Full paper

Click here to download Manuscript JIC Conference Paper - Mostafa et al. 2020.DOCX

Click here to view linked References

Springer
SPRINGER NATURE

Costs and benefits data mapping of BIM laser scan integration: A Case Study in Australia

Sherif Mostafa[1], Harold Villamor[1], Rodney A. Stewart[1], Katrin Sturm[2], Emiliya Suprun[1], , Scott Vohland[2]

[1]School of Engineering and Built Environment, Griffith University, QLD 4222, Australia
[2]Seqwater, Ipswich QLD 4305, Australia

Abstract. Building information modelling (BIM) has been increasingly popular in the utility industry due to substantial benefits of cost and time savings, and improved performance and asset management during the operations and maintenance (O&M) phase. With the recent addition of point cloud from laser scanning, the level of details opted BIM 3D models from 'as-designed' to 'as-constructed' which paves the way for more benefits to other stakeholders during the O&M phase. This research identified and developed the cost benefit elements of the laser-scan integrated BIM as part of a case study research project of a water treatment plant (WTP) in Queensland, Australia. The costs elements from stakeholder's perspective are predominantly BIM supporting software, hardware, labour and training. Whereas, the benefits are categorised based on communication, asset, data and risk management elements for the WTP stakeholders. This research evaluated the costs and benefits through 3D modelling, including asset input, of a WTP study section, site surveys and interviews. The research developed an association mapping between all costs and benefits elements for the WTP case selected.

Keywords: BIM, As designed as constructed assets, BIM adoption in the water industry

1 Introduction

Building Information Modelling (BIM) is one of the most promising developments in the architecture, engineering and construction (AEC) industry. It is a digital representation of a physical structure and functions of a project/facility supported by multiple software and technologies; and are managed by AEC professionals and other stakeholders. BIM is currently used by individuals and organisations such as business and government agencies for planning, designing, constructing, operating and maintaining various physical infrastructures from different industries including the water sector [1,2]. The recent advancement of BIM technologies has opted 3D models from "as designed" to "as constructed". Although construction industries have proven BIM adoption to be beneficial, case studies of the adoption in the water sector have

demonstrated related benefits such as reduced frequency of site survey, and enhanced client communication and associated costs.

BIM is an object-based organisation of information that represents a building to intelligent objects to carry detailed information which can be extracted, exchanged or networked to support decision-making, in contrast to the traditional method of file-based organisation of information which causes errors and omissions, and leads to financial expenses and delays [2]. However, [1] believes that BIM in a broader spectrum is not just an object but rather a human activity that involves people, system process and software. BIM connects AEC professionals and other stakeholders such as contractors and suppliers contributing and collaborating towards a common data environment (CDE). The CDE consists of project and asset 3D models which involve graphical and non-graphical data, and associated documents [2]. These 3D models are the stereotypical reflection of BIM since it constitutes technological advancement.

BIM 3D models are initially designed to record drawings and documentation during the design and construction phase [1], which is referred as “as-designed” BIM [3, 4]. It is argued that BIM excels mostly during these phases. However, the recent advancement of BIM technologies has opted BIM from "as designed" to "as-built". The latter is referred to as the utilisation of laser scan (LiDAR) technology and associated applications such as point cloud and web-share [5, 6]. For example, FARO Scene software utilises LiDAR equipment, where application includes point cloud generation from images; and extension file conversion to other software [6]. Another application of the software is the ability to share the 3D view (digital twin image) to the selected stakeholders including a webshare cloud option [6]. There are many BIM software products and associate tools either in conjunction or compatible separately on the market, but the majority have the same principle and use. They can be categorised based on the manufacturer, life-cycle stages use, and the main BIM dimensions i.e. 3D-modeling, 4D scheduling, 5D cost, 6D sustainability, and 7D (O&M) [6,7]. The use of these BIM technologies is also dependent on the activities and specific management system such as the drinking water treatment plant (WTP).

A WTP is a public facility that treats raw water and distributes it as portable water to clients from different sectors such as residential, commercial and industrial. The conventional water treatment processes include coagulation, flocculation and clarification, sedimentation, filtration, and disinfection; and are managed and operated by facility personnel including operators, maintenance planners, process engineers and asset managers. WTP assets include pipes and other equipment within the plant, and piping and instrumentation drawings (P&IDs), structural drawings, asset records/register, warranties and other documentation. In Australia, the water industry continues to recognise the community benefits of water infrastructure and is taking a more businesslike approach, with a number of Water Service Providers being commercialised and some corporatised [8].

