176] [178] [181] [186] [188] [189] [193] [199] [200] [203] [204] [207] [208] [209] [212]	[25] [32] [33] [34] [35] [36] [37] [38] [39] [40] [41] [42] [43] [44] [45] [46] [47] [48] [49] [50] [51] [52] [53] [54] [55] [56] [57] [58]
	Interoperability: software types and compatibility	[17] [18] [19] [28] [29] [99] [100] [101] [176] [186] [194]	
	BIM Process: complexity, limitations, lack of availability, applicability and practicability, manual efforts, lack of proven benefits	[63] [14] [117] [121] [122] [153] [154] [156] [160] [161] [163] [164] [165] [166] [167] [168] [169] [170] [171] [173] [179] [181] [182] [183] [184] [185] [187] [190] [191] [194] [195] [196] [197] [201] [202] [205] [210] [211]	
	Project complexity	[158] [174] [177] [192] [195] [196] [205] [206]	

Table 2.1 (continued) : Barriers hindering BIM adoption and collaborative working.

Category	Barrier	Main References	Supporting References
Culture and People	Inadequate knowledge base: lack of skills, knowledge, abilities, proper education	[71] [44] [61] [63] [68] [77] [80] [81] [82] [83] [84] [85] [86] [87] [88] [89] [91] [100] [102] [103] [104] [105] [106] [107] [108] [125] [126] [127] [130] [131] [132] [133] [134] [135] [137] [138] [139] [141] [142] [143] [150] [151] [154] [166] [171] [175] [176] [182] [200] [205] [211]	[41] [47] [68] [73] [80] [92] [93]
	Culture: resistance to change, unwillingness to adopt new technologies, unfamiliarity and lack of enthusiasm	[82] [97] [108] [109] [110] [111] [112] [113] [114] [115] [116] [126] [127] [130] [132] [133] [134] [137] [138] [139] [140] [141] [142] [143] [144] [146] [147] [150] [151] [175]	
	Environment: nature of the industry, cultural diversity, lack of demand and necessity	[14] [64] [65] [66] [97] [108] [115] [116]	

Table 2.1 (continued) : Barriers hindering BIM adoption and collaborative working.

Category	Barrier	Main References	Supporting References
Management and Organization	Organizational and team structures: fragmentation, lack of BIM-orientation, variance in structures, integration, institutional barriers	[60] [61] [63] [91] [154] [e4 [161] [162] [164] [171] [175] [182] [196] [198] [211]	
	Collaboration: inadequate collaboration, lack of teaming-up consciousness, communications outside BIM, isolated way of working, conflicts between BIM and non-BIM responsibles, inadequate planning	[26] [64] [65] [66] [68] [80] [90] [91] [94] [126] [128] [130] [135] [136] [137] [145] [147] [148] [150]	
	Management: inadequate support from management, managers do not recognize the value of BIM, superficial consideration of relationships between people, processes and technology, lack of investment capital, desire for minimum risk, unwillingness to share liabilities and financial rewards	[82] [100] [102] [103] [104] [105] [106] [107] [108] [109] [110] [111] [112] [113] [114] [129] [130] [131] [132] [135] [136] [139] [141] [144] [147] [151]	

Table 2.1 (continued) : Barriers hindering BIM adoption and collaborative working.

Category	Barrier	Main References	Supporting References
Legal	Standardization: lack of guidance and standardization, lack of appropriate and up-to-date legal governance	[29] [59] [60] [61] [62] [82] [124] [125] [126] [128] [129] [130] [132] [134] [135] [136] [137] [139] [144] [145] [146] [147] [148] [149] [150] [152] [154] [180] [188] [194] [195] [197] [211]	[25] [26] [27] [28] [30] [31] [32] [33] [34] [35] [36] [37] [38] [39] [40] [41] [42] [43] [44] [45] [46] [47] [48] [49] [50] [51] [52] [53] [54] [55] [56] [57] [58] [59] [67] [68] [69] [70] [71] [72] [73] [74] [75] [76] [77] [78] [79]
	IP Copyrights: data ownership and data privacy concerns, liabilities arising with BIM and legal fears	[23] [24] [135] [137] [141] [142] [175] [176]	
	Legal and contractual uncertainties	[95] [96] [97] [98]	
	Administration: lack of regulations and government encouragement, lawyers and insurers are lacking understanding of new roles and responsibilities	[82] [127] [135] [150] [95] [96] [97] [98]	
	Trust and External Collaboration: drawbacks to information sharing, lack of trust, transparency, communications and partnership	[82] [118] [119] [120] [125] [128] [130] [134] [135] [137] [139] [141] [146] [150]	

It is important to emphasize that there are no distinguished boundaries between all the barriers mentioned in the Table 2.1. Besides the intersections between barriers, a barrier within a category can also derive from other problems rooting from another category. Managerial problems may lead to technical feasibility issues. People related barriers may result in increased levels of management problems. Many barriers may also be causing other barriers to strength, and overcoming these barriers require a complete understanding of the environment rather than considering these

categories as independent issues. A solution for one of the barriers may also contribute to overcoming a number of different barriers.

Within the scope of this study, it is intended to address or contribute to addressing a number of barriers to overcome on the way to the effective adoption of BIM and therefore help facilitation of an efficient collaboration environment and execution of information delivery.

2.2 Project Information Management Process during Delivery

The building information modeling according to the ISO 19650 is about increasing efficiency and achieving more benefits by implementing better specification and delivering quantum satis information for design, construction and management of assets, via utilization tools of appropriate technology. The standard family aims best practice for all teams working for project delivery and asset management. It comprises the practices and covers processes through the entirety of the asset's lifecycle including the procurement and renovation, operation and decommissioning. Information management is a system that accommodates all typical management concepts including planning, organizing, structuring, processing, controlling, evaluation and reporting of information activities, all of which is needed in order to meet the requirements of the organizational function that is in need of the relevant information [213]. Adopting ISO 19650 vision within the information management process would bring together following:

- Increased clarity in definitions of required information by the appointing party.
- Increased clarity in the methods, processes, timeline and protocols that governing the procurement and exchange of information.
- Avoiding waste of effort and overproducing information exceeding required quantity and quality.
- Advanced knowledge in terms of decision making for the appointing party.
- Enhanced efficiency in information exchange between parties and through project stages, especially from project delivery to asset management.

- Ultimate increment in efficiency and reduction in risks for various activities across asset lifecycle [214].

Defining and delivering project and asset information complies with four fundamental principles:

1. During the entire asset life-cycle, information is necessary for decision making whether the purpose is developing an asset or improving or decommissioning an existing asset, as all of these are considerations within the scope of asset management system.
2. Appointing party defines the information progressively per sets of requirements, also additional reference information may be supplied. As the response, delivery teams plan and progressively undertake the delivery of information.
3. The information production responsibility and requirements should be passed to the most relevant party, if the delivery team contains multiple parties.
4. Exchange and coordination of information is to be done through a CDE. It is expected to provide a consistent approach for all parties involved, by using open standards as far as possible and explicitly specifying operating procedures.

As appropriately, these principles should be followed during the project delivery and asset management processes [215] (pp. 5-14).

As the asset lifecycle can be expressed in two phases as delivery and operational (asset management), the project delivery is undertaken when there is a need for development of a new asset, change or expansion in an existing asset or decommissioning of an asset. Information required per each decision making point throughout all phases and this shall follow a process of information management.

Information models are established as part of the information management process for asset and project delivery phases. They are defined as sets of structured and unstructured information containers. Asset information model is a virtual model to help the appointing party's everyday asset management activities. It may contain all kinds of information related to the asset, which can be classified in three categories as, graphical model, non-graphical data and documentation [216] (p. 42). The asset

information model (AIM) is established and managed throughout the asset lifecycle by the appointing party. It also provides initial information for the take-off of the project delivery process. On the other hand, the project information model (PIM) supports the project delivery process. It ultimately adds up to the AIM and becomes a part of it and therefore provides support to the asset management process. The asset lifecycle and transitions between delivery and operation can be seen in the Figure 2.1 (as indicated in ISO 19650-1:2018 Figure 3). Point A indicates the start of delivery process and transfer of appropriate information from AIM to PIM. Point B indicated the progressive development of the design intent model into the virtual construction model and where point C indicated the end of delivery process and transfer of appropriate information from PIM to AIM [215] (pp. 5-14). Also the complete information management concept within the asset lifecycle can be seen in the Figure 2.2, as illustrated on the ISO 19650-1:2018's Figure 11 [215] (pp. 28-29).

Decisions by the project information manager related to the project and asset are made with the help of PIM and AIM across the asset life cycle.

Figure 2.1 : *Generic project and asset information management life-cycle (Copyright: ISO 19650-1)*

During the delivery phase, the establishment of the PIM depends on the specification of asset and project related information set out by the appointing party. First the appointing party to specify sets of information requirements. Prospective appointed party per each requirements then to state a response for that requirement and these responses to be reviewed by the appointing party prior to the appointment. Following, planning for information delivery to take place by all appointed parties including development of their responses for information requirements. Information then to be managed and delivered by originating appointed parties and accepted by the party specifies related requirements. Shall the information deliverables require revisions, then feedback loops to be followed as appropriate as per the information delivery flow-chart indicated in Figure 2.3 (as indicated in ISO19650-1:2018 Figure 4) . This part of the study will continue to specify further activities as per ISO 19650-2 assembling the information management process during delivery. These activities further be the reference framework in setting out information management responsibilities of parties within a project [215] (pp. 5-14).

Information management for the delivery begins with the commencement of the delivery phase by exchanging required information from the asset information model to the project information model. Following the provision of relevant information, development of virtual construction model follows the process. And the completion of the delivery phase takes place with the exchange of developed project information in the opposite direction from the project information model to the asset information model [215] (pp. 5-14).

During the entirety of the project delivery phase, the process of information management shall be followed including all project stages. The information management process for project delivery can be expressed in a sequential group of activities from wider to the most specific, which are to be done per project or per each appointment within a project. These activities forming the information management process are consist of a number of responsibilities in order to complete each process and successfully correspond to the information requirements specified by the appointing party. Information management responsibilities are distributed between parties within an appointment with regards to capacity and qualification of parties as well as specified within the ISO 19650-2:2018 standard document. This will be further investigated in Section 5 of this study.

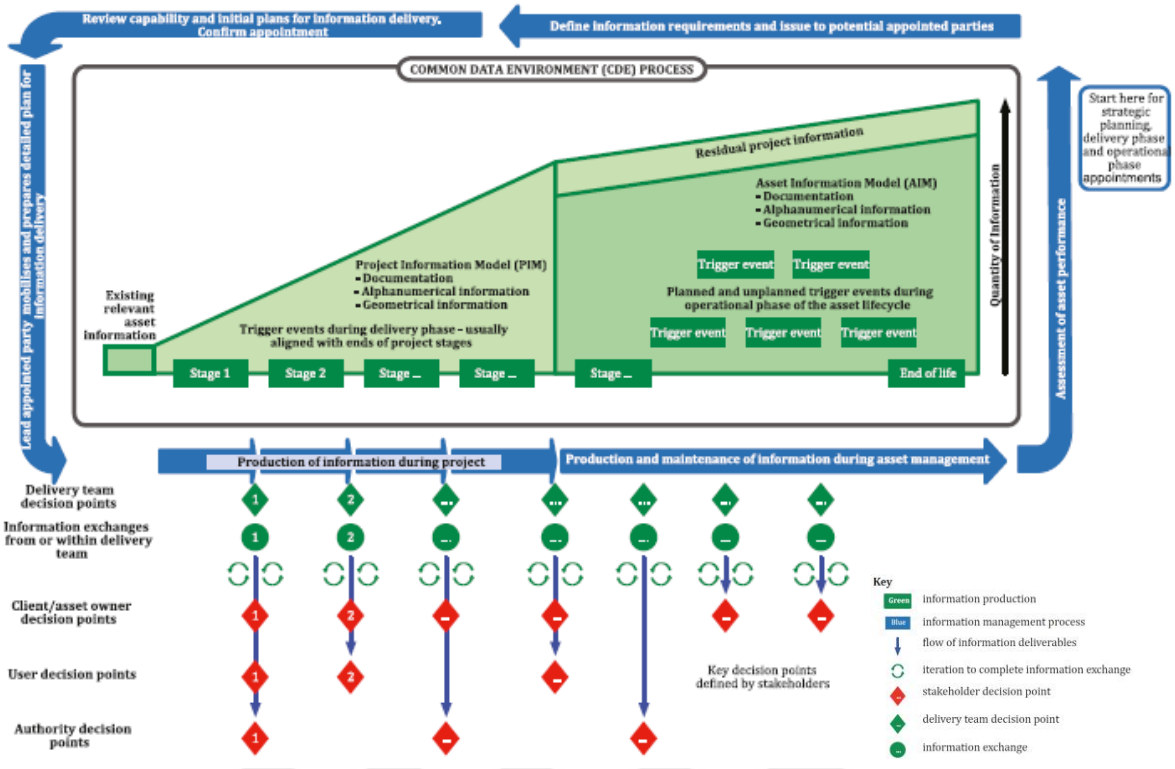

Figure 2.2 : *Information management process (Copyright: ISO 19650-1:2018)*

The first group of information management activities to be undertaken is concerned with the assessment and need, the initial preparation for a project delivery. These activities are for appointing party to undertake and the aim is to prepare for and to set out input requirements for the delivery phase. A variety of activities expand from appointing information management responsibilities to defining information requirements, delivery milestones, methods and procedures for the production of information and likes. These steps are taken for each project and outcomes of these activities to be followed for all the appointments throughout the delivery phase.

Following the assessment and need activities, there are further groups of activities to organize information per each appointment. An appointment can be specified in three stages as per;

- procurement,
- information planning, and
- information production.

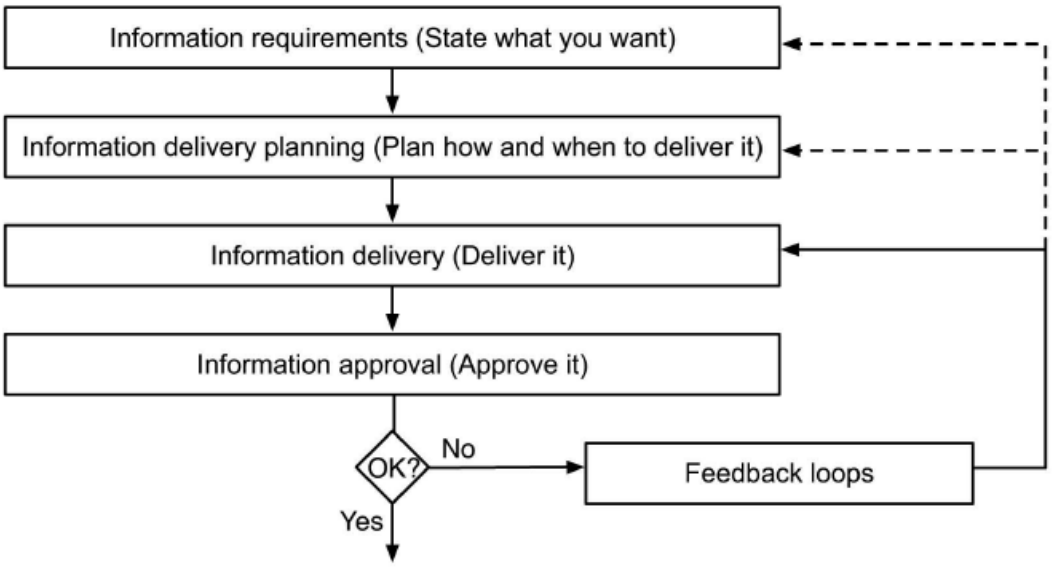

Figure 2.3 : *Generic specification and planning for information delivery flow-chart (Copyright: ISO 19650-1)*

The procurement stage of an appointment involves invitation to tender and tender response related activities of information management process. As part of the invitation to tender, activities done to set out exchange information requirements and establishing appropriate grounds for a tendering process. During the tender response, planning for the distribution of information management functions is held by appointing individuals for information management functions from prospective appointed party candidate bidders as applicable. Required activities held by bidders to respond to the tender such as defining pre-appointment BIM execution plan, mobilization plan, risk register and likes. Further, the appointing party undertake appropriate activities in order to evaluate tender responses from candidates [217] (pp.3-23).

The information planning stage of an appointment embodies appointment and mobilization related activities of information management process. These activities take place after the awarding of the project. Firstly, as part of appointment activities, initial planning tasks take place such as confirming the BIM execution plan, defining detailed responsibility matrix of the delivery team and information delivery plans, completing appointment documents and other tasks to finalize the appointment phase. After the completion of awarding, mobilization activities to be carried out by the lead appointed party and other appointed parties.

The information production stage comprises collaborative information production and information model delivery activities of information management process. Collaborative information production starts with ensuring access to reference information and continues with following series of generating information, checking quality, reviewing and approving for sharing activities. Subsequent to information production, appointed parties submit information models for authorization by lead appointed party and after review and authorization, lead appointed party submits the information model to appointing party. Information model delivery activities end up with the review and acceptance of the information model by appointing party.

Following information model delivery activities completed by subsequent delivery teams for each one of the appointments within a project, project close-out activities takes place and the delivery phase of a project comes to the conclusion.

Within the scope of information management process, all above activities distributed through parties as per their related responsibilities within a project. This will be further investigated in the Section 5 of this study [217] (pp.3-23).

2.3 Defining the Project Information Protocol

Enabling innovative ways of working in the construction scene with Building information modelling and an efficient information management through it can strikingly increase efficiency in delivery process and overall performance level. BIM can enable better strategic decisions, better risk management thus increased predictability, improved learning and higher certainty in operational outcomes. Implementing BIM as per the ISO 19650 family is important to improve information management methodologies. The ISO 19650 family defines the information management as depending on all parties involved and taking part with their responsibility boundaries within the entire process. In this sense, for example; an appointing party that is requesting simply “a BIM project”, or practices like utilization of just a shared drive as a common data environment (CDE) are not aligning with the ISO 19650 necessities and therefore will not achieve the benefits. It is indispensable that the appointing party must set out clearly what is required from their side as per the ISO 19650 [214]. It is helpful that the fundamental rules, practices, and required tools for the production, management and exchange of

information to be set out and agreed by all parties being sides of an appointment in order to achieve a smooth process throughout the project.

As per the ISO 19650 family, an agreement between an appointing party and an appointed party is defined as an appointment, which is usually set through a legal contract. In due course of initial establishment of an agreement, recognition of relationship between parties with regards to the information management process and their obligations attached to information management functions is essential. Concordantly, the ISO 19650-2 requires constitution of an information protocol of the project by the appointing party and incorporation of the protocol to all appointments [214].

A project information protocol (aiming analogous service with the BIM protocol) does cover coherent, noncontradictory and appropriate clauses to be agreed by the entire project team in a project, governing the production, use and exchange of project information. It does establish a regulatory ground for a BIM-enabled project in respect to data ownership and liability of data use, software choices, management of common data environment and workflow, technical frameworks to govern issues such as object or layer nomenclature, and so forth. The protocol provides ability to adopt BIM governance in order to procure an information model that is capable of answering information requirements of the appointing party by enabling legal application of required processes and procedures [6].

The ISO 19650-2 defines the considerations to be taken by the appointing party in the establishment of the project's information protocol as follows:

- Specific obligations -arising with association to information management and production and exchange (through CDE)- of each party: appointing, lead appointed and other appointed parties;
- Warranties and liabilities in relation to the project information model;
- Intellectual property rights of information;
- Existing asset information utilization;
- Utilization of shared resources;
- The use of information during the project and any linked licensing terms;

- The re-utilization of information following the appointment or with the termination [217].

Table 2.2 : Factors informing efficient BIM governance.

Area	Factor
ICT Factors	Having efficient communication and coordination practises
	Using appropriate tools for communication and coordination
	Relying on BIM technologies
	Using adequate ways for sharing data
	Adopting a CDE
	Track information
Socio-organizational Factors	Employer happiness
	Early employer involvement
	Educators
	Availability of technical trainings
	Early gathering and involvement of the team
	Existence of a strong leader
	Dedicated information manager
	Team collaboration
	Forward planning
	Mutual vision and values
	Clear roles and responsibilities
	Trust between team members
Practitioner Factors	Experience
	BIM-use ability
	Soft skills
	Accepting criticism

Table 2.2 (continued) : Factors informing efficient BIM governance.

Area	Factor
Practitioner Factors (cont'd)	Tendency to team work
	Willingness to exchange information
	Relationships with the employer
	Problem solving on time
	Raising issues on time
BIM Process Factors	Precise BIM implementation
	Precise collaboration procedures
	Methods and planning for information exchange
	Having milestones through project lifecycle
	Adopting integrated delivery methods
Financial and Legal Factors	Financial resourcing
	Motivating practitioners for the business
	Providing business opportunities
	Adopting overall legal framework
	Explicit roles and responsibilities for all actors
	Clear data ownership and IPRs

In an attempt to investigate further aspects of an efficient BIM governance, taking into account expert remarks based on their expertise can be helpful. Understanding what factors in real-time applications may affect an efficient information management governance is expected to improve the intended outcome of this study by means of answering realistic considerations of prospective end-users and applicability. That is why the outcoming factors informing efficient BIM governance of an interview undertaken by Alreshidi et al. with industry experts is examined as part of this study. These factors can be categorized in five areas in the Table 2.2 [3].

Findings of this study are also significantly aligning with the barriers hindering the adoption of BIM and collaborative working. Overcoming hinderances listed in Table 2.1 are, in other means, corresponding to having more factors in the Table 2.2 to take effect. For an effective and successful governance of information management throughout a construction project, some of these factors are intended to be satisfied as far as applicable, and it is expected that the contracting parties agree and confirm the intent by having the prospective project information protocol agreed upon. In addition to essential considerations by the ISO 19650-2, from a project implementation point of view of real-time experts, the information provided within Table 2.2 is further helpful to support defining the expected outcomes and to which extend these outcomes are being helpful for the information management process, by utilizing a project information protocol.

2.4 Status of BIM and Digitization of Information in the World

Publicly available information through web indicates a variety of different status from one country to another in terms of adaption of BIM and the legal governance related to both BIM and digitization and management of information. It is highly interesting to see the development of the information management and BIM-enabled governance for construction projects across the world from the point of view of this study. A summarized information about the status of governance of BIM-use, and also digitization and management of information in a number of countries from different parts of the world given in this section.

In the United Kingdom, BIM level 2 is an obligation for all government construction projects as part of their information management processes. The UK Government set out their construction strategy dating back to 2011. Government requires completely collaborative BIM use in 3D as of 2016. National BIM Report in 2018 states that a 20% of the UK construction industry has adopted BIM since 2016. This number goes much higher as the projects get bigger, as 78% of all projects with more than 51 employees has adopted BIM. On the other hand, mainly in the private sector the adoption of BIM more in the way of “lonely BIM” model, which more helps through the construction phase of a project and the industry seem to be developing slower in terms of the asset management part of the lifecycle of the asset [218] (pp. 88-102).

With the world leading introduction of BS PAS 1192 standard series, the UK have been a role model for the legal governance and standardization for digital information management and BIM. A whole governing body of standards including PAS 1192 series, together with other British Standards covering topics such as asset management, facility information management, management systems and quality management have been implemented by the built environment in the UK. Supporting documentation for an efficient application of BIM have also been widely and uniformly adopted such as COBie-UK, RIBA Digital Plan of Work, UniClass 2015, a generic Employer's Information Requirements and the CIC BIM Protocol. These tools (except standards and the CIC BIM Protocol), together with a wide digital library of BIM enabling elements have been compiled as a toolkit by the National BIM Library (NBS) as the NBS BIM Toolkit for an efficient and uniform way of managing BIM process through a variety of companies taking part of the UK construction industry. The NBS toolkit defined by Hamil, S. in 2016 as follows per the UK Government's Construction Strategy dating 2011:

"In terms of the definition of BIM, a five-year funded programme was developed that would deliver BIM level-2 via a world-class set of standards and tools. This NBS BIM Toolkit is part of this level-2 package and includes a library of thousands of cross-sector construction level-of-definition templates and a unified classification system. It also includes a free-to-use digital plan of work tool that enables the definition of who is doing what and when throughout a construction project."

The CIC BIM Protocol have also been commissioned as part of the UK Government BIM Strategy, by the Construction Industry Council. It is intended to be used by all common construction contracts available and to support BIM level 2. It was first published in 2013 and a second edition came to surface as of 2018 to adapt with changing practises and standards.

There are a number of organizations which draft standard BIM documents for their contract forms in the UK. One of them is Joint Contracts Tribunal (JCT). JCT introduced a document called Public Sector Supplement in 2011 including BIM amendments to its standard contract forms. Later in 2016, BIM-related clauses extended in the new revision. Amendments incorporate an agreed upon BIM protocol as an additional contract document or as part of Employer's Requirements. Another organization to be mentioned is NEC, and they introduced a guidance called "How to use BIM with NEC3 Contracts, as part of their NEC3 contracts series. NEC3 series

adopt the use of CIC BIM Protocol. The idea is having the technical requirements related parts of the protocol to be included into the works information or the scope, while the parts related to contracting parties' rights and obligations are incorporated within the contract clauses. The CIOB Contract for Use with Complex Projects also provides clauses in relation to BIM, these clauses are mainly to govern the common data environment, software usage, role of design coordination manager, suitability and compliance, archiving, maintenance and revisioning of the model and also notification of clashes. The contract allows parties to choose any protocol as desired and suggests the use of the protocol by American Institute of Architects if there is not a special interest in any other protocol form. Also, the PPC 2000 contract form makes provision of BIM with its Appendix 10 introduced in 2013 [218] (pp.88-102) [219].

BIM is not widely developed in Brazil, but an increasing interest in BIM is visible. A number of large projects have been utilized BIM, to some extent, such as stadiums, venues for Olympic games, airports and the Museum of Tomorrow, and also partially throughout the revitalization project in the port area of Rio de Janeiro. Currently BIM usage is not an obligation for public projects (it is becoming by 2021) and the use of BIM mostly as a management tool for larger companies, so as long as it is found beneficial. The use of a BIM protocol in construction projects is not common yet in Brazil. A ruling document called ABNT NBR 15965 which determines and classifies information to be used in BIM processes in architecture and engineering works introduced by the Brazilian Technical Rules Association (ABNT). The Brazilian Army is now using a BIM-based asset management system to maintain their buildings. This technology also being pursued to be adapted by the Secretary for the Federal Union Estate in order to manage their assets, as the Secretary identifies that life cycle costs for their assets goes beyond initial construction costs.

In 2017, the Strategic Committee for the Implementation of BIM (CE-BIM) and a technical support group (CAT-BIM) have been introduced in Brazil. The use of BIM will be mandatory by 2021 in the country and a roadmap for the BIM transition have been set out, which divided in three phases. The first phase is to kick-off in January 2021 with changing the status of BIM use as mandatory. The roadmap extends to the third phase effective as of January 2028 which will introduce governance of asset

management activities including not only newly constructed buildings but also maintenance of existing buildings [218] (pp. 9-25).

In Austria, the Austrian Standards Institute established the ÖNORM A6241-1 and A241-2 standards for technical handling of BIM. The use of these standards usually agreed in the contracts and high scale building projects are already being supported by BIM process. Also, the introduction of ÖNORM A6241-2 standards enable governance of BIM level 3. The use of a BIM protocol in construction projects is not widely common in Austria and there are no standard forms published as a BIM protocol [218] (pp. 9-25).

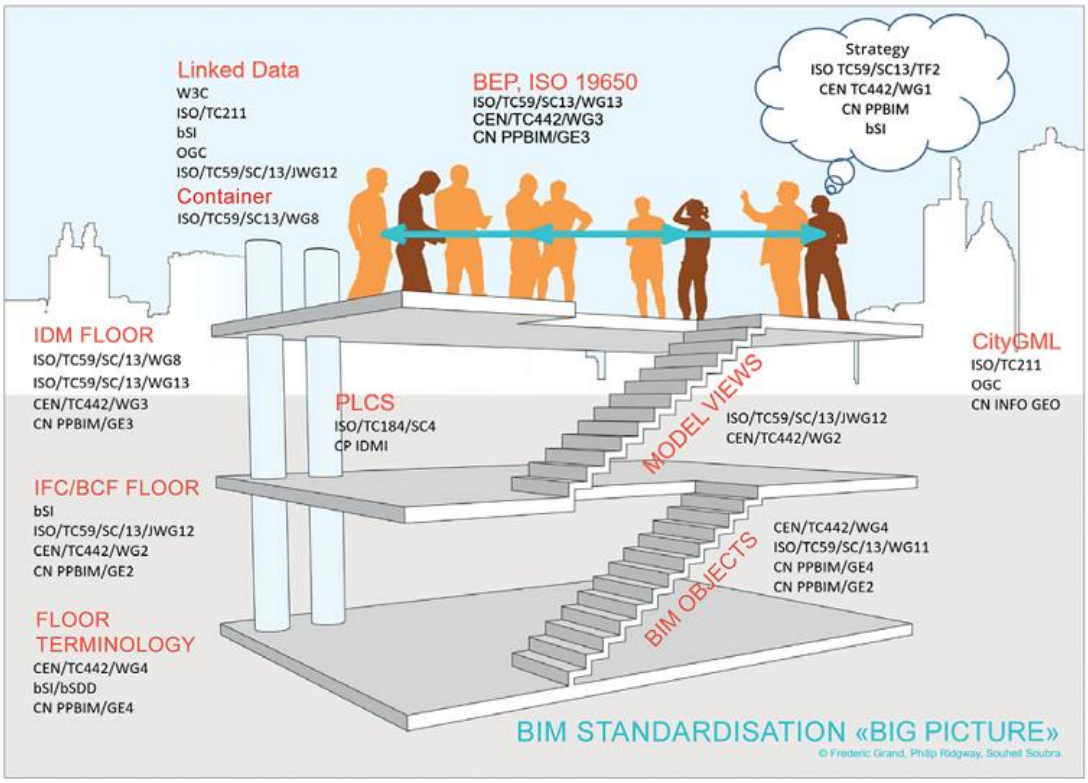

Figure 2.4 : *BIM Standardization in France as per PTNB (Copyright: Grand et al., 2017)*

French officials introduced a BIM standardization roadmap in 2017, namely the "Plan for the digital transition in the building industry (PTNB)". Main route of this roadmap is to have building and construction industry professionals, organizations and all other parties to get used to with the standardization progress being undertaken by national and international organizations (ISO, buildingSMART International, OGC, AFNOR and CEN). Through this plan, the standardization process is taught by

a three-storey building portrayal where each floor represents a level and stairs represent tools while other strategic elements are represented within the environment. Process level is represented by the roof and defines the collaborative working and information management, mainly based on the ISO 19650 standard family. The second floor represents machine-readable data, which focuses on the data exchange issue. And the ground floor represents the terminology with a focus on the XP P07-150, a standard for ways of managing properties with the help of a network of connected dictionaries. An illustration of the three-storey portrayal of the PTNB is given in the Figure 2.4 (directly derived from cobuilder.com, with copyrights belonging to Grand et al., 2017) [220].

Also, as a part of the ambition plans by the French Government through the PTNB plan, a collaborative environment for information exchange called KROQI, developed by the Centre Scientifique et Technique du Bâtiment, have been introduced. This is a platform where all the parties in the construction industry can make use of. The vision behind it is to:

- Enable BIM for companies of small to medium scale
- Stable digital environment
- Better management
- Higher productivity and efficiency
- Information exchange in real time
- Making digital models compatible for all parties, in compliance with contracts made (including the BIM protocols)

The platform is publicly available at no cost. It has software solutions for intended specific use with KROQI, dedicated separately for architectural design, landscaping, structural calculations, quantity take offs and an online browser for ease of use in terms of navigating in the model.

The aim for the French ambition plans is to meet with the objectives set for 2022. BIM objectives 2022 envisions all the parties/organizations in the built environment to voluntarily take actions in countenance of BIM process and digitized information management with the objective of more efficient constructions with achieving more and spending less [221].

A number of Dutch BIM standards have been developed for the Building Information Council (BIR). These include COINS, CB-NL and the information models for Systems Engineering (the latter are still being developed). The BIR has provided guidelines for the information technology to be applied for these 'own' standards. The 'Semantic Web Technology' of the World Wide Web Consortium (W3C) has been deliberately chosen. Also, a growing number of parties in the Dutch construction industry are joining the initiative to use a basic information delivery specification, called as the BIM basic Information Delivery Specification (ILS). The BIM Counter supports this initiative wholeheartedly. All relevant documents are therefore made available through this website. The management of the BIM basic ILS is designed in collaboration with buildingSMART Benelux. The BIM basic ILS is not a new standard but an answer to the question: how will we exchange information in the construction in a structured and unambiguous way?

The Building Information Council also presents a national BIM protocol and a national BIM implementation plan as the organization noted a growing need for clarity in terms of growing questions regarding to a variety of different publications as BIM protocols and BIM implementation plans. The BIR BIM Protocol Working Group presents two models: the "National Model BIM Protocol" and the "National Model BIM Implementation Plan". The Model BIM Protocol is intended as a basis for establishing project-specific contract provisions around BIM. The Model BIM Implementation Plan is a template that project teams can use to record their mutual BIM work agreements. The Models also offer a clear conceptual framework that is in line with developments in countries around the Netherlands and is prepared for future European BIM standards.

The Dutch open BIM standards have been developed over the years by different organizations for a variety of purposes. The management and further development of the standards are coordinated in the non-profit organization called BIM Loket. The aim is to strengthen the coherence between the standards. To be able to realize more synergy, a good overview of the standards and, in particular, of their mutual relationships is first of all required. The organization published a guidance for these standards, namely the Atlas of open BIM standards (can be found in the link as of April, 2019: https://www.bimloket.nl/upload/documents/downloads/Standaarden/Atlas%20Open%20BIM%20Standaarden%20v1.3.pdf). The atlas not only describes

the existing relationships, but also desired future relationships between the standards. The atlas thus forms input for the plans of the BIM counter for the coming years.

The BIM Loket strives for the realization of a generally accepted, coherent system of open BIM standards that is applied throughout the building. BIM Loket's guideline for the definition of open standards is the standardization management and development model for open standards (BOMOS) of Forum Standardization. At present, not all the standards described in the Atlas fully meet the definition. The standards have their own history and background, which in a number of cases means that complete openness is not yet feasible. In the long term, full openness of all the standards involved is explicitly the goal that we at BIM Loket are gradually working towards.

The BIM Loket also introduced a practical guidance called the Uniform Savings Statement (Basis USO) for the use of abovementioned open standards and for an efficient cooperation. The Basis USO is based on open standards such as IFC and BCF. This eliminates unnecessary barriers between parties. Information about savings at considerably more levels can also be requested and processed. Being able to work on the levels of building, floor, space, object and saving itself saves a lot of time and noise [222].

Besides all the open standards and achievements done by both private and public institutions in a collaborative way, a public organization needs to be mentioned by its own. The Rijkswaterstaat (the Dutch Directorate General for Public Works and Water Management) is amongst the leaders and moving towards being a role model of asset and information management over infrastructure projects through open BIM standards in Europe [223].

The BIM implementation plans began in the early 2000s in the Unites States of America and it continues to evolve. In the 2003, the General Services Administration (GSA), by its Public Buildings Service (PBS), established the National 3D-4D-BIM Program. This was an attempt for a policy mandating BIM adoption for all PBS projects and provided its intention to partner with BIM vendors, federal agencies as well as professional organizations, open standard organizations and academic institutions [224].

Today there is no such a national standard widely in use like the UK's PAS 1192 series in the USA, but rather companies tend to adopt their own internal standards for the utilization of BIM for information management within projects. However, the National Institute of Building Sciences have published the National BIM Standard for the USA (NBIMS-US), with the goal to establish, by adopting the NBIMS-US, the standards needed to boost innovation in information management processes and infrastructure so that the end-user within the industry may efficiently access to the information required for effective construction and operation of assets. The NBIMS-US is presented by a project committee of the buildingSMART alliance, which is a council of the National Institute of Building Sciences. The scope of the NBIMS-US is indicated in the Figure 2.5.

The BIM Forum (the USA chapter of the buildingSMART International) is an industry-driven group with regards to the BIM utilization, located in the USA. The BIM Forum has developed specification for the use by the construction industry, such as the LOD specification document, which is still being in use across the world [225].

Figure 2.5 : *Scope of the NBIMS-US (Copyright: National Institute of Building Sciences)*

Over the past few years now the USA has seen an ever-increasing boom of BIM in the industry. Construction modelling and collaboration are in a tremendous trend. The Dodge Data & Analytics SmartMarket Brief indicates that the construction modelling by trades has increased to include more than 90% of HVAC contractors, making the BIM is a standard within the industry. The Allied Market Research

reports that, from 2016 to 2022, the industry is expected to have a compound annual growth rate of more than 20 percent and earn over 11 billion USD. This growth is expected to be driven by the potential for savings in terms of time and money with the increased adoption of BIM [225] [226].

In the late 2017, the Development Bureau (DEVB) issued a technical circular regarding to adoption of BIM for capital works projects in Hong Kong. The circular states that:

"Capital works projects with project estimates more than 30 Million USD shall use BIM technology. The policy is applicable for projects in the investigation, feasibility, planning, design or construction stages in the Capital Works Programme irrespective of the modes of delivery as detailed in the ensuing paragraphs." [227]

Another technical circular dating 27 December 2018 have also been issued on the same topic as being effective by 1st of January 2019 and superseding the previous circular. As indicated in the new circular:

"The Government is firmly committed to the promotion and adoption of BIM technology in capital works projects with a view to enhancing the design, construction, project management, asset management and improving the overall productivity of the construction industry. The 2017 Policy Address has stated that Government will actively seek to require consultants and contractors to use this modelling technology when undertaking design of major government capital works projects from 2018 onwards. DEVB TC(W) No. 7/2017 was issued to set out details of this Policy Address initiative." [228]

The new circular also suggests the utilization of BIM in the projects that estimate more than 30 million USD. And the policy is still applicable for the same set of project categories. As per the contractual requirements, the technical circular suggests as follows:

"Contractual provisions adopted in pilot projects may continue to be used until advised otherwise. To cater for cases where small consultant or contractor firms may not be very well equipped with BIM expertise, provisions will be stipulated in the agreement or contract allowing the consultant or contractor to engage BIM sub-consultant or sub-contractor to assist them. The agreement or contract shall also contain terms requiring the consultant or contractor to train up a number of staff of the employer/their staff and their sub-consultant/sub-contractor staff. The Construction Industry Council (CIC) will suitably organise free BIM training places for WDs to allocate to their consultants/contractors successfully awarded the Agreements/Contracts…" [228]

The technical circular stands as an intensive guidance and provides a framework for how the use of BIM is mandated within the industry. But as to be discussed within this study, the term BIM alone brings together the concerns that to what extent it will be interpreted and adopted. In order to secure the potential benefits expected to achieve by the utilization of BIM, a broader definition with required technical outputs as well as guidance on legal governance that will constitute bindingness over contracting parties. Nevertheless, the technical circular provides a comprehensive guidance on various aspects from asset management to software usage.

Apart from the technical circular by the Development Bureau, there are other bodies and institutions providing guidance on BIM adoption such as the Housing Authority of Hong Kong. The Housing Authority has a set of standards and guidelines for the BIM implementation, namely the HABIM. Again, the HABIM stands as an extensive guidance on how to adopt a successful BIM implementation as deemed desired by the Housing Authority of Hong Kong [229].

Besides the high interest of government bodies in BIM, there is the Hong Kong Institute of Building Information Modelling that was established in 2009 with the objective of upholding and advancing the standard of competence for the building information management profession and promote the interest and recognition to its members within the industry and community. The institution recognizes the building information management as a profession and provides guidance on careers in building information management [230].

2.5 Previous Examples of Legal Coverage of Information Management and BIM

Information production, exchange and use, digitization of information and the management of digital intellectual property are concerns arising with the establishment of an appointment and they need to be addressed in order to avoid further conflicts and enable effective collaborative working. Various institutions and companies adopt ways to incorporate relevant consideration to appointment documents and address these concerns. Examples indicate that considerations so far include incorporating appropriate clauses directly into contract forms to an extent, incorporating appropriate clauses as appendices to contract forms (like BIM

protocols). These clauses are further supported with additional documents such as information requirements, schedules, implementation plans and so.

FIDIC's rainbow suite is one of the most common standard construction contract form suites and has a wide range of use across the world especially within public projects financed by multilateral development banks. FIDIC rainbow suite does not accommodate any BIM related clauses up to this date. However, it does specify key issues to be considered in case of utilization of BIM on a FIDIC project with its BIM Advisory Note. Moreover, current preparation studies for two guidance documents named "Technology Guidance" and "Definition of Scope Guideline Specific to BIM" are ongoing to provide further understanding on incorporation of BIM and relevant technological developments within legal context [6] (pp. 24).

The American Institute of Architects (AIA) has also a suite of standard contracts and these are the most widely used standard form contracts in the USA construction industry [231]. AIA utilizes the AIA Document E203-2013 Building Information Modeling and Digital Data Exhibit in order to provide guidance in implementing BIM and digitized information management together with contracts. The document is an exhibit to an agreement and it enables parties to agree on specific procedures to follow with respect to exchange of digital information.

The E203-2013 exhibit is intended to be an attachment to the contract. The exhibit consists of general conditions and also includes responsibility distribution for parties in terms of digital data management and model management. As the scope of services within the agreement is prone to be affected by these responsibilities, the use of the exhibit is therefore as part of the initial agreement.

The E203-2013 exhibit does not specify a specific framework to which extent BIM or digital data usage to be undertaken but instead enables parties to consider and discuss on the extent of BIM use and following a further agreement set the parties utilize the exhibit to document what is agreed upon in terms of scope and authorized use of BIM and other digital data [232]. However, the definition of BIM does not help specifying clearly what is the digital data that is regarded outside of "BIM", given the understanding of BIM is not solely providing a 3D model and rather it promises a digitized information management process. The consideration of BIM within the AIA's exhibit defined to be more inclined around the term of "modelling"

rather than a way of management [233]. The exhibit therefore includes two protocols, one of which being a protocol for BIM. It is intended to complete a single version of exhibit for a project and incorporate it into all contracts (appointments) within the projects.

After the execution of agreement, the E203-2013 exhibit then requires parties to meet and decide upon protocols for the production, use and exchange of digital data and BIM. The E203-2013 have two standard protocol forms as part of the exhibit, namely G201-2013 and G202-2013. G201-2013 is a standard protocol form to cover the agreed upon digital data protocols while G202-2013 is a standard protocol form to cover the agreed upon protocols for modelling.

The difference of the AIA system to cover the legal context of information management is that the protocol form is divided into two as being BIM and other digital data, and also more prominently, having these protocol forms not as part of the contract as attachments rather some protocols to be agreed upon after the agreement execution. Nevertheless, the exhibit, which is a part of the agreement, require both parties to follow agreed upon protocols. This enables parties to update protocols from time to time, as AIA explains, while on the other hand it brings together the question that considering the effect of these protocols on the scope of services to be provided by the appointed party, not considering them as part of the agreement may lead to short or long term disputes, or hardness in getting into an agreement on protocols further the execution of agreement. Once the parties agree upon a contract with its scope of works and all pricing considerations, given the fact that these are all fixed, there might be not enough space and flexibility for parties to set out protocols that satisfy ultimate quality, requirements for collaborative working and other concerns regarding to rights and obligations of parties arising around digital information [232].

On the other hand, AIA suggests that the separation of exhibit and protocols provide a number of benefits to parties. With the separation and agreeing only on the exhibit, parties no longer need to negotiate and finalize detailed information management processes. They are able to make their initial decisions regarding to production, use and exchange of digital information as part of the agreement via the exhibit, which are to be their general expectations, and this constitutes a general framework within the agreement. Later on, related methods and procedures to be adapted further

discussed and agreed between parties by protocols at a time that makes the most sense for each decision, with the ability to update the protocols at any given appropriate time. Per contra, concerns may arise around how the parties will agree on protocols and how the quality to be assured without protocols having binding restrictions arising from the contract as they are open for further negotiations where the scope and price are set in advance. The E203-2013 Exhibit deals with this concern in its Adjustments to the Agreement clauses (E203-2013 Section 1.3) but it again requires further discussion and negotiation of parties which may have negative effects in the total lifecycle, collaborative working process and ultimate quality. In the case of one of the parties believe that the protocols may result in a change in their scope of services, they are required to notify other party. Failing to provide notice results in further waiver of claims for adjustments [233] which again may have affected the eventual collaboration objective in a negative way.

The Joint Contracts Tribunal (JCT) is another producer for standard forms of construction contracts, which their products mainly used in construction projects within the UK. JCT has amendments published for the incorporation of BIM use on public sector projects within their 2011 Public Sector Supplement which could also be adopted by projects in private sector as well [234]. The amendment proposes the use of a BIM protocol containing necessary provisions to support BIM use within the project. Also, JCT's practical note "Building Information Modelling (BIM, Collaborative and Integrated Team Working" published in 2016 provides background information for the use of BIM as a guidance. The JCT 2016 Suite also contains further detailed amendments for the inclusion of BIM within the legal context. It provides again a clause enabling the incorporation of a BIM protocol within the project, and with this provision (in its design and build form) contractor becomes obliged to undertake works in compliance with the BIM protocol. There is not such specific BIM protocol draft by JCT and the contracts suite does not limit parties to use a specified protocol form, but it does encourages parties towards the use of the CIC BIM Protocol [6] (pp. 22-25).

Another commonly used, generally within the UK, standard contract forms suite is the New Engineering Contract (NEC) being published by Institution of Civil Engineers. "How to Use BIM with NEC3 Contracts" is a guidance by the NEC proposing inclusion of BIM terms into agreements. The guidance suggests

incorporation of technical aspects into the specifications and descriptions of works that the contractor is to provide, and incorporation of related obligations and liabilities into contract as amendments (as Z clauses as per the NEC suite glossary). Furthermore, the latest edition of the NEC suite, NEC4, includes BIM terms as the "Option X10: Information Management to cover the BIM process".

PPC2000 as part of the PPC Suite Contracts, which is also a widely used set of standard form of contracts (again recognition is widely within the UK) written by the Trowers & Hamlins LLP together with the input of various parties from the sector, is another standard form of contract that is concerned around BIM by proposing a 2013 BIM Supplement. The supplement includes a set of amendments and guidance about incorporating BIM process into agreement.

The CIOB Contracts are another standard contract forms series deal with the governance of BIM process which is published by Chartered Institute of Building (CIOB) in the UK. The CIOB's Time and Cost Management contract, which was initially published as Complex Projects Contract, contains special coverage of BIM process. It requires the use of a BIM Protocol, and encourages the use of AIA's BIM Protocol within the Digital Data Exhibit [6] (pp. 22-25).