The elements of this businesslike approach include a more rigorous infrastructure investment decision-making process with non-asset solutions, full cycle costs, risks and existing alternatives being considered before deciding to construct infrastructure; making the best use of existing infrastructure; ensuring that infrastructure can sustain agreed customer service standards; and a recognition that asset management is a core

business function to support service delivery [8]. For this purpose, the Queensland Government created and recommended the QLD water total management planning (TMPs) [9]. The "TMPs were introduced in 1994 to promote best practice planning and least cost outcomes for water supply and sewerage planning". A TMP quantifies and assesses the condition of assets, prioritises expenditure, and identifies options for cost saving and improvement in ways that are environmentally and financially sustainable" [8, 9]. This research adopts the TMPs' and identified four critical elements for better planning and managing of a water treatment asset. These elements are asset, risk and data management, and communication. This research mapped the BIM integration benefits in regards to these four elements.

BIM adoption has recently been increasing in the water industry due to substantial benefits in cost and time savings; and improved performance and asset management during the construction phase. With the recent addition of point cloud from laser scanning, the level of detail (LOD) and level of information (LOI) of as constructed assets are captured which pave the way for more benefits to other stakeholders during the O&M phase. Although many case studies are elaborating the benefits of using BIM in the construction industry [10], the water industry is also gaining momentum [11]. A case study in Queensland, Australia shows that the Kawana sewage treatment plant upgrade has successfully used BIM for design, construction and operation; through the 3D utility software Autodesk AutoCAD Plant 3D and other BIM software [12]. The case study illustrates the benefits of adopting BIM. Other case studies worldwide have also been reviewed and illustrated similar results [11]. Research reveals some of the workflows of the 3D modelling from laser-scan images to Plant 3D software and other BIM software such as Autodesk Navisworks with the aid from third party software FARO products [13]. Other workflows have also been illustrated in the 3D modelling case studies from other reviews [10]. These workflows will be explored during the 3D modelling process of the WTP case in this research.

2 Research Methodology

The scope of this research includes 3D modelling using point cloud which is extracted from laser-scan images; WTP asset input and validation; and investigation of the WTP stakeholders, for cost and benefit investigation of BIM integration and the creation of a data map for the WTP stakeholders. After a thorough review of relevant literature, the research adopted a mixed-method to allow for a combination of identifying patterns and categorising cost and benefit elements. An in-depth exploration of costs and benefits to relevant stakeholders across the asset life-cycle was conducted. The data collection methods comprised case study reviews and other 3D modelling processes evaluations; utilisation of WTP existing data; structured interview and equipment survey from the WTP site visit and group meetings; and experimentation of 3D modelling processes.

3 Results – 3D modelling processes and case studies comparison

The research reveals the costs, benefits and WTP stakeholders of BIM during the data collection mentioned in the previous section. The costs and benefits of the BIM adoption were recorded during the experimentation workflow shown in Fig.1, reflective of the actual BIM design phase; and literature review through case studies' defined costs and concluding benefits, reflective of the actual O&M and construction phases.

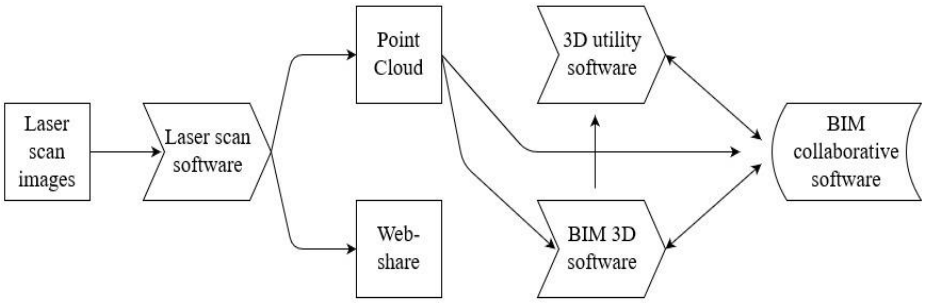

Fig. 1. The workflow of 3D modelling from laser-scan images.