The Construction Industry Council (CIC) Building Information Modelling Protocol: Standard protocol for use in projects using Building Information Modelling (the CIC BIM Protocol) is drafted as a supplementary legal agreement that can be incorporated into contracts. It establishes limitations, obligations and liabilities when parties agree to utilize building information modeling on a project. The UK Government Construction Strategy dating 2011 set out a number of requirements related to project delivery and asset information in digitized form (BIM mandate) on all public sector construction projects by 2016. Meeting with the BIM mandate require several legal and contractual issues to be addressed properly in a collaborative environment [4]. The CIC BIM Protocol was first published in 2013, and a revised version have been published in 2018.

The CIC BIM Protocol is a legal governance solution for the information management process as a requirement for Level 2 BIM (PAS 1192 compliant term equivalent to BIM according to ISO 19650, corresponding to compliance with BIM mandate). It is a supplementary legal agreement that suitable for incorporating into

various types of construction services agreements [235]. It sets out additional rights and responsibilities for parties. The protocol informs about particular matters per the agreement between the parties as follows:

- Responsibilities, liabilities and related limitations: these are set out for the project team member (lead appointed party) in the protocol.
- Copyright: the protocol provides copyright related clauses to the extent where the contract already includes adequate provisions for the intellectual property rights issues. It gives the employer the right to use information only for the "permitted purpose".
- Expected deliverables: Deliverables are defined within the protocol as with the required level of detail (LOD) and required timeline within the relevant project stage.
- Project information standard: The protocol adopts the PAS 1192 standards family and project delivery process follows the PAS 1192-2 [4].

The CIC BIM Protocol is intended to be incorporated into all direct contracts between the employer and all project team members. In example, in a case where the client employs separate design consultants and a building contractor, the protocol is to be included into all design consultants' contracts individually as well as the contract of the building contractor.

The CIC BIM Protocol consists of four parts (in its second edition dating 2018):

- A set of contractual conditions which are expected to form part of the agreement;
- Appendix 1 – Responsibility matrix, which identifies the specified information to be produced, shared and published by the project team member and the applicable LOD;
- Appendix 2 – Information Particulars, which incorporates a number of documents and references for information delivery and information management processes such as the employer's information requirements, BIM execution plan and supplementary provisions for coordination,

inconsistency, standards, software and alike issues that requires to be addressed;

- Appendix 3 which provides a set security minded provisions in order to enable parties to comply with relevant security concerns as identified within the PAS 1192-5.

The set of contractual conditions which are expected to form a part of the agreement is categorized as following:

- Clause 1- Definitions: provides a set of provisions for limitations within the scope of the protocol as well as a priority clause between the terms of the agreement and the CIC BIM Protocol.
- Clause 2 - Coordination and Resolution of Conflicts: a set of clauses guiding parties regarding to the process to be applied and directing parties to the relevant appendix in case of an inconsistency or a conflict.
- Clause 3 - Obligations of the Employer: sets out obligations of the employer with regards to the scope of the works concerned within the protocol.
- Clause 4 - Obligations of the Project Team Member: the base obligations of the project team member in relation to digital information production, delivery and management.
- Clause 5 - Electronic Data Exchange: statement that the project team member do not warrant the interoperability of any digitized information delivered in compliance with the protocol.
- Clause 6 - Use of Information: set of clauses specifying the use to which the models produced under the protocol may be put, including ownership of any IP in them.
- Clause 7 - Liabilities in Respect of Proprietary Material: the liability of a PTM for the models it delivers.
- Clause 8 - Remedies – Security: a set of security minded clauses as to comply with the requirements of PAS 1192-5 standard.

- Clause 9 - Termination: defines the terms of the protocol are intended to continue to have effect following the termination of the agreement between parties.
- Clause 10 - Defined Terms: Specifies definitions that apply to the protocol and its appendices.

As per the base obligations of the project team member with regards to the information management and BIM, the project team member to produce models to the level of detail specified in the information particulars and responsibility matrix, for a particular stage of the project [236].

The CIC BIM Protocol is ideally a "path-finder" document that is developed due to the fact that the BIM is a relatively new concept to the UK construction industry. The guidance in the CIC BIM Protocol's first edition dating 2013 acknowledges that, one of its aims being to:

"support the adoption of effective collaborative working practices in Project Teams. The encouragement of the adoption of common standards or working methods under PAS 1192-2:2013 are examples of best practice that can be made an explicit contractual requirement under the Protocol." [237]

The adoption of the CIC BIM Protocol have been widely accepted primarily in the UK, as well as within the EMEA. There are a number of key benefits making the document a de-facto standard in the construction industry as follows:

- It is issued by an industry wide body within the UK and it is widely available.
- It provides an "off-the-shelf" reference point for the lawyers, contract engineers or quantity surveyors that are inexperienced with BIM processes.
- It does not require a radical over-haul of the construction procurement process or contracting terms; rather it only requires that an identical protocol to be incorporated into all agreements/appointments within the project and it is to ensure overall end product to be compliant.
- It provides lawyers, contract engineers or quantity surveyors with a focus and prompts for considering the important issues, therefore it maximizes the prospect issues being addressed up-front [236].

These benefits are the reasons to adopt the CIC BIM Protocol as the reference point to this study, along with its widely accepted status and higher rate of familiarity within the industry relative to any other example of a BIM/information protocol or another way to govern the information management in a project. To provide further assess the selection of the second edition of the CIC BIM Protocol as the appropriate reference point, a previous study comparing various legal forms in terms of their behaviour in addressing key legal concerns regarding to BIM adoption is examined.

The above-mentioned 2019 study is examined in order to understand the different point of views adopted by different organizations and their ways of legal governance on information management and BIM processes. The study first defines contractual risks related to BIM and then compares a number of common ways of legal governance. The study first focuses on contractual risks related to the use of building information modeling and defines 13 legal risks (counts 14 in the original study, thus interoperability and software compatibility combined into single risk definition in this study) through compiled findings of an intensive literature survey [238]. Below is a summary of these risks are given:

- Intellectual property: Protecting IP rights of information [239] [240] [241] [242] [243],
- Professional liability: Liability over published information [240] [242] [243],
- Contract conditions: Governance of deliverables and delivery process [242] [243],
- Interoperability: Exchange of digitized information, software compatibility, data losses [239] [244] [245] [246] [247] [248] [249] [250],
- Procedures and obligations: Defining ways of communication and way of collaborative working between parties [239] [240] [242],
- Information security: Measures against corruption and manipulation of information [239] [242],
- Cost recompense: Balance of costs and benefits of BIM adoption for stakeholders [239] [240] [242],

- Unstructured BIM standardization: Contracts and relevant BIM standards are not satisfactory for appropriately operational BIM adoption [240] [247] [249],
- Professional skills and care: Rarity of parties capable of providing reasonable judgement to prevent waste during their services [240] [243],
- Acceptableness of digitized information: Acceptableness of digitized information before a court or a local administration [239] [243],
- Challenges of model management: Hardness of management of digitized information, updating and maintaining [244] [245] [246] [247] [251] [252],
- Information validation: Vetting of design documents with legal concerns [242] [243],
- Legislation and judicial precedence: Legal governance for BIM utilization [239] [242]

Furthermore, the study examines a number of ways of legal governance for BIM and information management available up to date (except for the CIC BIM Protocol's second edition dating 2018, instead the study considers its previous edition dating 2013), which are being:

- ConsensusDOCS 301 BIM Addendum (ConsensusDOCS 2008),
- AEC BIM Protocol (AEC 2012),
- AIA E203 Building Information Modelling and Digital Data Exhibit (AIA 2013),
- CIC BIM Protocol, 1st edition 2013,
- CIOB Time and Cost Management Contract (CIOB 2015),

The purpose of this examination is to define how these documents cover above-mentioned legal risks by their provisions.

It is important to state that the study considers the 2013 version of the CIC BIM Protocol, which have been superseded by its second edition dating 2018. In fact, both editions tend to cover similar issues, with different patterns of pliableness, except where the newer edition considers a wider range of aspects. Table 2.3 indicates the

comparison of the mitigation strategy proposed per literature, including the first edition of the CIC BIM Protocol, versus the second edition which is the reference point for this study.

Table 2.3 : Mitigation strategies for BIM-use related legal risks.

Risk	Strategy proposed per literature	CIC BIM Protocol (2nd edition)'s Strategy and Comments
IP	IP copyrights shall remain with the provider of information.	Same strategy is also adopted by CIC.
Liability	Provider of information is responsible for its obligations and shall be liable for its product.	Same strategy is further limited to ensure that the parties are not liable for fraud and uses for other than authorized purpose.
Contract conditions	There shall be a CDE, provided by the delivery team, and a common file format should be developed in BEP.	CIC addresses these concerns by its Information Particulars, besides provisions within obligations of parties regarding to the use of the CDE.
Interoperability	Delivery system to be addressed in BEP, client to direct the consultant for deliverables. Common software to be decided in BEP.	BEP is adopted and it provides for the details regarding to model production and delivery. Interoperability issues are mitigated through appropriate Exchange of Electronic Data clauses, ensuring parties with balanced and finite requirements.
Procedures	Client to appoint an information manager to lead BIM execution meetings.	Same approach adopted by the CIC. - Compliance with ISO 19650 is further required.
Security	Information to be stored in network servers with monitored access, all file revisions shall be stored and registered in a log.	CDE is available as a reliable solution for the monitored network concerns. Security minded provisions are provided for mitigation of security related risks.
Cost	Client to bear cost of model development.	-
Standardization	Legal framework for BIM process to be appended to the contract.	Sam approach adopted. - Compliance with ISO 19650 is further required.

Table 2.3 (continued) : Mitigation strategies for BIM-use related legal risks.

Risk	Strategy proposed per literature	CIC BIM Protocol (2nd edition)'s Strategy and Comments
Skill and care	All parties are responsible for their obligations regarding to provision of information.	Same approach adopted. - Compliance with ISO 19650 is further required.
Acceptableness	Digitized information and BIM (archived with appropriate time information) to be considered as part of the contract documents.	CDE, workflow and relevant information particulars are helping to mitigate relevant concerns. – Further compliance with ISO 19650 thus incorporation of information protocol together with EIR, BEP, MIDP and information standard into appointment documents may significantly contribute in mitigating relevant concerns. They are already partially available with the CIC BIM Protocol, yet the structure and purposes of documents according to ISO 19650 is a recognizable development.
Modeling Challenges	Information model to be maintained by the consultant in compliance with the BEP.	CIC provides for the Responsibility Matrix and guides parties to distribute responsibilities as necessary. Similar approach adopted by CIC with increased reliability. - Compliance with ISO 19650 is further required.
Validation	For local administrations purposes, non-editable 2D drawings to be procured in compliance with BIM protocol and BEP.	These may be specified per Employer's Information Requirements in the CIC BIM Protocol. - Compliance with ISO 19650 is further required as the new standards have a wider definition of information and thus helpful for defining requirements for a wider variety of purposes.
Legislation	"If BIM is used, then this addendum shall govern" approach to be adopted.	CIC BIM Protocol advices the use of an incorporation clause with a contract form and further provides order of precedence in between potential contract provisions and its own provisions as is necessary.

The study then proposes mitigation strategies for each legal risk, based on relevant findings from the examined documents and legal forms. A summary of proposed mitigation strategies is given in the Table 2.3 with corresponding strategy adopted by CIC BIM Protocol for comparison purposes. These strategies are considered to be a compilation of best practices adopted by different legal forms in order to find the best possible combination of mitigating legal risks in concern.

The comparison of mitigation strategies and CIC BIM Protocol's corresponding strategies presented in the Table 2.3 indicates how CIC BIM Protocol is ahead of the combination of best practices adopted in previous documents. The findings of the comparison stand as a supporting evidence for the adoption of CIC BIM Protocol as the reference point. Yet, the need for the compatibleness with the ISO 19650 standards is significant as proposed information management system through the new standards family provides for a more structured way of execution and increases the effectiveness of the BIM process. By having the legal framework established around this new standardized information production and delivery processes defined by ISO 19650, these BIM related risks may be mitigated with a higher rate of success. Following the examinations in Sections 3 to 5, evaluation of the proposed ISO 19650-compliant information protocol against existing mitigation strategies is presented in Section 6.

3. THEORETICAL FRAMEWORK

The information management governance (can also be addressed as BIM governance) is setting out a policy, throughout the project lifecycle and supply chain, for project information management supported with a building information model. This policy should consider all parties' rights and obligations over project information [253]. Alreshidi et al. (2017) argues that the determination of decision-makers is done through the governance, and decisions made through management (as cited in Newman and Logan, 2006) [230]. In today's construction projects, insufficient information management governance is a well-known fact and therefore an exigency for a generic information management governance model to guide the information management process through adopting BIM with a collaborative way of working over the course of the asset lifecycle is in existence [253].

The intention of a project information protocol is to guide and govern the information exchange and management with a legal binding. Prior to the new ISO 19650 standard family, this governance was undertaken with a number of ways, including a number of BIM protocols. Detailed information regarding to existing ways of governance given in the above Literature Overview section of this study. With the introduction of the ISO 19650 standard family, the information management is now required to be governed by an information protocol which also governs the BIM process. Therefore, instead of the previous definition of BIM protocol now the term "Project Information Protocol" is adopted. With the new definition, the information protocol scope covers the entire information management process through the project including building information modelling.

The project information protocol is designed to be incorporated into appointment documents as an attachment to the agreement between parties. The information protocol with its general clauses provide guidance for parties related to their obligations, liabilities, interoperability and conflict resolution. There are also several

appendices to modify the protocol to be suitable for the intended project and the appointment, and to incorporate any additional documents that are required for the information management process, which are designed as forms and parties are expected to fulfil these forms as appropriate prior to compiling the appointment documents.

The project information protocol, as a legal document (usually an appendix to a contract) used to identify specific obligations of parties and intellectual property rights and liabilities arising together with the use of digital information in a construction project where BIM is used to manage the digitized information. It is one of the solutions to help govern the legal context of digitized information management in construction projects.

A successful and efficient information management process from start to finish of any project relies upon all parties. A righteous and well-balanced distribution of roles and responsibilities is a key factor for both appointing and appointed parties to achieve their prospective goals and incumbencies. Clear boundaries between these responsibilities will increase efficiency. An appropriate distribution of responsibilities between parties which means a logical risk allocation by giving particular importance to the consideration of their suitability and capacity, will enable them to work with increased flexibility, efficiency and stability. A collective improvement in the total quality of the end product of a project, can be achieved through an outstanding governance of information management as mentioned above.

In a project where the information has been successfully managed through standardized guidance so far as possible during the project lifetime, the organized and classified information will pave the way for an advanced asset management opportunity through the remaining life cycle of the asset.

The justification for implementing the ISO 19650 series as the standard for information management, which includes altering the existing ways of legal governance including the CIC BIM Protocol to comply with the ISO 19650, can be specified in two cases as being technical and commercial.

The technical justification lays its foundations to the industry’s need to develop its processes and increase productivity and embrace the digital transformation. Also the

ISO 19650 series, as being an international standard family, facilitates an information management approach at an international level.

On the other hand, the commercial justification can be explained by the UK Government's support for the adoption of BIM on public sector projects. It has been an accelerant for the change in the industry and this being resulted in measured benefits and returns on investment across many departments in the UK. These inform a potential commercial benefit in the adoption of BIM and appropriate information management. There is a degree of investment to be made by an investing organization in order to adapt the ISO 19650, teaching its employees, examining new processes and standards, adapting new software as well as other possible technologies et cetera. This stands as a long-term investment and as can be learned from the examples within the UK, benefits in the long term are in favour. As the number of clients from both public and private sectors requires the use of information management standards (now the ISO 19650) are keeping tend to increase, the ISO 19650 is likely to become the primary driver of the supply chain organizations for adoption to ensure the ability to win work. Also, improvement of process and quality within projects, ease in adoption of new technologies and increased know-how and reduction of rework and improved efficiency are can be listed as other drivers for the adoption of the ISO 19650 [214] (p. 13).

3.1 Definitions

Introduction of the new ISO 19650 standard family brought together with an altered scope of terms and definitions to a number of phenomena for the information management process of built environment and the BIM process. While some of the existing features have been slightly changed in terms of either their definitions or names (such as the widely accepted term "employer" replaced with the "appointing party", or the "plain language questions" term from the PAS 1192 suite now succeeded by the "project information requirements"), some new terms and definitions have also been introduced to the system in order to be compliant across the world and be accepted in between all standardization institutions and also to adopt a more generic terms and definitions to enable utilization of more parties from everywhere [255] [258]. In order to provide a better understanding for the rest of this study, certain key definitions from the new standard family provided below:

- Appointment: agreed instruction for the provision of information concerning works, goods or services.
- Appointing Party: receiver of information concerning works, goods or services from a lead appointed party
- Appointed Party: provider of information concerning works, goods or services.
- Project Team: appointing party and all delivery teams.
- Delivery Team: lead appointed party and their appointed parties. A delivery team can be any size, from one person carrying out all the necessary functions through to complex, multi-layered task teams. The size and structure of each delivery team are in response to the scale and complexity of the asset management or project delivery activities.
- Task Team: individuals assembled to perform a specific task.
- Asset: item, thing or entity that has potential or actual value to an organization.
- Organizational Information Requirements: information requirements in relation to organizational objectives.
- Asset Information Requirements: information requirements in relation to the operation of an asset.
- Project Information Requirements: information requirements in relation to the delivery of an asset.
- Exchange Information Requirements: information requirements in relation to an appointment
- Information Container: named persistent set of information retrievable from within a file, system or application storage hierarchy.
- Level of Information Need: framework which defines the extent and granularity of information.
- BIM Execution Plan: plan that explains how the information management aspects of the appointment will be carried out by the delivery team. The pre-

appointment BIM execution plan focuses on the delivery team's proposed approach to information management and their capability and capacity to manage information.

- Information Delivery Milestone: scheduled event for a predefined information exchange.
- Task Information Delivery Plan: schedule of information containers and delivery dates, for a specific task team.
- Master Information Delivery Plan: plan incorporating all relevant task information delivery plans [217] [215].

3.2 Concept and Scope

The examples of existing BIM protocols have a wide range of variety in terms of their scope of provisions.

A number of considerations for the terms used within this study have been taken into account in the making of the project information protocol. Following explanation is to clarify the project, appointment, and designated parties to the protocol. The protocol intended to be incorporated into an appointment, via as an attachment to the contract between contracting parties. Therefore, the protocol form should be considered as a part of the agreement set by the contract which it is attached to, between only the parties who are acceding to that particular agreement. It is envisioned and recommended that the same protocol form draft should be completed appropriately for the intended use per each appointment within the context of a project, and thereby incorporated into each corresponding appointment. It is critical that all the protocol forms used should be consistent and there should be no conflicts amongst forms incorporated into different appointments. Ultimately all appointments are within the same context of the project. All the information delivered are in alignment with the information requirements of the same appointing party for the project at stake. After all is said and done, it is crucial that all the information to be incorporated into the asset information model (AIM) shall be compatible with the asset information requirements (AIR) [259] [5] [261].

In order to append the Project Information Protocol into an agreement, an amendment to the contract form with a special clause is required. By doing so, parties are agreed upon and enabled the incorporation of such protocol and its clauses are confirmed in effect. This special clause is called incorporation clause and following is the recommended clause for the use of the intended Project Information Protocol.

"● The [Client/Employer/as entitled by the intended contract form] and the [Consultant/Contractor/as entitled by the intended contract form] shall:

1. comply with their respective obligations set out in the Project Information Protocol, PIP/19 ("Information Protocol"), as further defined in Appendix [X];

2. have the benefit of any rights granted to them in the Information Protocol; and

3. have the benefit of any limitations or exclusions of their liability contained in the Information Protocol.

● The [Client/Employer/as entitled by the intended contract form] and the [Consultant/Contractor/as entitled by the intended contract form] agree that, subject to clause 1.2 of the Information Protocol, this Agreement shall be amended as set out in the Information Protocol.

● Any reference to "[Appointing Party]" in the Information Protocol shall have the same meaning as the definition "[Client/Employer/as entitled by the intended contract form]" under the Agreement. Any reference to "[Lead Appointed Party]" in the Information Protocol shall have the same meaning as the definition "[Consultant/Contractor/as entitled by the intended contract form]" under the Agreement."

The incorporation clause is an altered version of the CIC BIM Protocol's adviced incorporation clause. The alteration is made to ensure that any references to contracting parties in the protocol form are to be interpreted and addressed to the right party in the same way by all parties. The clause shall be filled in with appropriate titles and addresses then it can be incorporated as a special provision to the contract form, as applicable. Yet, there are a large variety of special contract forms available for the use of parties and the adviced incorporation clause may not

be suitable in each case. It is important for parties to have legal consultancy in preparing contract documents and adopting the information protocol [262].

4. GENERAL CONDITIONS

A successful and efficient information management process from start to finish of any project relies upon all parties. A righteous and well-balanced distribution of roles and responsibilities is a key factor for both appointing and appointed parties to achieve their prospective goals and incumbencies. Clear boundaries between these responsibilities will increase efficiency. An appropriate distribution of responsibilities between parties which means a logical risk allocation by giving particular importance to the consideration of their suitability and capacity, will enable them to work with increased flexibility, efficiency and stability. A collective improvement in the total quality of the end product of a project, can be achieved through an outstanding governance of information management as mentioned above.

In a project where the information has been successfully managed through standardized guidance so far as possible during the project lifetime, the organized and classified information will pave the way for an advanced asset management opportunity through the remaining life cycle of the asset.

A well organized, smooth and efficient information management process can be a key element to the success of any project. Efficient information management process is more achievable with determination and consciousness of contracting parties. In order to enable parties to undertake their functions properly, their roles and responsibilities must be clear and explicit. A righteous and well-balanced distribution of responsibilities is important for both appointing and appointed parties to carry through their prospective goals and incumbencies. It is aimed with this study to have these responsibilities distributed with fair proportions and by doing so to enable parties to step up to the plate in favour of the best end product of the project by means of an effective information management.

In the abovementioned context, is important to have clear distinction between areas of responsibility for each party that are participating in the information management

process. Having each party aware of their obligations, and also their enablers through the input from other parties, loud and clear, is expected to improve efficiency of the information exchange.

This section of the study aims to explore the administrative point of view that needs to be considered in terms of setting out clauses of an information protocol for a project. Insofar as possible brief and to the point it is intended to set out contextual limitations within the information protocol (limitations include the defined terms placed at the end of the information protocol as addressed within the first clause), obligations of associated parties, methods for coordination and conflict resolution in the case of an contradiction between parties arising from either an unforeseeable event or a difference in interpreting conditions of the information management procedures, governance principles for the use of information and resultant liability, as well as the interoperability concerns of the digitized information. Also, terms for the termination of the intended protocol is accommodated at the end of the section.

4.1 Contextual Limitations

This is the first section of the information protocol and aims to provide mainly the definitions used to limit the context of the document. As the CIC BIM Protocol have been admitted as the reference point, a similar approach to its “definitions” clause (clause 1) have been adopted with some alterations to the scope and wording, in order to comply with the ISO 19650. First of all, the mention of defined terms given in the clause 9 have been placed just like as provided in the CIC BIM Protocol to provide for intended meanings of each technical term used within the information protocol. Further the clause 9 of the information protocol specifies all the defined terms within the document. This clause is intended to secure parties from any results due to misinterpretation of other provisions resulting from a potential misconception of these terms. Any potential misinterpretation may cause to disputes which will bring together inefficiency in the overall project performance and consequently may result in excessive waste in terms of time and costs. Parties shall be careful with the terms when they agree to make alterations to the information protocol as additions and/or amendments as any improvidence related to defining appropriate terms may lead to abovementioned disputes or inconsistencies. All the terms used in the information protocol are compliant with the terms used in the ISO 19650 standards.

A very limited number of terms adopted as used in the CIC BIM Protocol with particular care given to the aspect that any term brought from the CIC BIM Protocol shall have no inconsistency with the ISO 19650. It is particularly avoided to invent any new terms as this may lead to confusion given the fact that any such information protocol compliant with the international ISO 19650 standards may be used across different parts of the world and terms and definitions may change in a wide range. Therefore, instead of inventing new terms for any repetitive and specific definitions, a consideration adopted as providing necessary wording to clearly describe such definition with the available wording of the ISO 19650 [258]

Another provision provided to clarify the position of the information protocol as part of the contract documents and to the extent where it is stated otherwise within any section or the appendix of the information protocol, the protocol prevails the agreement in a possible conflict or inconsistency between the agreement and the obligations of parties (related to clauses 3 and 4 as well as appendices A to G) as provided within the information protocol. This provision is also extracted from the CIC BIM Protocol and altered to comply with the structure of this information protocol.

4.2 Coordination and Conflict Resolution

Another aspect intended to be governed by the prospective project information protocol is the methodology to follow in the case of an unforeseeable reason for a concern or a misinterpretation of conditions of information management process, or an inconsistency within the information protocol's appendices following a failure to complete the document with consistent information, that are causing parties to conflict with regards to information management and exchange. A clause provided to manage a possible conflict of interest between parties in the context of information management, on the purpose of resolving potential problems in the most desired ways to the favour of the overall project success by minimizing interruptions to the information exchange, ambiguities and clashes between parties, damages causing undesirable time and budget surpasses. Again, in this chapter, it is acknowledged that the CIC BIM Protocol is the reference material to pursue to the appropriate extent. As the CIC BIM Protocol also suggests for, this clause have been limited to instructions for parties where a party becomes aware of a conflict or inconsistency

and a reference to the Methodology for Resolving Inconsistency document (appendix F to the project information protocol) in which document parties may provide desired methods and procedures to resolve any inconsistency or conflict as appropriate. Also it is possible for parties to provide for a clause to define periodical meetings in order to mitigate regular inconsistencies and avoid potential conflicts.

4.3 Obligations of the Appointing Party

In order to enable the delivery team to successfully comply with all the requirements of the agreement to the satisfaction of the appointing party, the appointing party shall be incumbent upon providing appropriate necessities arising through an appointment.

A set of regulatory clauses to describe boundaries of appointing party's responsibilities in terms of information management have been identified by the Construction Industry Council in the CIC BIM Protocol and within the scope of this study, clauses of the CIC BIM Protocol have been examined as a reference point and adopted with alterations to comply with the ISO 19650.

Initially as per the original protocol, the appointing party (referred to as the employer) is in brief responsible for:

- Arranging for a completed information protocol,
- Complying with its obligations under the project standards, methods and procedures referred to in the information particulars (an appendix to the CIC BIM Protocol defining details regarding to information management process and responsibilities),
- Appointing the project information manager (referred to as the employer's information manager) and built asset security manager throughout the project,
- Providing for the CDE and enabling the delivery team to make use of it,
- Reviewing and updating as necessary the responsibility matrix, the information particulars and the security requirements.

According to the ISO 19650, parties may agree to make additions or amendments to the information protocol. This topic requires a specific coverage within the information protocol as now the lead appointed party or its appointed parties may

propose for an input for the information protocol. Taking into account that the information protocol is a project specific document rather than an appointment specific document, and any agreed additions/amendments for the information protocol between the appointing party and a delivery team may not be feasible or suitable to other delivery teams. Therefore, any such additions/amendments shall be limited to an extent where the obligations of parties preserved compliant across all appointments.

Another significant change for the scope of the appointing party's obligations is the term project standards, methods and procedures. Per the ISO 19650 now project's information standard and project's information production methods and procedures have specific definitions. As for the information production methods and procedures; the appointing party initially defines them as a project specific document, and the delivery team addresses these methods and procedures as an answer within their BIM execution plan. As far as parties agree, the BIM execution plan becomes finalized during the awarding. Therefore, there is no such need for these to be separately incorporated into the information protocol as they shall be addressed within the agreed BIM execution plan. On the other hand, ISO 19650 specifically requires the project's information standard to be incorporated into appointment documents. Furthermore, besides being a project specific documents like the information protocol, information standard also has the possibility to have additions and/or amendments. Within this case, a similar approach adopted for the information standard as the information protocol and clauses have been incorporated to guide the arrangement and facilitation of such document. A limitation for any additions/amendments provided for, similar to as indicated by the ISO 19650, where such additions and/or amendments are required by the delivery team to facilitate the effective:

- Exchange of information between task teams,
- Distribution of information to other delivery teams or third-parties, or
- Delivery of information to the appointing party.

As the information standard now have a specific definition as per the ISO 19650, the obligations of the appointing party are defined within the information management assignment matrix referred to in the Appendix A of the information protocol and the

relevant clause of the CIC BIM Protocol altered to refer to the matrix rather than the information standard, yet by mentioning the required compliance with the information standard which includes the ISO 19650 which all the parties shall comply with during the project lifetime.

CIC BIM Protocol's responsibility matrix have been replaced by the information management assignment matrix as provided within the Annex A of the ISO 19650-2. This matrix is defined for an appropriate allocation of responsibilities between parties of an appointment and by adopting this matrix it is expected to provide a better guidance on drawing visible boundaries between parties' responsibilities. The existing information management assignment matrix in the attachment of this study is provided as an informative table and required further tailoring to fit with the structure of the delivery team and the appointing party may fill in responsibility distribution based on an agreement with the lead appointed party. Further the lead appointed party may distribute their assignments within the delivery team with the consent of the appointing party.

Additional changes have been made to terms and definitions in order to comply with the ISO 19650 such as the terms project information model and information particulars are in use in replacement to the material or specified information terms of the CIC BIM Protocol. Obligations concerning security requirements have been discarded within the scope of this information protocol as the ISO 19650-5 have not been yet published. It is intended that security concerns may be addressed through an appendix where it is possible to incorporate appropriate clauses of CIC BIM Protocol or any other additional clauses to satisfy desired security standards such as PAS 1192-5. As the ISO 19650-5 is currently in preparation and it is the only relevant security standard that is in full compliance with the rest of the ISO 19650 family, it is avoided to stick with a different security standard and the decision to incorporate appropriate clauses left for the end user. In the Conclusion section of this study, considerations regarding to a future adoption of the upcoming ISO 19650-5 standard is being further discussed.

4.4 Obligations of the Lead Appointed Party

As being the main responsible for the quality of the work, the lead appointed party is expected to satisfy requirements set out by exchange information requirements (EIR), which are in the appropriate alignment of project information requirements (PIR) and asset information requirements (EIR). Their obligations are intended to be explicitly put forward through this section of the information protocol in order to ensure they cover the requirements to the appropriate extent.

Also, for the obligations of the lead appointed party, the CIC BIM Protocol stands as the guiding instrument, so far as applicable. Obligations of the lead appointed party have been adopted to comply with the ISO 19650 and it is expected to draw boundaries of the obligations of the appointed party arising from an appointment to exhibit a successful information management and achieve a better and sustainable ultimate result during the delivery phase of a project.

As per the information protocol, the lead appointed party is obliged to comply with their responsibilities within the information management assignment matrix and generate the project information model (limited to the information containers within their scope of works as specified by the exchange information requirements) in compliance with information standard and in accordance with the delivery team's information production methods and procedures per the delivery team's BIM execution plan. The lead appointed party also to own full responsibility of its appointed parties' respective obligations, in case such obligations provided separately under the information management assignment matrix. As per the ISO 19650, the information protocol also clarifies responsibilities of the appointed parties within the delivery team and for that matter, a clause has been incorporated into the information protocol to confirm the full responsibility of the lead appointed party over the works undertaken by the entirety of the delivery team.

Delivery of the information created by the delivery team shall be through the CDE, in compliance with the exchange information requirements and information standard, and during the project stage and at such times specified in the MIDP (within its relevant TIPDs). Within the CIC BIM Protocol, similar clause provided for such times specified in the responsibility matrix, information particulars or any other part of the agreement. As with the requirements of the ISO 19650, TIDPs to incorporate

such delivery plans and considering these to be agreed by parties, such delivery times as per MIDP is considered satisfactory to bind the delivery team through the information protocol.

Likewise, to the obligations of the appointing party, additional changes have been also made to terms and definitions in order to comply with the ISO 19650. Obligations concerning security requirements have also been discarded within the same context as explained above, in the Section 4.2 of this study.

4.5 Use of Information and Liabilities in Respect of Proprietary Information Containers

Along with the way to produce the information, the use of information also needs governance. Each information produced brings together its copyrights issues as the producers of the information make a living through the know-how of related information. Agreed upon contract may provide intensive or superficial guidance on the copyrights and security of intellectual properties of all contracting parties, yet it is more common to see that no such concern may be covered within the contract form. In such case likewise the latter, in order to support the contract conditions within the scope of information management, a guidance is to be provided inside the information protocol by setting out clauses regarding to the use of information and liability. If the intellectual property rights are governed by the contract to the sufficient extent, it is no longer needed for a supplement via the information protocol and therefore this section might be excluded. This is the approach by the CIC BIM Protocol and have been adopted within the same context. Liabilities regarding to further handling of information containers, after the delivery from the producer of the information to the user are also a key issue requires to be addressed. As also indicated by the CIC BIM Protocol, it is intended to secure the producer of information from any further modification, amendment or a use or a transmission to any other individual other than the authorized purpose by providing appropriate clauses within the information protocol section regarding to liabilities in respect of proprietary information containers.

In order to enable parties other than the producer of any information container, the producer, which is also the owner of the information container, grants a licence for

authorized use to the party receiving the information. The authorized use including the transmission of the information to relevant parties under a sub-licence again solely with the purpose of authorized use of the sub-licenced party. The same approach is effectual to both parties to the agreement and each party's licences granted is detailed with a set of clauses. This licencing approach originates in the CIC BIM Protocol.

In addition to the CIC BIM Protocol's approach, which have been adopted substantially within the use of information clause of the information protocol, satisfactory clauses have been incorporated to confirm that the appointed parties are also subject to the same conditions with their lead appointed party as well as is in between lead appointed party and the appointing party, in terms of owning information containers that they produce and granting such licence to their lead appointed party and sub-licence for solely the authorized use of other actors including the appointing party.

4.6 Exchange of Digitized Information

Interoperability is a key issue to be addressed in order to avoid any misinterpretation of the desired governance of the exchange of digitized information.

In theory, the appointing party specifies what exactly is needed in terms of production and delivery of information within the exchange information requirements. Ideally those requirements are in alignment with the project information requirements and asset information requirements. Therefore, the information containers received from the delivery team should be in satisfactory conditions for intended utilization purposes of all requirements.

As long as the delivery team meets with the conditions of the exchange information requirements in their produced information containers, including the required file format standards, the handling of the delivered digital information containers by the appointing party is at their own account. The lead appointed party does not warrant the compatibility of the software used to prepare the information containers or the software format in which the information containers shared with the any software or software format used by the appointing party or any other receiver of information.

Furthermore, the lead appointed party has also no liability to the appointing party with respect to any corruption and/or unintended alterations of the digital information in any information container further to its delivery through the CDE to the appointing party (or any relevant party within the project team).

4.7 Termination

Termination of the provisions of the prospective information protocol are due different aspects per the provision. Some of the provisions are solely intended for the governance of information production and exchange throughout the lifetime of the project. These are to be terminated by the end of the project, when the information production by the appointed parties are completed. On the other hand, some provisions are governing the states of affairs beyond the completion of projects, such as liabilities arising from use and ownership of intellectual properties. Some of these provisions may have no such termination due date. All the provisions that are governing the information production and exchange as long as the production continues are due termination by the end of the agreement between the appointing and lead appointed parties where the responsibilities of the lead appointed party are successfully been addressed to the satisfaction of the appointing party, and the resulting information is completely handed over to and accepted by the appointing party. The termination clause is designed as to indicate that the provisions that requires to continue to apply shall continue after the termination of the agreement between parties. These provisions are the ones relate to:

- Order of precedence between the agreement and the information protocol,
- Conflict resolution and coordination,
- Obligations of the appointing party,
- Use of information,
- Liabilities in respect of proprietary information containers, and
- Interoperability of digitized information.

Any other provisions shall terminate along with the termination of the agreement between parties.

4.8 Summary of General Provisions

As detailed in previous sections, general provisions of the intended project information protocol are prepared based on the CIC BIM Protocol and further altered to comply with the ISO 19650 standards, with additional considerations in regard to the overview of the existing situation and expert reviews. Table 4.1 indicates a list of provisions, their corresponding predecessors (if applicable) from the CIC BIM Protocol and the explanation of the change applied or the reason for inclusion. The CIC BIM Protocol is open for public access and can be achieved through the CIC's website: <cic.org.uk/admin/resources/bim-protocol-2nd-edition-2.pdf>.

Table 4.1 : Summary of general provisions of the Project Information Protocol.

Content	PIP Cl.	CIC Cl.	Explanation
1. Contextual Limitations			
Terms and meanings	1.1	1.1	Clause 9 is being addressed instead of 10, both corresponds to defined terms clause.
Status of the Information Protocol within contract documents and explanation of order of precedence	1.2	1.4	Same approach is adopted, corresponding clauses and appendices concerning obligations of the parties addressed.
Declaration of appointment	1.3	-	Included in order to declare the establishment of the appointment (regarding to procurement of information).
2. Conflict Resolution and Coordination			
Instructions for actions in case of a conflict/inconsistency	2.1	2.2	Identical approach is adopted. "Employer's Information Manager" term replaced with "Project Information Manager". Addressing provided for the Appendix F.
Option for coordination meetings	2.2	2.1	CIC's meetings obligation is altered to be optional per parties' desire. This aims increased freedom as not every project and every project team structure may require such meetings. Selection of coordination methodology left for parties' decision based on their best practice.

Table 4.1 (continued): Summary of general provisions of the Project Information Protocol.

Content	PIP Cl.	CIC Cl.	Explanation
3. Obligations of the Appointing Party			
Obligations of the Appointing Party	3.1	3.1	"Employer" term is replaced with the term "Appointing Party".
Arrangement of the Information Protocol	3.1.1	3.1.1	Remains identical with minor changes in terms.
Incorporation of agreed additions /amendments to the Information Protocol	3.1.2	-	This clause is included to confirm Appointing Party's obligation regarding to incorporating any agreed upon additions and/or amendments to the Information Protocol as explained in the ISO 19650 and ensures an amendment may not alter any obligations of the parties and thus the form will substantially remain the same in all appointments.
Arrangement of the Information Standard	3.1.3	-	As instructed per the ISO 19650, project's information standard have to be set out. It is intended to assign this information management activity to the Appointing Party with the same terms as for the Information Protocol.
Incorporation of agreed additions /amendments to the Information Standard	3.1.4	-	Similar to the Information Protocol, Information Standard also requires the option to incorporate any agreed additions and/or amendments. This clause confirms the activity, provides for the condition of existence of a legitimate purpose for any such addition/amendment and further ensures that any such amendment may not alter any obligations of the parties and thus the form will substantially remain the same in all appointments.
Arrangement of the Information Management Assignment Matrix	3.1.5	-	This clause is incorporated to ensure the provision of the Appendix A of the Information Protocol which comprises the Information Management Assignment Matrix.

Table 4.1 (continued): Summary of general provisions of the Project Information Protocol.

Content	PIP Cl.	CIC Cl.	Explanation
Declaration of the Appointing Party's liability to fulfil its obligations per Information Management Assignment Matrix	3.1.6	3.1.2	Alteration is made to address Information Management Assignment Matrix instead of "Project standards, methods and procedures" as currently the obligations are distributed in the Matrix. Compliance with Information Standards rather ensured within the Lead Appointed Party's obligations as the Appointing Party have no information production liabilities to any other party. In case the Appointing Party produces information, then it is responsible to themselves.
Declaration of the Appointing Party's obligations regarding to facilitation of an efficient information production and delivery process by the Delivery Team	3.1.7	3.1.3	(a) "Information Particulars" and "Responsibility Matrix" terms are replaced with the Information Management Assignment Matrix and Exchange Information Requirements terms in order to comply with the new structure of the Information Protocol. (b) "Employer's Information Manager" term is replaced with "Project Information Manager". The new term does not include the Employer as the Appointing Party may (although being not advised) transfer this responsibility to a member of the Delivery Team or an individual from a third party. Also the Project Information Manager concept instead of Employer's supports the intention for a more collaborative environment and considers the project team as one. (c) Compliance with the Information Protocol and Information Management Assignment Matrix are included for ensuring the terms of these documents applies. (d) This item is introduced to ensure the Delivery Team's access enabled to necessary Project's Reference Information and Shared Resources, and Information Containers produced by Other Delivery Teams shared through CDE, subject to

Table 4.1 (continued): Summary of general provisions of the Project Information Protocol.

Content	PIP Cl.	CIC Cl.	Explanation
(cont'd)	3.1.7	3.1.3	Clause 6 (Liabilities in Respect of Proprietary Information Containers) of the Information Protocol. (e) Remains similar to previous 3.1.3 (d) concerning the rights of the Delivery Team to access to their licenced Information Containers shared through CDE following the termination of the agreement. "Project Team Member" term replaced with the "Delivery Team" term to both comply with the new terms and provide for not only the Lead Appointed Party's but also the entire Delivery Team's appropriate rights as required per ISO 19650.
4. Obligations of the Lead Appointed Party			
Obligations of the lead appointed party	4.1	4.1	"Project Team Member" term is replaced with the term "Lead Appointed Party".
Declaration of the Lead Appointed Party's liability to fulfil its obligations per the Information Management Assignment Matrix	4.1.1	4.1.1	This clause is incorporated to address the Information Management Assignment Matrix for relevant obligations. This is intended to ensure covering all information management responsibilities of the Lead Appointed Party, including Information Model production which is listed in the Matrix.
Confirmation of the Lead Appointed Party's accountability over its entire Delivery Team	4.1.2	-	This clause is incorporated to ensure that the Lead Appointed Party is fully responsible for its Appointed Parties' respective responsibilities. This clause is deemed necessary as now also the Appointed Parties' rights and responsibilities are indirectly covered within the Information Protocol and its appendices.
Lead Appointed Party's obligation with regards to production of PIM	4.1.3	4.1.1	Alteration is made for compliance with the new structure of the Information Protocol and ensurance of compliance with relevant requirements and standards. "Specified Information" term is replaced with the term "Project Information Model". The Delivery

Table 4.1 (continued): Summary of general provisions of the Project Information Protocol.

Content	PIP Cl.	CIC Cl.	Explanation
(cont'd)	4.1.3	4.1.1	Team is responsible for the production of Information Containers forming part (or complete) of the PIM as specified in the EIR. Relevant references to EIR, Project's Information Standard and Delivery Team's Information Production Methods and Procedures (part of Delivery Team's BEP) are provided to ensure appropriate compliance.
Production and Delivery of PIM/Information Containers: Quality compliance and time schedule related obligations of the Lead Appointed Party and consequently its Delivery Team	4.1.4	4.1.2	The term "Project Team Member" is replaced with the term "Lead Appointed Party". (a) "Level of Definition specified in the Responsibility Matrix" is now corresponds to "compliance with EIR and Project's Information Standard", as LoIN is now specified within the EIR per each information container(s) as detailed as deemed necessary by the Appointing Party. LoIN also mentioned to strengthen the emphasis on it. (b) Requirements for delivery time is now referenced through MIDP as the MIDP provides necessary delivery schedule information. Therefore, referrals to "Responsibility Matrix" for project stage and to "Responsibility Matrix, Information Particulars and any other part of the Agreement" terms are removed and the term "MIDP" took place instead.
Production and Delivery of PIM/Information Containers: Confirmation of compliance with the provisions of the Information Protocol and its appendices.	4.1.5	4.1.3	Remains identical with the change in the term "Information Particulars" which being replaced to address the Information Protocol itself with its appendices.

Table 4.1 (continued): Summary of general provisions of the Project Information Protocol.

Content	PIP Cl.	CIC Cl.	Explanation
Guidance for the use of Information provided by the Appointing Party	4.1.6	4.1.4	Alteration is made to ensure the necessary utilization of Project's Reference Information and Shared Resources as well as any project related information produced and shared through CDE by Other Delivery Teams. Previous clause of the CIC BIM Protocol is altered to cater the use of Project's Reference Information and Shared Resources.
5. Use of Information			
Declaration of agreement between parties on the conditions regarding to the use of information	5.1	6.1	Terms are altered to comply with the ISO 19650. Appointed Parties are also mentioned in the agreement sentence as to imply they agree to the same conditions. This is intended as to comply with ISO 19650 requirements to identify rights and obligations of the Appointed Parties in the Information Protocol. Therefore, it is suitable to maintain substantially the same Information Protocol into different agreements also between the Lead Appointed Party and its Appointed Parties.
Indication to ensure that the Agreement provisions prevails in terms of IP copyrights.	5.1.1	6.1.1	The structure of the clause remains substantially the same as the CIC BIM Protocol, with necessary alterations made in terms to comply with the ISO 19650.
Conditions for ownership rights of proprietary Information Containers produced by the Delivery Team	5.2	6.2	The clause structure remains within the same context with a significant alteration to embody the ownership rights of the Appointed Parties regarding to their proprietary Information Containers.

Table 4.1 (continued): Summary of general provisions of the Project Information Protocol.

Content	PIP Cl.	CIC Cl.	Explanation
Guidance on the use of Information Containers produced by the Delivery Team and granting appropriate licences for the use of the Appointing Party and other parties as required	5.3	6.3	The clause remains in the same context with changes made to comply with the new defined terms per ISO 19650. Also, the term "Permitted Purpose" is replaced with the term "Authorized Purpose" to indicate that the subject licencing is there to provide authorization for use due an appropriate reason. Therefore, the term "Authorized Purpose" deemed on-point.
Guidance on the use of Information Containers produced by the Appointed Parties and granting appropriate licences for the use of the Lead Appointed Party, and also the use of the Appointing Party and other parties as required	5.4	-	This clause is incorporated to provide same conditions in terms of granting licences for the Information Containers owned by the Appointed Parties and ensure their rights in terms of appropriate Information Container ownership.
Limitations on the actions permitted for parties (within the Project Team or any third party, apart from the Delivery Team) with any licence granted under Clause 5	5.5	6.4	The clause remains in the identical structure and context with alterations made in terms to comply with the ISO 19650.
Guidance on the use of Information Containers owned by the members of Other Delivery Teams, and the conditions of granting a sub-licence to the Delivery Team by the Appointing Party	5.6	6.5	The clause remains in the identical structure and context with alterations made in terms to comply with the ISO 19650. With the introduction of the new terms, the clause is refined and more clear with the boundaries for definitions of each party.

Table 4.1 (continued): Summary of general provisions of the Project Information Protocol.

Content	PIP Cl.	CIC Cl.	Explanation
Guidance on the use of Information Containers owned by the Appointing Party, and the conditions of granting a licence/ sub-licence to the Delivery Team by the Appointing Party	5.7	6.6	The clause remains in the identical structure and context with alterations made in terms to comply with the ISO 19650.
Limitations on the actions permitted for parties (within the Delivery Team) with any licence granted under Clause 5	5.8	6.7	The clause remains in the identical structure and context with alterations made in terms to comply with the ISO 19650.
The Lead Appointed Party's representation of ownership of the rights to grant a licence /sublicense per Clauses 5.3 and 5.4	5.9	6.8	The clause remains in the identical structure and context with alterations made in terms to comply with the ISO 19650.
The Lead Appointed Party's representation of ownership of the rights to grant a licence /sublicense per Clauses 5.6 and 5.7	5.10	6.9	The clause remains in the identical structure and context with alterations made in terms to comply with the ISO 19650.
6. Liabilities in Respect of Proprietary Information Containers			
Condition regarding to the relevant Agreement provisions and instructions for necessary variations.	6.1	7.1	The clause remains in the identical context with alterations made in addressee clauses to comply with the new structure of the Information Protocol.

Table 4.1 (continued): Summary of general provisions of the Project Information Protocol.

Content	PIP Cl.	CIC Cl.	Explanation
Declaration that the Lead Appointed Party have no liabilities regarding to use or modification of its deliverables for any purpose other than the Authorized Purpose	6.2	7.2	The clause remains in the identical structure and context with alterations made in terms to comply with the ISO 19650.
Declaration that the Appointing Party have no liabilities regarding to use or modification of Information Containers (where licence granted by the Appointing Party) for any purpose other than the Authorized Purpose	6.3	7.3	The clause remains in the identical structure and context with alterations made in terms to comply with the ISO 19650.
7. Exchange of Digitized Information			
Interoperability of software /software format	7.1	5.1	The clause remains in the identical structure and context with alterations made in terms to comply with the ISO 19650.
Declaration that the Lead Appointed Party is not responsible for digitized information corruption thereafter the issuance	7.2	5.2	The clause remains in the identical structure and context with alterations made in terms to comply with the ISO 19650.

Table 4.1 (continued): Summary of general provisions of the Project Information Protocol.

8. Termination			
Identification of which clauses shall continue to apply following termination of the Agreement	8.1	9.1	The clause remains in the identical structure and context with minor alteration made in terms to comply with the ISO 19650.
9. Defined Terms			
Definitions of terms used	9	10	Various terms are replaced with new terms as adopted from the new information management (and delivery) process introduced by the ISO 19650 [260].
x. Remedies - Security			
Security minded provisions	-	8	Security minded provisions of the CIC BIM Protocol are excluded within the new proposed Information Protocol. The reason for this change is that the existing provisions are based on PAS 1192-5. The subsequent international standard is in the making currently as being ISO 19650-5. It is intended not to stick with any other information management standard and therefore the adoption of PAS 1192-5 left for the end user's decision. Appropriate appendix (Appendix H) for any security minded provisions is provided for and CIC BIM Protocol's relevant clauses (including clauses regarding to sensitive information apart from the Clause 8 as alterations to other clauses of the Information Protocol) may be incorporated, as deemed necessary.

5. APPENDICES

The clauses of the information protocol provide a framework for the obligations of parties and an understanding of how the information production and delivery processes are governed within the appointment. In order to go further in detailing specific obligations of parties and management of information, specific to any given project and its appointments, there are a set of appendices designated to be a part of the information protocol.

The first appendix (Appendix A) is the Information Management Assignment Matrix. The matrix is further to be detailed in the following clauses of this section. In brief it does clearly sets out boundaries of each party's responsibility with respect to each information management activity. Within the information protocol provided as an appendix to this study, the matrix provided as an informative table similar to the Annex A of the ISO 19650-2:2018. When needed, parties may alter the table to suit with their intended responsibility distribution.

Another appendix to the information protocol is the Exchange Information Requirements (Appendix B). The appointing party shall define their exchange information requirements prior to invitation to tender per each appointment, which is intended to be met by the prospective lead appointed party during the appointment. According to the ISO 19650, the appointing party shall consider following in the making of the EIR:

- Organizational information requirements
- Asset information requirements
- Project information requirements

The appointing party also required to define their acceptance criteria per each information requirement as a minimum reference point for the delivery team, considering project's information standard, information production methods and

procedures and the reference information and shared resources as appropriate to in order to save to the extent that the information to be produced by the delivery team will be satisfactory in terms of OIR, AIR and EIR.

The project's information standard document is also attached to the information protocol (Appendix C). One key standard is the ISO 19650 family that should be incorporated into the information standard. Apart from the standard for management of information, there might be additional national and/or international standards guiding various concerns related to organization and classification of information as well as project management and likes. The identification for the system to be adopted as the level of information need for the information to be produced by the delivery team is also intended to be provided within the information standard.

Following the information standard, the Delivery Team's BIM Execution Plan takes place as the Appendix D to the information protocol. It is the document that defines the adopted strategy by the delivery team for the information delivery process. It includes, not limited to, information related to delivery process such as individuals assigned with information management functions, delivery team's federation strategy agreed by the appointing party, delivery team's high-level responsibility matrix, delivery team's confirmation of agreed upon proect's information standard and information production methods and procedures, and a schedule of IT infrastructure including software and hardware information.

Master Information Delivery Plan is another attachment to the information protocol. This plan is the compilation of Task Information Delivery Plans (TIDP) from each task team. The TIDP of a task team includes information regarding to delivery planning of the information containers to be produced by the relevant task team. It is in compliance with the project's information delivery milestones, task team's responsibilities within the delivery team's responsibility matrix, the lead appointed party's information requirements, shared resources and the available time schedule for the task team to produce the information containers.

Apart from quality and planning purposes, another key issue to be addressed through this information protocol is the ways to resolve potential inconsistencies and conflicts. Supplementary to clause 2 of the information protocol related to the conflict resolution, the Appendix F is intended to be drafted by parties in order to set

out the appropriate methodology to follow in case of an inconsistency during the project delivery or a conflict between parties.

Abovementioned appendices, as leaving the option to adopt all to parties, are intended to be incorporated into any project that the information protocol is being used. An accomplished use of the information protocol is only possible with incorporation of all appendices from A to F (except where in example the agreement has sufficient provisions for conflict resolution, and parties agree to exclude the clause 2 of the information protocol, then the appendix F may not be required to be accommodated). Following appendices are also defined as optional provisions that parties may opt for incorporating them into the information protocol as deemed necessary:

- Appendix G – Particular Clauses for Amendments: may be required for supplementary clauses in case of any additions/amendments to the information protocol
- Appendix H – Particular Clauses for Compliance with Specific Standards and Processes: this appendix is intended for the consideration of specifying any security minded requirements. CIC BIM Protocol's related clauses and appendix C may be adopted as appropriate and PAS 1192-5 may be complied with, hinge upon agreement by parties. Security related provisions of CIC BIM Protocol have been completely excluded as the ISO 19650-5 have not been issued and it is admitted to leave the choice of any other standard to the parties.
- Appendix I – CDE and Workflow Instructions: intended for use in case it is not considered satisfactory the requirements of EIR with regards to adoption of the CDE workflow by the delivery team, in order to guide and bind parties to achieve an efficient common data environment process throughout the project delivery.
- Appendix J – Information Delivery Milestones: The EIR and BEP are, ideally, expected to be in compliance with the work program and all relevant information delivery milestones set out by the appointing party. Provision of complete information delivery milestones can be of use in case of any potential dispute with time extension and/or cost compensation concerns in

order to analyse outcomes of such events entitling the lead appointed party with extension of time, addition of time or cost reimbursement.

- Appendix K – Delivery Team's Mobilization Plan: As informed by the ISO 19650-2:2018, the mobilization plan indicates approaches, timescales and responsibilities for various aspects including testing capabilities of and delivery strategy established by the delivery team, testing the CDE process, procuring, implementing, configuring and testing IT infrastructure, preparing the delivery team for a successful delivery process. Provision of the delivery team's mobilization plan is also intended for the potential use in case of a dispute between parties to assess the extent the delivery team is responsible for the work subject to a failure causing time or cost related issues.
- Appendix L – Delivery Team's Risk Register: It is also intended with the possible incorporation of the results of delivery team's risk assessment to the information protocol as to measure the extent that the delivery team is responsible for the work subject to a failure causing time or cost related issues.
- Appendix M – List of Reference Information and Shared Resources: These are ideally already traceable via the CDE, but it might be of interest between parties to incorporate a list of reference information and shared resources provided by the appointing party in order to secure the rights and responsibilities arising from the transaction of such information. It is advised to provide with the date of delivery and details as deemed necessary by the appointing party.

Detailed information to be provided in the following sections regarding to appendices A to F. Section 5.1 covers the Appendix A and identifies the information management functions concept. Section 5.2 indicates explanation regarding to Appendix B, the exchange information requirements. Section 5.3 identifies what standards shall be incorporated into Appendix C, project's information standard and Section 5.4 further clarifies the Level of Information Need and its methodology which required to be part of the project's information standard. An example of Level of Information Need methodology also given in this section. Sections 5.4 and 5.5 provides understanding for the information delivery, common data environment and

workflow notions within the scope of BIM execution plan and master information delivery plan concepts. Section 5.5 also provides additional guidance for the preparation of Appendix I (CDE and Workflow Instructions). Further Section 5.7 broadly describes appendices D and E, which are respectively the BEP and the MIDP.

5.1 Information Management Assignment Matrix and Information Management Functions

According to ISO 19650-1:2018 standard, a responsibility matrix is defined as “chart that describes the participation by various functions in completing tasks or deliverables”. It requires the responsibility matrix to indicate the relationship of the information management functions with information management tasks of the project or asset, or directly the information deliverables.

The information management functions are generally consisting of appointing party, lead appointed party, other appointed parties and other third parties if there are any. Information management tasks are specified in the ISO 19650-2:2018, and the Annex A to this standard indicates an informative matrix including these tasks in one of the axes. Information deliverables may vary depending on the project scope and it is a decision for the appointing party to include these in the information management assignment matrix. Each function may have a level of participation as specified in the informative Annex A of the ISO 19650-2:2018, Information management assignment matrix [217] (pp.24-25). For this study, it is decided to use the same interface and same participation levels as indicated in the standard, and the matrix is designed to indicate only the information management tasks as designated in the standard. Abovementioned participation levels are as follows:

- Responsible for undertaking activity
- Accountable for activity completion
- Consulted during activity
- Informed following activity completion [217] (pp.24-25)

Depending on the scope or the complexity of an intended project, the responsibility matrix draft can be updated to have more (such as approvals) or less (such as each

function is only responsible or not) participation levels. Also, additional information management tasks may be included as required. A reference assignment matrix that is prone to project-specific updates filled out to be incorporated in the protocol which is to be set as the start point for any specific project to adopt the intended protocol, and it can be seen in the Table 5.1. The information management tasks where responsibilities left blank are to be further designated with appropriate participation levels by the information manager of the appointing party during the planning stage of the project.

The responsibilities should be clearly set out during the information management planning stage considering the requirements of the standard and the project specific requirements and agreements. The clarity of the responsibility matrix is important to conserve a healthy progress for the following stages of the information management process. Lack of clarity in the responsibility matrix may result in higher number of disputes between contracting parties.

Table 5.1 : Information management assignment matrix (informative).

No	Responsibility	Appointing Party	Lead Appointed Party	Appointed Party
1	Appoint individuals to undertake the information management function			
2	Establish the project's information requirements			
3	Establish the project's information delivery milestones			
4	Establish the project’s information standard			
5	Establish the project's information production methods and procedures			
6	Establish the project’s reference information and shared resources			
7	Establish the project's common data environment			
8	Establish the project's information protocol			

Table 5.1 (continued): Information management assignment matrix (informative).

No	Responsibility	Appointing Party	Lead Appointed Party	Appointed Party
9	Establish the appointing party's exchange information requirements			
10	Assemble reference information and shared resources			
11	Establish tender response requirements and evaluation criteria			
12	Compile invitation to tender information			
13	Nominate individuals to undertake the information management function			
14	Establish the delivery team's (pre-appointment) BIM execution plan			
15	Assess each task team capability and capacity			
16	Establish the delivery team's capability and capacity			
17	Establish the delivery team's mobilization plan			
18	Establish the delivery team's risk register			
19	Compile the delivery team's tender response			
20	Confirm the delivery team's BIM execution plan			
21	Establish the delivery team's detailed responsibility matrix			
22	Establish the lead appointed party's exchange information requirements			
23	Establish the task information delivery plan(s)			
24	Establish the master information delivery plan			
25	Complete lead appointed party's appointment documents			

Table 5.1 (continued): Information management assignment matrix (informative).

No	Responsibility	Appointing Party	Lead Appointed Party	Appointed Party
26	Complete appointed party's appointment documents			
27	Mobilize resources			
28	Mobilize information technology			
29	Test the project's information production methods and procedures			
30	Check availability of reference information and shared resources			
31	Generate information			
32	Undertake quality assurance check			
33	Review information and approve for sharing			
34	Information model review			
35	Submit information model for lead appointed party authorization			
36	Review and authorize the information model			
37	Submit information model for appointing party acceptance			
38	Review and accept the information model			
39	Archive the project information model			
40	Capture lessons learned for future projects			

In order to maintain an efficient management of information; responsibilities of all parties and individuals from these parties with information management responsibilities assigned with regards to the information management functions as defined by the ISO 19650 should be distinctive. Each information management function needs be addressed to a party, and to an individual within the party through an appointment [215] (pp. 18-19).

As per ISO 19650-1:2018, information management functions are mainly divided into three function groups as follows:

- Asset information management functions
- Project information management functions
- Task information management functions

In addition to these, for complex projects, a possibility to designate additional functions to govern the facilitation of information arises as to help an effective information management within a collaborative working environment [215] (pp. 18-19). For this study, this option kept excluded as a further decision for prospective user. Distribution of information management functions between parties is intended to be identified in this appendix of the protocol.

Asset information management functions are determined based on the complexity of the asset. Depending on the complexity of the asset, the need for the management function may change. Also, management functions for asset information management should be addressed to organizations and/or individuals throughout the asset life cycle. Arising from a generally long-term life duration of an asset, addresses of these functions are prone to change. These functions are to be assigned to staff from the appointing party, and their responsibility includes validation and authorization of information delivered by appointed parties which to be incorporated into the AIM [215] (pp. 18-19). As a minimum, an individual from the appointing party shall be appointed as the Asset Information Manager. This is a project specific role and do not necessary to be mentioned within any appointment documents. It is also possible for the appointing party to assign this functions to a specific 3rd party on behalf of themselves. In that case, the prospective 3rd party may be incorporated into the information management assignment matrix and their responsibilities would be clearly identified [259].

Project information management functions are also determined based on the complexity of related projects. These functions should be addressed to organizations and/or individuals throughout the project life, and addressees can be changed with respect to the procurement process of the project. Responsibilities of these organizations and/or individuals are including setting out information standards for the project, methods of production of information and leading the management the

common data environment for the project. Appointing party and lead appointed parties are to be partially responsible for project information management functions (as functions being distributed by the appointing party) [215] (pp. 18-19).

Task information management functions are the information management functions that are distributed where a delivery team divided into task teams. Task information management functions are dealing with task information and its delivery and also coordination between information associated with different tasks [215] (pp. 18-19).

For each information management function, a time frame is to be set and the allocation route to be determined, as far as applicable within the protocol [259]. This will guide parties to collaborate in accordance with the asset and project life cycle requirements and avoid clashes between responsibilities and authorizations of parties at any given time within the project life cycle. This will also keep the whole information management process in alignment with the ISO 19650-1:2018 standard. These could be addressed within the appendix G for each individual assigned with an information management function only for a limited time frame. If time frames are not scheduled initially, or not possible to be foreseen, then a clause could be drafted also within the appendix G with appropriate terms defining conditions for a change in the function. If such function that may requires a further change is a sole responsibility of the delivery team, then these could be mentioned as part of their relevant TIPDs.

Task information managers for the delivery team members that are assigned for individual tasks to also be identified in TIDPs. If desired, a reference can be made to the BIM Execution Plan for specific task information management function titles [259]. This clause is expected to be reviewed by the appointing party, during the information management planning stage and prior to the appointment, and any additions and/or exclusions can be made as per project-specific requirements.

5.2 Exchange Information Requirements

The exchange information requirements provide managerial, commercial and technical aspects of production of the project information. Aspects related to management and commerce are including the project's information standard and production methods and procedures to be implemented by the delivery team. These

also intended to be addressed and confirmed in terms of compliance by the delivery team within the BIM execution plan. Project's information standard also required to be attached to the information protocol. In such case that the EIR includes the information standard to the extent necessary for the implementation of the information production, the appendix presenting information standard shall be coherent with the EIR. It shall be noted that the EIR is an appointment specific document, contrary to the project's information standard which is a project wide document. Any potential addition/amendment to the project's information standard shall also be indicated within the EIR or it shall be congruent.

On the other hand, the technical aspects of the EIR specifies in detail the information needed to address the PIR and also the EIR should be compatible with the AIR as the asset information requirements shall be satisfied in order to provide relevant project information to further be incorporated into the AIM. It should be noted that these requirements are intended to be an appendix of the information protocol and to be incorporated into appointments, therefore they should be expressed in such way suitable [217] (pp. 10-11). It is intended that the EIR per each specific appointment within a project should ideally be specified individually. Shall the appointing party desires to publish a single EIR document and specify exchange information requirements for the entire project, then a relevant exchange information requirements distribution matrix to work with the scope of works defined for each delivery team is advised to be provided for. By doing so the appointing party may avoid any potential scope clashes and conflicts between parties which would contradict with the purpose of the information protocol to support collaboration.

Exchange information requirements is the ISO 19650 compliant correspondent of the Employer's information requirements of the CIC BIM Protocol which is drafted by having the PAS 1192 series as its reference information management standard. It have been incorporated into the information protocol in such way similar to the CIC BIM Protocol with the alterations of its definition to match with the ISO 19650 standards. Project Procedures section of the Information Particulars of the CIC BIM Protocol is now mostly presented within the EIR, with the rest being provided for as separate appendices, including requirements for:

- The information and assistance required in respect of Asset Information Model (as the EIR is fed by the AIR).
- Level of definition (methodology regarding to LoIN is now presented inside the project's information standard, and relevant particulars related to each information container's levels are to be provided within the EIR).
- The agreed approach in respect of different software formats/interoperability (requirements to be incorporated within the EIR and compliance confirmation/proposals for alteration to be addressed within the pre-awarding and final BEPs.
- Specified information which is the information to be provided by the delivery team which is not stated in the responsibility matrix (these to be specified within the EIR and the correspondence to be given within the BEP, to the extent where security requirements specifies otherwise) [260].

5.3 Project's Information Standard

In order to achieve the desired outcome from a project, it is expected that all contributory parties shall work in compliance to anticipated standards and with required methods by adopting appropriate procedures. As a part of the information management process; information standards that are required to be complied with are initially set out as a project specific document and shall be incorporated into all appointments. In this study, project's information standards are intended to be included in the appointment documents through as an appendix to the information protocol. This establishes a binding ground for all the parties to ensure that all the works they conduct on the purpose of producing and sharing information are in line with suitable standards and the way they undertake their responsibilities are inclining with the right way of working.

The information should be based on a solid standard specified by the appointing party as per their requirements with the consideration of their transfer of information within the appointing party and with other parties, and with other projects, their utilization of information for asset management, development level of the information and the way of information structuring [217] (pp.3-6). A critical information standard that all parties are required to be complying with is the ISO

19650 series as being the core source of reference for information management processes.

Also, it is possible that parties may require to incorporate national or international standards/specifications guiding aspects such as information organization and classification or asset and project management. Quality assurance for the information shall be set out within information requirements of the appointing party. To ensure the agreed quality standards, these requirements included into the intended protocol with following breakdown:

- Information format
- Delivery format
- Information model structure
- Classification method of information
- Data attribute names for all information deliverables

Further, the ISO 12006-2 standards set out principles for object classification and the ISO 12006-3 sets out object information criteria, which the information deliverables are also required to be compliant to and this shall be a part of information standard of the project [215] (pp. 23-24).

In addition to these standards, the appointing party should consider the transfer of information and utilization of information for asset management aspects and define a way for sufficient handling of the information from project information model to the asset information model. An example for the procedure of transferring information from PIM to AIM is utilization of a non-proprietary data format such as Construction Operations Building Information Exchange (COBie) [260].

The methodology to define the appropriate level of information need for information containers also shall be incorporated as part of the project's information standard. As per the specified methodology adopted by the parties, the level of information need shall be defined for all the specific information types/groups in the exchange information requirements. Then as per the EIR, the task teams to define each information container with their respective level of information needs within relevant TIDPs [259].

5.4 Level of Information Need

According to ISO 19650-1:2018, the level of information need (level of definition as previously accustomed by the PAS 1192 series) defined as:

"The level of information need of each information deliverable should be determined according to its purpose. This should include the appropriate determination of quality, quantity and granularity of information. This is referred to as its level of information need and this can vary from deliverable to deliverable."

With the level of information need, the appointing party defines required information detail for the graphical content of the models, as well as the non-graphical content of the models. A metrics system defined within the PAS 1192-2 provided as an example for the proposed protocol as given below:

- Brief: Initial basic information to provide the brief, performance requirements and performance benchmarks together with site constraints.
- Concept: First response to the brief, visual intent and outline performance requirements. Suitable for early design development, analysis, early rough estimations and coordination.
- Definition: Scaled and coordinated model. Response to brief, visual intent and performance information to a degree that can be used for analysis, design development, planning, estimating and early contractor engagement.
- Design: Scaled and coordinated model that can be utilized for verification of compliance with regulations. Suitable to be the reference point for specialist design models. Information can be used for fabrication, planning, estimating and coordination as wel as contracting with a target price/guaranteed maximum price.
- Build and Commission: Accurate model of the asset (before and during the construction) comprising specialist models and related model attributes. Suitable for installation planning and capture of as-installed information.
- Handover and Closeout: Accurate record of the asset as constructed, comprising all required information for operation and maintenance purposes.
- Operation: Updated record of the asset at a specific time point to incorporate major changes made in the asset following the handover [216].

Each of the abovementioned definition informs a level for a specified information container to satisfy the reason it is required for. The LoIN describes the minimum required information detail in order to satisfy each relevant requirement [215] (pp. 23-24). LoIN per each specific part of the information deliverables must be specified clearly in information requirements from the appointing party (EIR). Then as part of the planning activities by the delivery team, it must be defined for each information container. This is to be done by each relevant task team within their TIPDs. Then as part of the MIDP, all information containers are provided with a LoIN within the scope of the information protocol. LoIN information is also useful for the delivery team's federation strategy within the BIM execution plan.

Within the scope of the information protocol, the level of information needs are defined within the EIR as per identified methodology within the project's information standard, and the appointed party is obliged to conform with the required information level to the satisfaction of EIR and other related requirements.

5.5 Information Delivery

According to ISO 19650-1:2018, "the appointing party should define the occasions or times when they have to make key decisions, and precisely what information they require from the delivery team to make each decision". Each delivery milestone and their respective scope of deliverables should be clearly defined by the appointing party, and the related document (exchange information requirements) is addressed with corresponding dates per each delivery milestone where the appointing party require input from lead appointing party to make a key decision. Information delivery milestones should be determined in accordance with the project's plan of work.

Not only the information standard but also the project's information production methods and procedures also shall be established by the appointing party, considering available asset information, procedures in creating the new information (reviews, approvals), hand out of information to the appointing party and also security concerns related to the information exchange [217] (pp.3-6). Any potential security concerns related to information exchange should be clearly defined within the exchange information requirements by the appointing party, and lead appointed

party should clarify if any additional requirements would be applicable in order to contribute to the collaborative result of work and increase its efficiency. Sensitive information, which is intended to be kept separated from the CDE process as defined in the information requirements by the appointing party as part of the security requirements shall be clearly examined and confirmed by the appointed party. The handling of these information shall be defined within the planning activities by the lead appointed party and relevant procedures shall be summed up in the BIM execution plan [257] (pp. VI-VII). Information production methods and procedures are also required to be addressed by the lead appointed party within delivery team's delivery strategy within the BIM execution plan.

Besides setting out abovementioned requirements, the appointing party also provides reference information and shared resources for the project to the lead appointed party, and other appointed parties through the lead appointed party. Obligations and responsibilities deriving from these resources such as available asset information and other shared templates and libraries are intended to be mentioned within a specific appendix to the information protocol, if desired by parties. Ideally these information are already traceable within the CDE, but such attachment to the information protocol might be of interest of parties in order to confirm which information have been provided to the delivery team in case of a further conflict required delay and cost assessments.

5.6 Common Data Environment (CDE) and Workflow

A common data environment (CDE) is a process where the information in the form of files, documents and other related data are stored, managed and distributed through a workflow. It is an assembly of relevant hardware, software and the workflow which is set out by appropriate procedures below [257] (p.8). Both during the asset management and project delivery, the information is intended to be managed through the CDE process.

Collaborative production of information and information model delivery stages (being part of project delivery) of the information management process as set out in ISO 19650-2:2018 are to be managed through a CDE solution and an adequately defined workflow. The required CDE system, including software information (if any)

and the using instructions to be provided by the appointing party prior to the appointment, and these should be addressed as the delivery team confirms their compliance within the BIM execution plan. After the appointment, the appointing party may allocate the management responsibility of the CDE to the lead appointed party or a third-party until the end of the relevant project delivery period. The procedure and timeline for handover to be clearly stated as part of the assignment of information management functions.

Information containers placed in the CDE shall have a progress state per each, the state can be one of the following:

- Work in Progress
- Shared
- Published
- Archive

Progress states for information containers are as per the ISO 19650-1:2018 criteria, and within the standard concept of the states given as an indicative figure, for a better understanding, as indicated in the Figure 5.1.

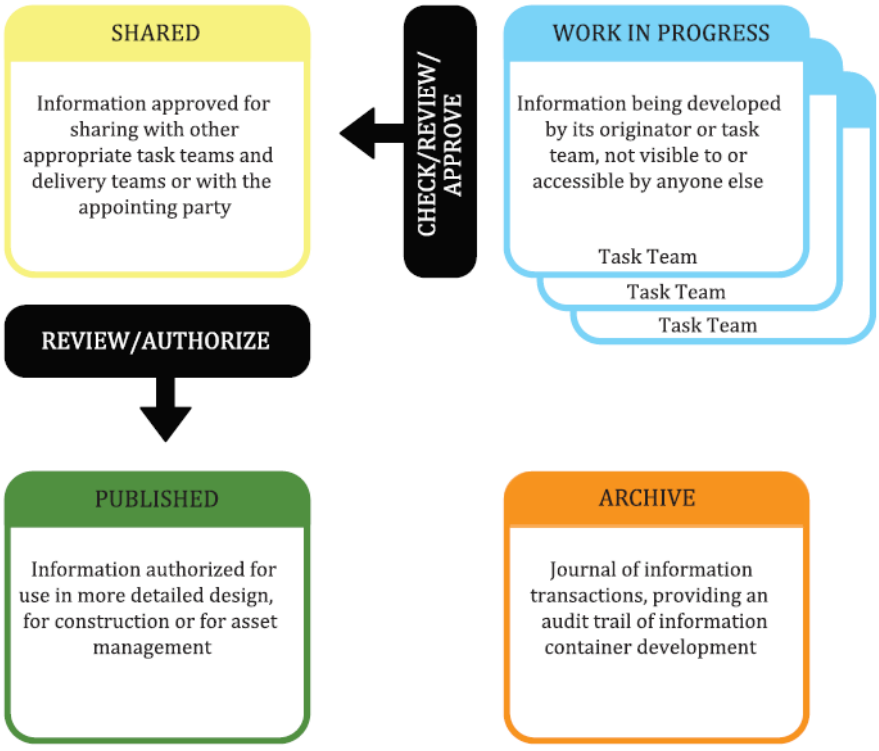

Figure 5.1 : CDE Workflow Concept (Copyright: ISO 19650-1:2018)

The archive state is to store all existing information containers which have been shared and published as a part of the information management process. This enables checking and investigating the development of current information by being able to reach to previous states during its production and development.

Requirements for the workflow process are to be set out by EIR, and the appointing party may incorporate the CDE and workflow instructions as an appendix to the information protocol to confirm the obligations of parties deriving from managing the information through the CDE process. Confirmation of requirements to be set out as to indicate a general margin of agreement by the parties, which are to be as follows:

- Information containers available at a given time in the CDE can exist in one of the three stages as work in progress, shared or published (The archive state is to provide a journal of all information container exchange history, archived containers are not considered as a part of the ongoing information exchange process).
- Change from one state to another requires approval and authorization processes.
- Each information container shall have a revision code and a status code (status of its state) such as R01 as to indicate its revision and FC (for construction) as to indicate its permitted use.
- An information container, through all its states at a given time, is in the responsibility boundary of its producer, and only the producer (team/organization) of that information container is allowed to change the content.
- An information container in work in progress state shall not be visible or accessible to other task teams than its producer.
- Check/review/approve transition shall be made by the originator of the relevant information container(s).
- An information container in its shared state shall not be editable by any parties. In the case where an amendment is required, the information container shall be returned back to the work in progress state and resubmitted

after the required editing by its own producer. Revision codes to be applied as appropriate.

- Authorization is done with the consideration of the subjected information container's compliance with relevant information requirements in terms of integrity, exhaustiveness, coordination and accuracy. When the information container complies with all the requirements, then its state switches to published. In the case of incompliance with the requirements, the switch takes action to the work in progress state for appropriate revisions and the same procedures as defined above to be repeated.
- Only the information with published state (and also archive state if necessary) may be incorporated into the Asset Information Model. Also, at the completion of any project, the final Project Information Model consists of information containers only in the published and archive stated [215] (pp. 24-26).

5.7 Information Delivery Planning

Planning for information delivery takes place as a requirement for the lead appointed party within the intended protocol. Principals for information delivery planning should be based on initial boundaries set out by the appointing party, as planned from the beginning based on the current situation and requirements expected to be compliant with the existing asset and project information, and also supported with previous studies during the concept design of the project (in the case of a design build awarding). Before the awarding and engagement with the clauses of the information protocol, the lead appointed party must have been delivered a pre-awarding planning in order to enable the appointing party to review, according to ISO 19650-1:2018. An information delivery plan must be based on answering mainly the following:

- How to satisfy exchange and asset information requirements;
- Time based planning of deliveries, with regards to milestones and deadlines;
- Method of delivering the information;

- Federation strategy of the information, and how to be compliant with the strategy;
- Scope of the information to be delivered;
- Responsibility matrix for the information deliverables;
- Recipients of the deliverables [215] (pp. 21-22).

The brief of the expected planning from the lead appointed party will be in a report form called as the delivery team's BIM Execution Plan (BEP). An initial BEP must have been delivered prior to awarding with the relevant draft information regarding to abovementioned concerns. This forms a part of the delivery team's tender response and it is subject to the appointing party's review. The Figure 5.2 indicates the delivery team's tender response [263]. After the awarding, the final BEP shall be delivered by the lead appointed party, including alterations to address appointing party's considerations following the pre-awarding BEP, with satisfying information to exchange information requirements and in compliance with the existing planning activities [264]. Within the information protocol, the lead appointed party is expected to deliver finalized planning information regarding to as follows:

- Key information responsibles (including the Project Information Manager),
- Responsibility matrix,
- BIM goals and strategy,
- IT solutions: Software information, exchange formats and data management systems,
- Time schedule for information deliverables as per agreed milestones and deadlines,
- Procurement and delivery methods explained,
- Information supply chain capability assessment confirmation,
- Procurement strategy and compliance guarantee explained for the exchange of information between the lead and other apppointed parties,
- PIM introduction: origin and orientation (geo-references et cetera),
- Compliance with CDE explained,

- Document naming and CAD standards explained in compliance with requirements,
- Compliance with the federation strategy explained,
- Clash detection strategy explained,
- Information container breakdown structure,
- Any additional design information as appropriate,
- Security Implications (if any) as required by the appointing party,
- Any proposed alterations for the project's information standard and information production methods and procedures (this is part of the pre-appointment BIM execution plan, the final version will present compliance with agreed upon information standard as well as information production methods and procedures),
- Best practices and example use of BIM softwares, and
- Any other information if required, such as meetings and workshops schedule.

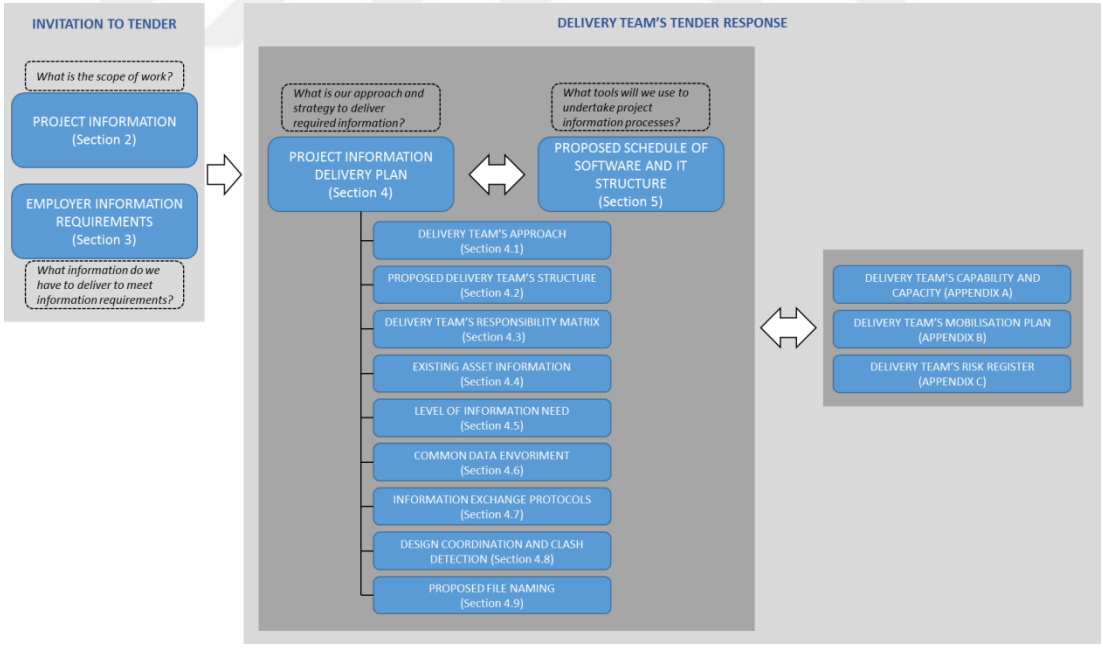

Figure 5.2 : Structure of Delivery Team's Tender Response

As per the expectations set out by the appointing party, based on ever-changing environments of construction projects, any additional explanation for the planning can be included to the BIM execution plan as deemed necessary by the delivery

team. Above requirements are accepted to be the base of an information delivery planning activity [265] [216] (pp. 16-17).

Master information delivery plan (and task information delivery plans as part of it) is also another document that shall be incorporated into appointment documents as per ISO 19650 requirements.

Master information delivery plan shall include a confirmation of resource availability and self-assessment with regards to the responsibility matrix, an indication of needs for adequate training and education, and cooperation of task teams' task information delivery plans (TIDPs). A list of all the information deliverables also shall be incorporated into the MIDP, and therefore the BIM execution plan.

Per each task team, an own task information delivery plan (TIDP) shall be created and these further to be incorporated into the MIDP by the lead appointed party as appropriate. TIDPs set out task teams' corresponding delivery plans (compliant with design and construction programmes), team members' responsibilities and appropriate method of information transfer in between team members [216] (pp. 16-17). MIDPs and TIPDs are to be in compliance with their corresponding definitions given in the ISO 19650-2:2018 as part of the project information standard.

Delivery team's mobilization plan is also another aspect that the appointing party may require it to be incorporated into the information protocol as an attachment. This would be a reference to determine the role of the lead appointed party and its delivery team in a potential case of conflict or inconsistency.

6. EVALUATION

Within the scope of previous Sections 4 and 5 of this study, the proposed Project Information Protocol, as a draft form consisting of additional provisions concerning the information management process of a project via utilizing BIM and its appendices to provide satisfactory input and required amendments in order to enable a working governance system, has been set out and discussed. Prior to setting out the information protocol, several barriers hindering an effective BIM adoption and a collaborative working environment were identified through an intensive literature survey. As part of this study, the aim for the establishment of the information protocol was to overcome or contribute to overcoming of a number of these barriers through the provision of a standardized legal coverage to the information management process.

Further to the identification of barriers, during the selection of the most suitable existing way of legal governance, findings of a previous study have been examined which compares most common ways of governance published by different organizations in terms of how they address 13 identified legal risks arising through the adoption of BIM. Then these findings are compared with the second edition of the CIC BIM Protocol, which is the defined reference point in the preparation of the proposed information protocol.

In this section, first the legal risks given in the section 2.5 are evaluated from the point of view of this study together with the summarized evaluation of the proposed information protocol is evaluated in terms of how it answers each of above-mentioned risks. Results of the first evaluation is presented in the Table 6.1. In the sequel the resulting proposed information protocol is again evaluated in the Table 6.2 against the barriers provided in Section 2.1 in order to identify the information protocol is expected to contribute in overcoming of which barriers and how is the contribution.

Table 6.1 : Evaluation of PIP against BIM-use related legal risks.

Risk	Strategy proposed per literature	Remarks on the proposed strategy per this study and PIP response
IP	IP copyrights shall remain with the provider of information.	Widely accepted best practice. Same approach adopted in the PIP.
Liability	Provider of information is responsible for its obligations and shall be liable for its product.	The extent shall be clear and termination terms shall be defined. Liabilities clearly set out in the PIP to the extent where the provider of information is no longer responsible (i.e. data fraud after the submission of the information container).
Contract conditions	There shall be a CDE, provided by the delivery team, and a common file format should be developed in BEP.	CDE is best to be established before the appointment, ideally by the appointing party as advised per the ISO 19650-2:2018. File format can be addressed per the EIR and project's information standard. PIP obliges for the provision of the CDE, the responsible party can be defined within the Matrix. Ideally, the appointing party can be responsible. Project's information standard caters for software standards etc. The EIR caters for which information type is required in which software format. A structured way of delivery is established through the PIP and its appendices.
Interoperability	Delivery system to be addressed in BEP, client to direct the consultant for deliverables. Common software to be decided in BEP.	Interoperability, file format and software related issues are intended to be governed by information protocol, information standard, EIR and BEP as appropriate, which are to be incorporated into appointment documents. ISO 19650 defines purposes of these documents, and principles of requiring and delivering information (including concerns related to waste of information by either over-production or redundant requirements). Also the information protocol is essential to guide parties on digitized information exchange and interoperability. In addition to the contract conditions related risk (which addresses most of this risk in advance), the exchange of digitized

Table 6.1 (continued): Evaluation of PIP against BIM-use related legal risks.

Risk	Strategy proposed per literature	Remarks on the proposed strategy per this study and PIP response
Interoperability (cont'd)		information clause provides for the interoperability concerns to ensure both parties are responsible to the extent the defined requirements. Boundaries set to avoid infinite requests between parties in terms of software solutions which would eventually block the effectiveness of the process.
Procedures	Client to appoint an information manager to lead BIM execution meetings.	Information management process is defined in the ISO 19650-2:2018. Information management assignment matrix can be adopted for distribution of activity responsibilities. An information protocol is essential to provide governance through the appointment. PIP adopts the same approach and obliges for the appointment of a project information manager throughout the project, but the responsibility may be transferred to the lead appointed party or a third party.
Security	Information to be stored in network servers with monitored access, all revisions of files shall be stored and registered in a log.	For security purposes, PAS 1192-5 or further the upcoming ISO19650-5 can be adopted (security-minded BIM). Appropriate consideration can be incorporated into the information protocol, CIC BIM Protocol includes reference security concerned provisions. For delivery, storage and archiving, CDE and workflow are intended to be the appropriate process. These shall be clearly defined to address related concerns. PIP do not cater for the security minded provisions as they are not yet standardized by ISO (ISO 19650-5 is under development during the preparation of this paper), but provides for appropriate appendix so that any security minded provisions may be included, i.e. relevant CIC BIM Protocol clauses. Strategy proposed in the literature is already covered by the appropriate adoption of CDE and workflow process, and with the security minded provisions, binding guidance o security may be covered.

Table 6.1 (continued): Evaluation of PIP against BIM-use related legal risks.

Risk	Strategy proposed per literature	Remarks on the proposed strategy per this study and PIP response
Cost	Client to bear cost of model development.	Tender process does exist to make a financial agreement to the interest of both parties. PIP does not provide for such condition. Parties agree for a specified fee with the awarding. The delivery team is responsible for information production and tenders with the pricing considering its obligations. Client to bear cost of model development does not distribute risk and is unhelpful in terms of collaborative working. Even distribution of risks may result in increased efficiency.
Standardization	Legal framework for BIM process to be appended to the contract.	ISO 19650 is the new standard to guide information management process. Bodies publishing standard contract forms have different approaches for BIM. An information protocol is advised (by the ISO 19650) to be incorporated into agreements per ISO 19650. Through the incorporation of it, a legal framework can be drawn for BIM execution. The execution must be in compliance with the ISO 19650. The PIP is prepared to provide the legal framework for the information management through BIM according to ISO 19650. It is prepared to be an appendix to a contract form.
Skill and care	All parties are responsible for their obligations regarding to provision of information.	Parties shall be accountable for their obligations. An information protocol is essential to determine boundaries between responsibilities of parties regarding to information management. PIP provides for obligations of parties involved in an appointment, and also provides for liabilities arising from the use of information. Incorporation of the PIP into agreements is intended to cater for increased clarity between responsibility boundaries of parties.

Table 6.1 (continued): Evaluation of PIP against BIM-use related legal risks.

Risk	Strategy proposed per literature	Remarks on the proposed strategy per this study and PIP response
Acceptableness	Digitized information and BIM (archived with appropriate time information) to be considered as part of the contract documents.	Incorporation of information protocol together with EIR, BEP, MIDPs and information standard into appointment documents, as specified in ISO 19650, can be a valid solution for the risk in question. The PIP includes all abovementioned documents as appendices and appropriate references made to these appendices within the clauses informing obligations of parties to provide for descriptions detailed as necessary. By doing so, these documents constitute bindingness for contracting parties.
Modeling Challenges	Information model to be maintained by the consultant in compliance with the BEP.	Undertaking capacity and capability assessment, risk assessment and preparing a mobilization plan are part of the information management process as per the ISO 19650 which are to be done by prospective providers of information to enable clients to evaluate proposals by bidding parties. Following initial assessments, the information production follows BEP and MIDP. All these preparations are intended to help delivery team to overcome difficulties in modeling. Expressed methodology is adopted by PIP and is expected to oblige the delivery team to plan the activities and structure the information production and delivery phases thus contribute in overcoming modeling challenges.
Validation	For local administrations purposes, non-editable 2D drawings to be produced in compliance with BIM protocol and BEP.	Information can be extracted from deliverables in any form suitable to local requirements with ways of validation suitable to local best practices. A generic governance solution to address this concern is likely to be not helpful and also not necessarily deemed essential. Parties may consider this risk initially to define a methodology for local validation.

Table 6.1 (continued): Evaluation of PIP against BIM-use related legal risks.

Risk	Strategy proposed per literature	Remarks on the proposed strategy per this study and PIP response
Validation (cont'd)		These considerations can be addressed through the EIR within the BIM process, where the appointing party may provide for what information is required in which form and what format. Also, these requirements may be supported within the project's information standard by providing the methodology and definitions of required formats for the relevant information deliverables. PIP provides for the necessary flexibility for parties to adjust the framework as required per each specific project.
Legislation	"If BIM is used, then this addendum shall govern" approach to be adopted.	As advised by the CIC BIM Protocol, an incorporation clause may be used within special provisions of the contract. CIC BIM Protocol also defines which clauses of it precedes the agreement in which way. The protocol's way of governance may require alteration per contract it is appended to, as different types of contracts accommodate diverse provisions. PIP adopts the same approach as the CIC BIM Protocol. An incorporation clause is advised to be incorporated into the contract. The protocol specifies the order of precedence for occasional provisions as deemed necessary.

Table 6.1 identifies how legal risks in question are assessed and addressed by the proposed Project Information Protocol. After ensuring the information protocol is satisfactorily capable of mitigating potential risks, the focus is given onto the factors consisting barriers to an effective BIM execution and collaboration to be established and how the Project Information Protocol is helping to overcome these barriers. Table 6.2 summarizes the evaluation concerning the potential contribution of the proposed information protocol.

Table 6.2 : Potential contribution of PIP in overcoming BIM adoption and collaboration barriers.

Category	Barrier	Main References
Technology and technical feasibility	Inadequate technological support: software and hardware limitations, complexity of usage requirements	PIP has no such recognizable direct or indirect contribution (potentially) in overcoming inadequate technological infrastructure. This is related to investment costs and availability of tools. Overcoming culture and management related barriers may help to increase the investment but this barrier is more related to high prices in the market, complexity of tools and everchanging and constantly updating nature of the software business.
	Interoperability: software types and compatibility	Clauses regarding to the exchange of digitized information may help overcome interoperability issues and conflicts arising out of.
	BIM Process: complexity, limitations, lack of availability, applicability and practicability, manual efforts, lack of proven benefits	PIP as being compatible with the ISO 19650 international information management standards and obliging parties to comply with it may help overcoming issues arising out of the complexity of BIM. As parties become familiar with the standardized system, complexity perception is expected to tend to diminish.
	Project complexity	More complex a project by its nature, harder to implement an information management system. Again, adoption of a standardized system and implementing it with an appropriate legal framework by having PIP incorporated into contract may relatively ease the implementation of BIM in complex projects.
Culture and People	Inadequate knowledge base: lack of skills, knowledge, abilities, proper education	Standardization of the information management system may ease the learning process. Adoption of PIP in projects may have indirect contribution as obliging the use of international standards.

Table 6.2 (continued): Potential contribution of PIP in overcoming BIM adoption and collaboration barriers.

Category	Barrier	Main References
Culture and People (cont'd)	Culture: resistance to change, unwillingness to adopt new technologies, unfamiliarity and lack of enthusiasm	PIP's contributions to Inadequate knowledge base and Environment barriers may have also indirect effects in overcoming cultural barriers such as resistance to change and unwillingness to adopt new technologies.
	Environment: nature of the industry, cultural diversity, lack of demand and necessity	Providing a legal governance through the adoption of PIP and therefore implementation of ISO 19650 may result in noticeable positive outcomes. This may have an indirect contribution in terms of recognition of the necessity of the BIM.
Management and Organization	Organizational and team structures: fragmentation, lack of BIM-orientation, variance in structures, integration, institutional barriers	PIP has no significant direct or indirect contribution (potentially) to barriers related to organizational/team structures. Adoption of PIP within projects and thus obligation to comply with ISO 19650 may result in eventual BIM-oriented team structures (in time) and organizations may find the need for overcoming institutional barriers indispensable.
	Collaboration: inadequate collaboration, lack of teaming-up consciousness, communications outside BIM, isolated way of working, conflicts between BIM and non-BIM responsibles, inadequate planning	Following the clauses and appendices of the PIP and eventually complying with ISO 19650 may result in significant increase in the collaboration. In order to satisfy PIP's requirements, the delivery team needs to be collaborative and efficient, and they are required to adopt a standardized way of information management.

Table 6.2 (continued): Potential contribution of PIP in overcoming BIM adoption and collaboration barriers.

Category	Barrier	Main References
Management and Organization (cont'd)	Management: inadequate support from management, managers do not recognize the value of BIM, superficial consideration of relationships between people, processes and technology, lack of investment capital, desire for minimum risk, unwillingness to share liabilities and financial rewards	PIP provides for a balanced distribution of risks between parties and ensures their rights on proprietary information containers. This may help overcoming unwillingness to share liabilities for the management team. In addition to this, overcoming Cultural and people related barriers may have indirect contribution in overcoming management related barriers. Appropriate implementation of ISO 19650 may bring together significant benefits, and this may help the BIM process to become visible for management teams. Relationship between people, processes and technology is handled with due diligence in PIP which enables organizations to thoroughly understand the relationship and establish awareness.
Legal	Standardization: lack of guidance and standardization, lack of appropriate and up-to-date legal governance	The most significant contribution of the PIP is regarding to the standardization related barriers. It provides for a legal framework and obliges to comply with international ISO 19650 standards in terms of information management.
	IP Copyrights: data ownership and data privacy concerns, liabilities arising with BIM and legal fears	Intellectual property issues are one of the key aspects the PIP is intended to govern. The use of the information protocol ensures ownership rights of each party on the information containers produced by them. It also provides guidance on licencing these information containers in order to enable other parties to use the information for the authorized purpose to the appropriate extent. PIP has significant potential contribution to overcoming copyrights related issues as well as legal fears arising through the use and exchange of information.

Table 6.2 (continued): Potential contribution of PIP in overcoming BIM adoption and collaboration barriers.

Category	Barrier	Main References
Legal (cont'd)	Legal and contractual uncertainties	Incorporation of PIP into contract documents may reduce the uncertainties arising around the information management and BIM execution topics as the PIP is capable of satisfactorily addressing many different legal risks through its clauses and appendices.
	Administration: lack of regulations and government encouragement, lawyers and insurers are lacking understanding of new roles and responsibilities	There are no significant direct contributions by the PIP in terms of administration related barriers. As explained above, by the time proven benefits of establishing a legal framework for information management and BIM execution may increase awareness and motivate governmental bodies to arrange for relevant regulations and encouragements.
	Trust and External Collaboration: drawbacks to information sharing, lack of trust, transparency, communications and partnership	PIP provides for identification of clear boundaries between the obligation of parties, provides for appropriate conditions guiding the use and exchange of information and liabilities arising from, and provides for binding provisions in contact with relevant technical input. Herewith it is expected by incorporating it into contracts to establish a proper ground for parties to trust each other more and seek for collaboration with decreased fears of misconduct by the other parties.

7. CONCLUSION

Construction industry is in a digital transformation. Introduction of new technologies and adoption of new ways of working brings together highly valuable benefits to various actors of the industry from contractors to designers and manufacturers. There is an ever-accelerating orientation towards trying and adopting what is new and this is somewhat an outlander behaviour to an industry that is traditionally not very innovation-inclined. The engineering and construction sector is one of the largest in the world, yet one of the least efficient as well by taking into account large percentages of loose value to waste in an average construction project. This is actually why now the industry embracing technology more and more. Clients are interested in much more efficient solutions as with the enhancing technology possibilities for better solutions are evolving almost every day and high level of competency makes obligatory companies to keep pace with these new possibilities of adopting better solutions to clients' expectations. There is an accelerating shift from the physical to the digital environment.

BIM is one of the developments indicating where the industry moving forward, enabling parties work in a more efficient and collaborative way and leaving lesser space for mistakes and waste. Moreover, it enables collection and storage of information in digital formats which opens the doors for companies to build funds of knowledge and utilize the digital information to manage the facilities during their operational lives. Being an unarguable potential for a tremendous change in the definition of waste and inefficiency throughout the industry, BIM and digitized information have been welcomed across the industry. BIM is also like a window to the digital world for the industry, it is the fundamental process in order to allow a wide range of trending digital tools and applications such as artificial intelligence and machine learning, internet of things, site sensors and wearables, augmented and virtual reality and so on. Digitization of information enables all sort of state-of-the-art pieces of technology for the construction people. The construction world is

becoming more prone to change and able to comply with the today's technology with the increasing use of digitized information.

Adoption of BIM and the use of digital information also brings together the requirement of new ways of legal governance as the traditional ways of doing business in construction scenery are not capable of covering essential aspects of the management of digital information. Institutions and organizations publishing standard contract forms have various attempts to cover the legal framework of digital information production, use and exchange while maintaining the procurement agreements within the appropriate means. Solutions are evolving in different forms including amendments to conventional contract documents and various supplementary documentation.

It is not known where the digital transformation is taking the industry standards towards, but at the moment ways of adopting a legal consideration around information management are arising around amending contracts with documents consisting of additional provisions and relevant information. An information protocol is the widely adopted way of incorporating additional information management related provisions into contracts and it is supported by necessary input such as information requirements, work and implementation plans, contractor responses, risk registers, delivery agendas and so on.

This research has been done in order to achieve improved efficiency and collaborative working conditions in buildings and civil engineering works, through contributing to the project information management process. A project information protocol form that is in compliance with the ISO 19650 standards is proposed as a way to incorporate relevant information management provisions into agreements for buildings and civil engineering works. By doing so, the envision behind is advancing the ability to draw a more visible legal framework than what has been done up to date and thus enabling parties to work within a more efficient and collaborative environment.

In order to achieve the vision, first of all a literature survey have been undertaken. Various publications that concerned around adoption of BIM and efficient collaboration, the legal governance of information management, digitization of information in construction industry and BIM process have been went through and

the outcomes in relation with this study have been utilized as reference points to both determine problems within the information management process and propose appropriate solutions by synthesizing their relevant approaches, and also for benchmarking purposes.

The information management process during delivery have been examined in detail in order to provide understanding of the adopted approach for the information management process as per the ISO 19650-2:2018. All stages consisting in and required activities to be undertaken per initial assessment, tendering, mobilization, information production, information delivery, approvals and project close-out set out in brief to satisfy the cognizance of the reader.

Afterwards, a detailed definition has been set out for a project information protocol with the help of the existing literature. The requirements of the scope of a such form as per the ISO 19650 necessities are indicated and a summary of further factors informing efficient BIM governance as proposed by Alreshidi et al. presented to advance the conception of what would be an expected benefit of incorporating an information protocol into an agreement. Addressing these factors through the adoption of the proposed information protocol have been one of the concerns throughout the study.

Following the definition, an investigation on the status of BIM adoption around the world have been undertaken with an attempt to demonstrate the existing situation around handling digital information management and BIM processes at the moment and where the leading industry standards are moving towards.

After providing a clear understanding of the background of information management process, the information protocol definition and having a glance at the current development of BIM applications within the construction world, a discussion on the existing ways of providing legal framework for information management and BIM within construction projects took place. Different approaches from various organizations in terms of legal governance of information production, use and exchange have been summarized. Previous examples of BIM protocols have been went through. AIA's E203-2013 Building Information Modeling and Digital Data Exhibit (together with its BIM and digital data protocols) and CIC's BIM Protocol (2nd edition dating 2018) as being two of them that are officially adopted or

recommended by acknowledged standard form drafting institutions have been mentioned and further examined within the second chapter of this study. The CIC BIM Protocol is adopted as the reference point for this study. Adoption of CIC BIM Protocol is also supported with a study comparing other legal forms through their strategies to mitigate various legal risks arising from BIM adoption. A compilation of best approaches for mitigation strategies proposed by these legal forms are first compared with the CIC BIM Protocol's second edition in this chapter. Following the discussion regarding to these legal risks, a more in-depth evaluation of the proposed information protocol compared to existing strategies and remarks regarding to the risks are presented in the evaluation chapter.

After the literature study explained in the overview chapter, the theoretical framework of the study has been set out in the third chapter. As the CIC BIM Protocol being the reference point of the intended project information protocol, the adoption of the CIC BIM Protocol is also explained within this chapter supported with appropriate justification. Definitions of new terms adopted in the information management process with the introduction of new ISO 19650 standards have been described. The concept that have been shaped the study towards setting out the proposed project information protocol together with the intended scope have also been presented within the theoretical framework chapter.

Following the theoretical framework, within the main discussion of this paper, the proposed structure of the project information protocol have been set out. General provisions and provisions as appendices are provided within sections 4 and 5 respectively. Each provision that is determined to be essential and intended to be provided within the protocol form have been explained to the extent supported by the appropriate evidence. The adopted method of explanation is as following procedures:

- Determine information management process requirements as per ISO 19650
- Determine project information protocol requirements as per ISO 19650
- Define how to respond to above stated requirements of ISO 19650
- Review relevant input by the CIC BIM Protocol 2nd edition (as this reference document is designed for the use within the information management process

identified by PAS 1192 series which is the predecessor of ISO 19650 standards)

- Cross check compliance of the CIC BIM Protocol input with the ISO 19650
- Revise the input as appropriate to suit with the ISO 19650
- Define distinctive requirements of information management process introduced with ISO 19650
- Identify possible supporting evidence within literature survey to match with new requirements of ISO 19650
- Undertake expert interviews to address distinctive requirements of the information management process as per 19650
- Undertake expert interviews to review existing evidence by CIC BIM Protocol and other literature findings
- Finalize provisions as to address all information management requirements to the satisfactory extent.

Further discussion has been undertaken to monitor the explanations of provisions of the proposed project information protocol in each section of this study. Provisions have been analogized with the CIC BIM Protocol approach where applicable in order to provide a relative valuation of the expected achievement by the proposed protocol, to a certain extent. With this it is intended to provide a benchmarking in conjunction with the factors for efficient BIM governance have been presented to evaluate which of these factors can potentially be addressed and to what extent through the project information protocol.

Proposed information protocol is then evaluated in two aspects. An initial evaluation is undertaken to assess how the protocol is capable of mitigating legal risks arising from the adoption of BIM. In sequel of ensuring the information protocol being sufficiently capable of mitigating potential legal risks, the second evaluation took place indicating how the information protocol is contributing in overcoming various barriers hindering BIM adoption and collaborative working. Findings of the evaluation indicate the significant progress promised through the incorporation of the ISO 19650-compliant project information protocol. The protocol provides a clear

legal framework supported by the well-structured information management process defined by ISO 19650 and contribute to the project team in overcoming various barriers towards efficient information management and collaborative working.

It is desired to achieve appropriate satisfaction to security concerns regarding to both asset security management and sensitive information as well as potential issues related to the use of information arising around intellectual property rights. Current development studies are ongoing for security minded information management, namely for the new ISO 19650-5 edition of the new information management standards family, which would be a global adaption of similarly inclined standards document PAS 1192-5. As the current evaluation of security concerns have been adopted as per the PAS 1192-5 specifications within the CIC BIM Protocol, it is intended not to adopt any other national standards to be adopted apart from the ISO 19650 family, therefore these security minded provisions of the CIC BIM Protocol are excluded from the information protocol form. Instead, an appendix is designated for this purpose and the decision to adopt either the CIC BIM Protocol's clauses as in compliance with the PAS 1192-5 or any other specific provisions, as deemed necessary, left for the contracting parties. Further developments to be presented with the ISO 19650-5 can be adopted to increase integrity and usability of the project information protocol around the world.

Through the outcome of this study, it is aspired to adopt the ISO 19650 standards within a project's information management process, including information production and delivery. The resulting project information protocol form demonstrates how, potentially, the new standards be adopted with respect to the legal governance of the information management processes including the building information modelling. It is expected with the adoption of the project information protocol within a project, achieving a better-rounded legal control and a more comprehensive technical responsibility and risk distribution between parties in terms of digital information management. This may provide a clear view of responsibility boundaries for parties, which brings together better communication, increased efficiency, a smaller number of disputes and lower legal costs, and all together a smoother and effective development during the entire lifecycle of the asset.

An outstanding evidence for the need of a BIM maturity definition can be obtained from an interview undertaken with the industry recognized BIM experts from the

UK, as part of the background study within the Winfield Rock Report. Their responses for the definition of BIM Level 2 (PAS 1192 compliant equivalent of the BIM according to the ISO 19650) have been different per each one of them. This result informs, considering each individual's different roles and responsibilities and resulting unique point of views, that the BIM term itself is being defined in various different ways. This brings together the question, in such case, how it is possible to maintain equivalent results from different projects by expecting parties to deliver to BIM Level 2. The definition of BIM or BIM according to the ISO 19650 alone may lead to misinterpretations and projects with unintended results. Another desired outcome of this study is securing an overall performance within projects by avoiding such misinterpretations. Adopting the project information protocol, along with complying with the ISO 19650, may provide a better understanding of the information management process, increased awareness of obligations for involved parties, clear boundaries between obligations and a more definitive legal framework around the information management with BIM.

Further development on this study might be, developing in the process of time the industry gains experience with the new ISO 19650 standards, altering the resulting information protocol form to address more practical issues severely reported by experts and professionals with different backgrounds involved in the BIM and information management processes. Another development might be the adoption of the upcoming ISO 19650-5 series regarding to security minded information management. The CIC BIM Protocol's relevant provisions as well as other considerations might be adopted, as altered to comply with the ISO 19650-5, can be incorporated to this project information protocol. Finally, as a kind and exciting thought, that this study may assist the enhancement of knowledge within the industry regarding to information management and may contribute to further studies aspiring continuous improvement of legal governance of digitization of information and information management using building information modelling, by helping to develop a better understanding of how to comply with the ISO 19650 within the contractual context.

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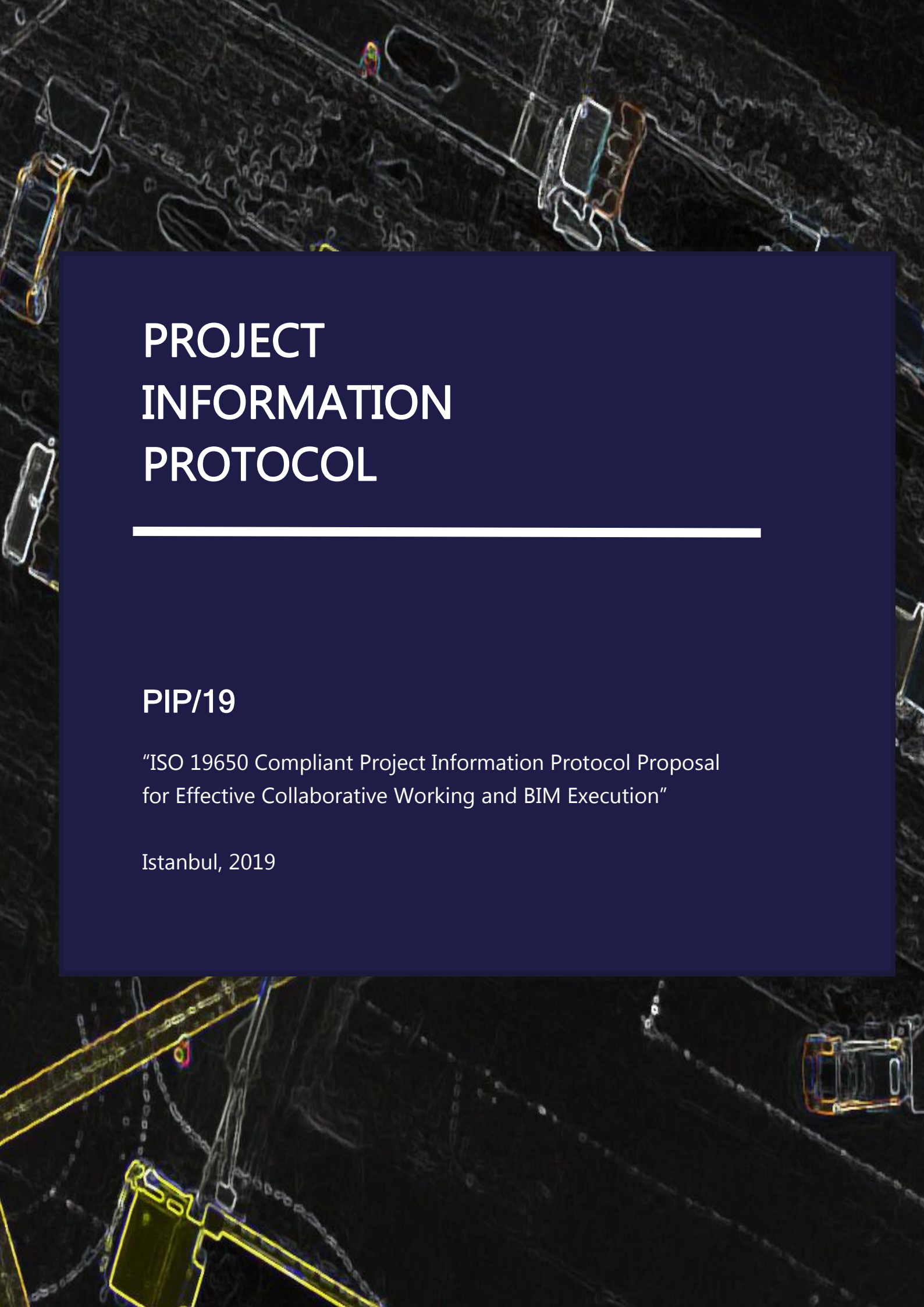
APPENDICES

APPENDIX A: Project Information Protocol

APPENDIX A

The Project Information Protocol is attached hereby:



PROJECT INFORMATION PROTOCOL

PIP/19

"ISO 19650 Compliant Project Information Protocol Proposal for Effective Collaborative Working and BIM Execution"

Istanbul, 2019

Disclaimer and Acknowledgement

This Project Information Protocol is prepared as part of a master's thesis drafted at the Istanbul Technical University Graduate School of Science Engineering and Technology, with the title of "ISO 19650 Compliant Project Information Protocol Proposal for Effective Collaborative Working and BIM Execution" and defended on 13th of May, 2019.

This Project Information Protocol has been drafted by adopting the CIC BIM Protocol as the reference point. The CIC BIM Protocol have been revised in order to comply with the ISO 19650 standards family and to address minor concerns obtained from a literature survey and expert interviews. It is therefore acknowledged technical input and vision provided by the drafters and consultees of CIC BIM Protocol, ISO 19650-1:2018 and ISO 19650-2:2018 as well as by experts interviewed through this study.

This Project Information Protocol is intended to be an academic study and contents within are for general information purposes only. This document may contain copyrighted contents which belong to the CIC or the ISO. Contents of which copyrights belong to the CIC extracted based on its public availability. Contents of which copyrights belong to the ISO extracted via educational licence provided for Istanbul Technical University.

How to use the Project Information Protocol

For the Project Information Protocol to have contractual effect, it is essential that a set of "incorporation clauses" are included in each contract into which it is to be incorporated. A suggested set of incorporation clauses are as follows:

"● The [Client/Employer/as entitled by the intended contract form] and the [Consultant/Contractor/as entitled by the intended contract form] shall:

1. comply with their respective obligations set out in the Project Information Protocol, PIP/19 ("Information Protocol"), as further defined in Appendix [X];
2. have the benefit of any rights granted to them in the Information Protocol; and
3. have the benefit of any limitations or exclusions of their liability contained in the Information Protocol.

● The [Client/Employer/as entitled by the intended contract form] and the [Consultant/Contractor/as entitled by the intended contract form] agree that, subject to clause 1.2 of the Information Protocol, this Agreement shall be amended as set out in the Information Protocol.

● Any reference to "[Appointing Party]" in the Information Protocol shall have the same meaning as the definition "[Client/Employer/as entitled by the intended contract form]" under the Agreement. Any reference to "[Lead Appointed Party]" in the Information Protocol shall have the same meaning as the definition "[Consultant/Contractor/as entitled by the intended contract form]" under the Agreement."

Definitions of Parties in the Information Protocol and their corresponding titles under the Agreement should be carefully addressed in the incorporation clauses to the Agreement. Necessary changes should be made to the suggested incorporation clauses as appropriate.

A completed version of the Information Protocol including Appendices and any agreed additions or amendments, should then be appended to the contract in the place referred to in the incorporation clause.

If any additions or amendments need to be done after the appointment agreement is concluded, this should be instructed or agreed in accordance with the terms of the appointment agreement.

The incorporation clause should be considered on a contract to contract basis and legal advice sought in this regard. Any conflict between the contract, Information Protocol and any other appointment documents, and the order of precedence should also be considered carefully. If it is desired that the Information Protocol as a whole to have the intended effect, any order of precedence should state that the Information Protocol takes precedence subject to clause 1.2 of the Information Protocol. In case it is desired to have the appointment agreement to take precedence, amendment to the Information Protocol may be done by deleting from "provided that" in the clause 1.2 of the Information Protocol until the end of the clause.

List of Appendices

- Appendix A – Information Management Assignment Matrix
- Appendix B – Exchange Information Requirements
- Appendix C – Project's Information Standard
- Appendix D – Delivery Team's BIM Execution Plan
- Appendix E – Master Information Delivery Plan
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Supplementary Appendices (optional as deemed necessary):

- Appendix G – Particular Clauses for Amendments
- Appendix H – Particular Clauses for Compliance with Specific Security Standards and Processes
- Appendix I – CDE and Workflow Instructions
- Appendix J – Information Delivery Milestones
- Appendix K – Delivery Team's Mobilization Plan
- Appendix L – Delivery Team's Risk Register
- Appendix M – List of Reference Information and Shared Resources

PROJECT INFORMATION PROTOCOL

PIP/19

Project Name Here

Appointment Work Title Here

Project Information Protocol

1. Contextual Limitations

1.1 In this Information Protocol, unless the context otherwise requires, the words and phrases used shall have the meanings set out in clause 9 of the Information Protocol.

1.2 This Information Protocol forms part of the Agreement. In the event of any conflict or inconsistency between the Information Protocol and any other documents contained in and/or forming part of the Agreement, such conflict or inconsistency shall be resolved in accordance with the Agreement, provided that:

1.2.1 if there is any conflict or inconsistency between clause 3, clause 4, Appendices A to G of this Information Protocol and the rights and/or obligations in any other Appointment documents contained in and/or forming part of the Agreement, except where the Information Protocol states otherwise, the part of this Information Protocol referred to in this clause shall prevail, and

1.2.2 if the Agreement does not include provisions stating how such conflict or inconsistency should be resolved, the terms of this Information Protocol shall prevail.

1.3 Per this Information Protocol, the Appointment is established between the Parties to the Agreement.

2. Conflict Resolution and Coordination

2.1 The Parties shall comply with any applicable provisions in the Agreement in respect of any ambiguity, conflict or inconsistency in or between Information Containers and/or any information extracted from the Project Information Model. If there are no such provisions and a Party becomes aware of any ambiguity, conflict or inconsistency in or between Information Containers and/or any information extracted from the Project Information Model, or if a Party becomes aware of any other ambiguity, conflict or inconsistency which the Appendices of this Information Protocol state will be resolved in accordance with this clause 2.1, that Party shall notify the other Party and the Parties shall seek to agree how such ambiguity, conflict or inconsistency shall be resolved. If no agreement is reached, the Parties shall, having regard to the Appendix F, meet with each other, the Project Information Manager and such other individuals assigned with information management functions as is necessary, in order to seek to resolve the ambiguity, conflict or inconsistency.

2.2 Based on the Appointing Party's request, Parties may agree to organize coordination meetings on a periodical basis. In such case, individuals responsible for relevant information management functions shall attend to meetings with the Project Information Manager as specified in the Appendix F.

3. Obligations of the Appointing Party

3.1 The Appointing Party shall:

3.1.1 arrange for a completed Project Information Protocol (Information Protocol) and for the obligations set out herein to be incorporated into all Appointments within the Project in substantially the same terms as this Protocol;

3.1.2 save to the extent that such additions and/or amendments shall not prevail any clauses of this Information Protocol, and subject to clause 3.1.1 in respect of obligations of Parties (as stated in clauses 3, 4, 5 and Appendix A) preserved compliant in all Appointments within the Project, incorporate any specific additions and/or amendments to the Information Protocol agreed upon by Parties to this particular Appointment;

3.1.3 arrange for completed Project's Information Standards referred to in Appendix C of this Information Protocol;

3.1.4 save to the extent that such additions and/or amendments are required by the Delivery Team to facilitate the effective:

- exchange of information between Task Teams,
- distribution of information to Other Delivery Teams or third-parties, or
- delivery of information to the Appointing Party

and are subject to clause 3.1.1 in respect of obligations of Parties (as stated in clauses 3, 4, 5 and Appendix A) preserved compliant in all Appointments within the Project, incorporate any specific additions and/or amendments to the Project's Information Standards agreed upon by Parties to this particular Appointment;

3.1.5 arrange for a completed Information Management Assignment Matrix referred to in Appendix A of this Information Protocol;

3.1.6 fulfill its obligations under the Information Management Assignment Matrix referred to in Appendix A;

3.1.7 save to the extent that such obligations are within the scope of Lead Appointed Party's obligations under the Agreement, this Information Protocol and the Information Management Assignment Matrix, arrange for:

(a) Information Management Assignment Matrix and Exchange Information Requirements to be reviewed and updated (if necessary) at each defined project stage until the end of the Project. Arising additional obligations for the Lead Appointed Party (if any) following any such update after the date of Agreement are subject to Lead Appointed Party's consent and the Lead Appointed Party's rights (if any) shall be assessed in accordance with the Agreement and this Information Protocol;

(b) the appointment of the Project Information Manager to be made, changed or renewed as necessary such that there is at all times until the end of the Project a Project Information Manager;

(c) the Delivery Team to be able to make use of the CDE with appropriate workflow to the extent necessary to enable the Lead Appointed Party and its Appointed Parties to comply with the Agreement, this Information Protocol and Information Management Assignment Matrix;

(d) subject to clause 6, the Delivery Team to access necessary Project's Reference Information and Shared Resources, and Information Containers produced by Other Delivery Teams shared through the CDE to the extent only necessary to enable the Delivery Team to fulfill its obligations;

(e) the Delivery Team to access their licenced Information Containers shared through the CDE for the purpose of retaining a record copy of the Information Containers at the end of the Project or following any earlier termination of the Agreement.

4. Obligations of the Lead Appointed Party

4.1 The Lead Appointed Party shall, exercising the relevant level of skill and care applicable to its equivalent obligations in the Agreement:

4.1.1 fulfill its obligations under the Information Management Assignment Matrix referred to in Appendix A;

4.1.2 own full responsibility of its Appointed Parties' respective obligations (if specified separately) under the Information Management Assignment Matrix referred to in Appendix A;

4.1.3 generate Project Information Model (or part of it) as specified in the Exchange Information Requirements referred to in Appendix B, in compliance with Project's Information Standard referred to in Appendix C, and in accordance with Delivery Team's Information Production Methods and Procedures as in Delivery Team's BIM Execution Plan referred to in Appendix D;

4.1.4 subject to any events or circumstances which entitle the Lead Appointed Party to an extension of time or additional time under the Agreement, use the CDE to deliver the Project Information Model generated by the Delivery Team:

(a) in compliance with, including at the Level of Information Need, the Exchange Information Requirements referred to in Appendix B and Project's Information Standard referred to in Appendix C;

(b) during the Project stage and at such times as specified in the MIDP referred to in Appendix E;

4.1.5 comply with this Information Protocol and its appendices when producing and delivering Project Information Model;

4.1.6 use necessary Project's Reference Information and Shared Resources, and Project Information by Other Delivery Teams shared through the CDE in accordance with this Information Protocol and its appendices.

5. Use of Information

5.1 The Appointing Party, the Lead Appointed Party and its Appointed Parties agree that:

5.1.1 if there are any provisions in the Agreement in relation to copyright (or any other rights) in information produced by the Lead Appointed Party or its Appointed Parties, clauses 5.2 to 5.5 shall not apply, and such provisions of the Agreement are hereby varied so far as is necessary to:

(a) apply to the Information Containers produced by the Delivery Team and any proprietary work contained in or extracted from the Information Containers produced by the Delivery Team;

(b) enable the Appointing Party to grant licences or sub-licences to Other Parties within the Project Team, in respect of the Information Containers produced by the Delivery Team and any proprietary work contained in or extracted from the Information Containers produced by the Delivery Team, on terms substentially the same as clause 5.6 and/or 5.7 of this Information Protocol;

5.1.2 if there are no such provisions, clauses 5.2 to 5.5 shall apply.

5.2 Subject to clause 5.1, any rights (including but not limited to any copyright) subsisting in the Information Containers produced by the Delivery Team and any proprietary work contained in or extracted from the Information Containers produced by the Delivery Team shall, as the case may be,:

(a) vest or remain vested in the Lead Appointed Party for which Information Containers produced by the Lead Appointed Party;

(b) vest or remain vested in the corresponding Appointed Party for which Information Containers produced by the same Appointed Party.

5.3 Subject to clauses 5.1 and 5.5, the Lead Appointed Party grants to the Appointing Party a non-exclusive, royalty free and irrevocable licence, and, to the extent that the Information Containers produced by the Delivery Team, any proprietary work contained in or extracted from the Information Containers produced by the Delivery Team,

and any rights subsisting therein are owned by Appointed Parties, grants a sub-licence (including the rights to grant sub-licences on identical terms to Other Lead Appointed Parties, which shall include the right to grant sub-sub-licences on identical terms to Other Parties within the Project Team) to transmit, copy and use for the Authorized Purpose the Information Containers produced by the Delivery Team and any proprietary work contained in or extracted from the Information Containers produced by the Delivery Team.

5.4 Subject to clauses 5.1 and 5.5, to the extent Information Containers produced by Appointed Parties, any proprietary work contained in or extracted from the Information Containers produced by Appointed Parties, and any rights subsisting therein are owned by Appointed Parties, all Appointed Parties grant to the Lead Appointed Party a non-exclusive, royalty free and irrevocable licence (including the rights to grant sub-licence to the Appointing Party on identical terms as clause 5.3) to transmit, copy and use for the Authorized Purpose the Information Containers produced by corresponding Appointed Party and any proprietary work contained in or extracted from the Information Containers produced by corresponding Appointed Party.

5.5 Any licence and/or sub-licence granted in clauses 5.3 and 5.4 shall not include the right to:

5.5.1 amend or modify the Information Containers produced by the Delivery Team without the Lead Appointed Party's or it's corresponding Appointed Parties' written consent (not to be unreasonably witheld), save where such amendment or modification is:

(a) provided for within this Information Protocol and its appendices; or

(b) made for the Authorized Purpose following the termination of the Lead Appointed Party's appointment under the Agreement (following termination of an Appointed Party's appointment, rights to amend or modify Information Containers owned by corresponding Appointed Party for the

Authorized Purpose remains with the Lead Appointed Party); or

5.5.2 reproduce any Information Container owned by the Lead Appointed Party or its Appointed Parties for any extension of the Project.

5.6 Subject to clause 5.8, the Appointing Party grants to the Lead Appointed Party a non-exclusive sub-licence (including the right to grant sub-sub-licences on identical terms to the Appointed Parties) to transmit, copy and use such Information Containers as is owned by Other Parties within the Project Team, for the Authorized Purpose.

5.7 Insofar as the Appointing Party owns any rights subsisting in Information Containers, subject to clause 5.8, the Appointing Party grants to the Lead Appointed Party a non-exclusive licence (including the right to grant sub-sub-licences on identical terms to the Appointed Parties) to transmit, copy and use such Information Containers for the Authorized Purpose.

5.8 The licence and sub-licence (if any) granted in clauses 5.6 and 5.7 shall not include the right to:

5.8.1 amend or modify any Information Container (other than to the extent produced by the Delivery Team) without written consent (not to be unreasonably withheld) of the Appointing Party or Other Parties within the Project Team who owns such Information Container, save where such amendment or modification is:

(a) provided for within this Information Protocol and its appendices; or

(b) in respect of Information Container produced or delivered by Other Parties within the Project Team, made for the Authorized Purpose following the termination of corresponding Party's appointment under the Agreement; or

5.8.2 reproduce any Information Container (other than to the extent produced by the Delivery Team) for any extension of the Project.

5.9 Insofar as clauses 5.2 to 5.5 apply the Lead Appointed Party represents to the Appointing Party that it has, or that it will procure, the right to grant either a licence and/or sub-licence in the form granted in clauses 5.3.

5.10 The Appointing Party represents to the Lead Appointed Party that it has, or that it will procure, the right to grant a sub-licence in the form granted in clause 5.6 and/or a licence in the form granted in clause 5.7.

6. Liabilities in Respect of Proprietary Information Containers

6.1 The Appointing Party and the Lead Appointed Party agree that any provisions in the Agreement concerning any Information Container produced by the Delivery Team shall be varied to the extent necessary to give effect to clauses 6.2 and 6.3. If there are no such provisions clauses 6.2 and 6.3 shall apply.

6.2 The Lead Appointed Party shall have no liability to the Appointing Party arising out of any modification or amendment to, or any transmission, copying or use of the Information Containers produced by the Delivery Team or any proprietary work contained therein, by the Appointing Party, or any Other Delivery Teams or any third-party for any purpose other than the Authorized Purpose.

6.3 The Appointing Party shall have no liability to the Lead Appointed Party arising out of any modification or amendment to, or any transmission, copying or use by the Delivery Team or any third-party of any Information Container in respect of which a sub-licence or licence is granted by the Appointing Party pursuant to clauses 5.6 and 5.7, for any purpose other than the Authorized Purpose.

7. Exchange of Digitized Information

7.1 Without prejudice to any of the Lead Appointed Party's obligations or duties under or in connection with this Information Protocol and/or the Agreement, the Lead Appointed Party does not warrant, expressly or impliedly, that:

7.1.1 any software used to prepare the Information Containers; or

7.1.2 any software format in which the Information Containers is shared, published or otherwise issued in accordance with this Information Protocol and the Agreement, is compatible with any software or software format used by or on behalf of the Appointing Party or any Other Parties within the Project Team.

7.2 Save where it is a result of the Lead Appointed Party's failure to comply with this Information Protocol and/or the Agreement, the Lead Appointed Party shall have no liability to the Appointing Party in connection with any corruption or unintended amendment, modification or alteration of the electronic information (including, without limitation, any software) in any Information Container which occurs after it has been shared, published or otherwise issued through the CDE by the Lead Appointed Party.

8. Termination

8.1 Clauses 1.2, 2, 3, 5, 6 and 7 of this Information Protocol shall continue to apply following termination of the Agreement.

9. Defined Terms

9.1 Agreement means the agreement between the Appointing Party and the Lead Appointed Party, or between the Lead Appointed Party and an Appointed Party and into which this Information Protocol is incorporated. The Agreement brings information requirements into being.

9.2 Appointment means agreed instruction for the provision of information concerning works, goods or services. An Appointment may be established with or without a written Agreement. Per this Information Protocol, the Appointment is established between the Parties to the Agreement as being either:

(a) the Appointing Party appoints the Lead Appointed Party for the provision of defined information as specified in this Information Protocol and its appendices, if the Agreement is between the Appointing Party and the Lead Appointed Party; or else,

(b) the Lead Appointed Party appoints the respective Appointed Party for the provision of defined information as specified in this Information Protocol and its appendices, if the Agreement is between the Lead Appointed Party and an Appointed Party.

9.3 Appointing Party means the party appointing the Lead Appointed Party pursuant to the Appointment Agreement and the receiver of information concerning works, goods or services from the Delivery Team.

9.4 Appointed Party means provider of information concerning works, goods or services.

9.5 Asset means the built end result of the project, or the built including the end result of the project in which the asset/part of the asset is designed, constructed and commissioned.

9.6 Authorized Purpose means a purpose of permitted use related to the Project (and/or the construction, refurbishment, extension, operation, management and/or maintenance of the Asset) which is consistent with:

(a) the applicable Level of Information Need of the relevant Information Container,
(b) the status, revision and classification attributes assigned to the relevant Information Container,
(c) the purpose for which the relevant Information Container was prepared.

9.7 BIM Execution Plan means the plan that explains how the information management aspects of the appointment will be carried out by the delivery team.

9.8 Building Information Modelling (BIM) means use of a shared digital representation of a built asset to facilitate design, construction and operation processes to form a reliable basis for decisions.

9.9 Common Data Environment (CDE) means agreed source of information for the project, for collecting, managing and disseminating each Information Container through a managed process.

9.10 Delivery Phase means part of the asset life cycle during which the asset is designed, constructed and commissioned.

9.11 Delivery Team means the Lead Appointed Party and their Appointed Parties.

9.12 Exchange Information Requirements (EIR) mean information requirements in relation to an appointment.

9.13 Information means reinterpretable representation of data in a formalized manner suitable for communication, interpretation or processing.

9.14 Information Container means named persistent set of information retrievable from within a file, system or application storage hierarchy.

9.15 Information Management Assignment Matrix means the chart that describes the participation by various functions in completing tasks or deliverables.

9.16 Information Model means set of structured and unstructured information containers

9.17 Information Protocol means this Project Information Protocol including Appendices A, B, C, D and E.

9.18 Information Requirement means specification for what, when, how and for whom information is to be produced.

9.19 Lead Appointed Party means the party appointed by the Appointing Party pursuant to the Appointment Agreement and main responsible for provision of information by the Delivery Team.

9.20 Level of Information Need means the framework which defines the extent and granularity of information.

9.21 Master Information Delivery Plan (MIDP) means the plan incorporating all relevant task information delivery plans.

9.22 Other Delivery Team means any other delivery team than the Delivery Team led by the Lead Appointed Party of this Appointment, within the Project Team.

9.23 Other Lead Appointed Party means any other lead appointed party than the Lead Appointed Party of this Appointment, within the Project Team.

9.24 Other Party within the Project Team means any other party participating in the Project Team including other parties within Other Delivery Teams.

9.25 Party means one of the parties to the Agreement; the Appointing Party or the Lead Appointed Party, or else an Appointed Party as appropriate. As the context requires, the word "party" may also be part of different definitions refer to any other actor within the Project Team as part of any Other Delivery Team.

9.26 Project means the project to which the Appointment Agreement relates.

9.27 Project Information Model (PIM) means information model relating to the Delivery Phase. The Project Information Model term may refer to the entirety of the model or a part of it as defined per the scope of works within the Exchange Information Requirements referred to in Appendix B.

9.28 Status Code means meta-data describing the suitability of the content of an Information Container.

9.29 Task Information Delivery Plan (TIDP) means the schedule of Information Containers and delivery dates, for a specific task team.

9.30 Task Team means individuals within the Delivery Team assembled to perform a specific task.

9.31 Workflow means the description of managed process to be used within the CDE.

Appendix A

Information Management Assignment Matrix

No	Task	Appointing Party	Lead Appointed Party	Appointed Party
1	Appoint individuals to undertake the information management function			
2	Establish the project's information requirements			
3	Establish the project's information delivery milestones			
4	Establish the project’s information standard			
5	Establish the project's information production methods and procedures			
6	Establish the project’s reference information and shared resources			
7	Establish the project's common data environment			
8	Establish the project's information protocol			
9	Establish the appointing party’s exchange information requirements			
10	Assemble reference information and shared resources			
11	Establish tender response requirements and evaluation criteria			
12	Compile invitation to tender information			
13	Nominate individuals to undertake the information management function			
14	Establish the delivery team's (pre-appointment) BIM execution plan			
15	Assess each task team capability and capacity			
16	Establish the delivery team's capability and capacity			
17	Establish the delivery team’s mobilization plan			
18	Establish the delivery team’s risk register			
19	Compile the delivery team's tender response			
20	Confirm the delivery team's BIM execution plan			
21	Establish the delivery team’s detailed responsibility matrix			

No	Task	Appointing Party	Lead Appointed Party	Appointed Party
22	Establish the lead appointed party's exchange information requirements			
23	Establish the task information delivery plan(s)			
24	Establish the master information delivery plan			
25	Complete lead appointed party's appointment documents			
26	Complete appointed party's appointment documents			
27	Mobilize resources			
28	Mobilize information technology			
29	Test the project's information production methods and procedures			
30	Check availability of reference information and shared resources			
31	Generate information			
32	Undertake quality assurance check			
33	Review information and approve for sharing			
34	Information model review			
35	Submit information model for lead appointed party authorization			
36	Review and authorize the information model			
37	Submit information model for appointing party acceptance			
38	Review and accept the information model			
39	Archive the project information model			
40	Capture lessons learned for future projects			

Key

R Responsible for undertaking activity

A Accountable for activity completion

C Consulted during activity

I Informed following activity completion

Appendix B

Exchange Information Requirements

The Exchange Information Requirements are set out in the following document: _____

Appendix C

Project's Information Standard

The Project's Information Standard are set out in the following document: _____, as may be amended following agreement by the Parties subject to clause 3.1.4 of the Project Information Protocol.

Appendix D

Delivery Team's BIM Execution Plan

The Delivery Team's BIM Execution Plan is the following document: _____, as may be amended following agreement by the Parties.

If there is any ambiguity, conflict or inconsistency between the Delivery Team's BIM Execution Plan and the Exchange Information Requirements, it will be resolved in accordance with clause 2.1 of the Project Information Protocol.

Appendix E

Master Information Delivery Plan

The Master Information Delivery Plan is the following document: _____, as may be amended following agreement by the Parties.

Appendix F

Methodology for Resolving Inconsistencies

The methodology/approach for resolving any inconsistency in or between Information Containers and any information extracted from Project Information Model (see clause 2.1 of the Project Information Protocol) is as follows: _____

Appendix G

Particular Clauses for Amendments

Appendix H

Particular Clauses for Compliance with Specific Security Standards and Processes

Appendix I

CDE and Workflow Instructions

Appendix J

Information Delivery Milestones

The Information Delivery Milestones are provided in the following document: _____

Appendix K

Delivery Team's Mobilization Plan

The Delivery Team's Mobilization Plan is the following document:

_____

Appendix L

Delivery Team's Risk Register

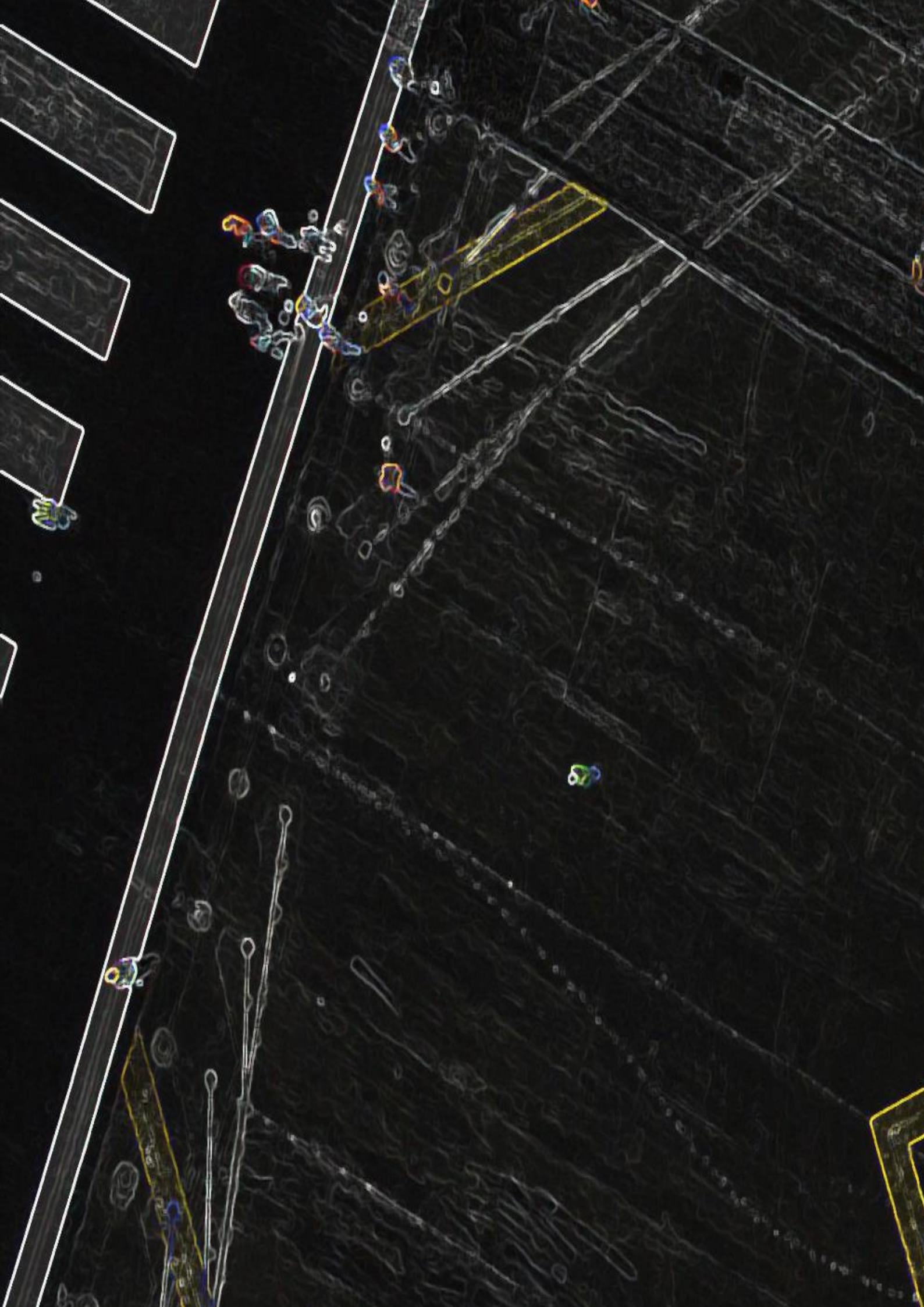
The Delivery Team's Risk Register is provided in the following document: _____

Appendix M

List of Reference Information and Shared Resources

Reference Information and Shared Resources as provided within the CDE by the Appointing Party are listed below, and this list shall be updated as required:

_____



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