The overall costs include software such as scan processor software (e.g. FARO Scene and Autodesk Recap), BIM software (e.g. Autodesk Revit and Navisworks), and 3D utility software (e.g. Autodesk AutoCAD Plant 3D). Although the research hardware available is web-browsing devices and 8G RAM PC specification, other PC specifications have been recommended for optimal 3D modelling and model use. To quantify the labour and training costs, the intensities have been quantified based on a scale of high, medium and low as illustrated in Table 1.

Table 1. Labour and training scale reflective of the costs identified during the data collection.

Element	Low	Medium	High
Labour	0 to 20 hours	20 to 40 hours	40 to 80 hours
Training	Online tutorials	Same with scale Low plus manual consultations	Same with scale Medium plus expert consultations, e.g. diagnostic blogs, company inquiry request, expert advice

Through experimentation and literature review, the costs of the WTP BIM adoption were observed and recorded during the BIM life-cycle phases i.e. BIM design, O&M, BIM redesign for WTP upgrade and construction for WTP upgrade activities. BIM design and redesign for WTP upgrade activities include laser scanning, laser-scan to point cloud, web-share uploading, and 3D modelling using different BIM software, and utilities, and other tools. The O&M and construction for WTP upgrade activities include data access, input and output, and surveying. Through literature review by comparing benefits from case studies and experimentation by validating benefits from case studies,

the benefits include reduced time and costs during all phases, clients' serviceability and improved communication.

4 Discussion – Costs and benefits data mapping

The research reveals that the costs and benefits of BIM adoption can be described based on their respective elements. Costs of point cloud-based BIM or webshare from the laser scan images are predominately software, hardware, labour and training elements as illustrated in Table 2.

Table 2. Cost and source references.

	Software	Hardware	Labour	Training	Source
	S	**H**	**L**	**T**	**R**
1	Scan processor	PC -8G RAM	High	High	Lit. Review
2	FARO Scene	PC -16G RAM	Medium	Medium	Online Tutorial
3	Recap	PC -16G RAM above	Low	Low	3D Modelling
4	Revit	Web-browsing device	Utility		Site survey
5	Plant 3D		**U**		Site Interview
6	Navisworks		Internet CXN		Scan Company

These cost elements were identified during the 3D modelling processes experimentation and case study comparisons from all BIM life-cycle phases. Each phase consists of activities and thus, to avoid duplication of costs, the data are presented in matrix form as illustrated in Table 3.

Table 3. Some costs investigated for the different BIM life-cycle phases. (Refer to Table 2)

Activity	Code	Processes / Function	Cost Element: Software	Hardware	Labour	Training	Utility	Source
Experimental BIM design								
Scan	C1	Laser scanning site	AUD $3500 (provided)					R6
P. Cloud	C2	Scanning processes	S2	H1	L2	T1	U6	R1,R2,R3
Webshare	C3	Uploading processes	scan package					R6
O&M and Potential upgrade								
Access	C10	Webshare viewing		H4	L3	T3	U6	R1, R2
Input	C12	Webshare data relay		H4	L2	T2	U6	R1, R2
Output	C15	Webshare print out		H4	L3	T2	U6	R1, R2

Table 3 shows the cost-activity matrix of laser scan processes during the experimental BIM design and fixed prices from the laser scan company. The table also shows the WTP cost-activity matrix during the O&M and potential upgrade found in the literature review. Other WTP costs associated with 3D modelling using utility software and BIM software, are presented in the same manner. It was found that this

software has cost impacts when using in conjunction with each other, and could potentially reduce the cost of the processes. Benefits can be organised from the data, asset and risk management, and communication elements based the TMPs' interpretations i.e. Queensland government's recommendation of asset management as a business-like approach as illustrated in Table 4.

Table 4. Some of the LS-I-BIM validated benefits. (Refer to Table 2)

Code	Benefit	Elements	Source
B1	better design solutions	Data/Asset	R1,R3,R4
B12	increased client satisfaction	Comm./Risk	R1,R4
B18	increased profits on projects	Asset/Risk	R1

Table 4 shows some of the potential benefits with respect to the activities illustrated in Table 2. It shows design, client and overall project benefits which were found during literature review and experimentation. Other benefits were also found regarding the O&M and upgrade phases, and the design of BIM models. An accurate design of BIM models is essential since it will become the CDE of all stakeholders. WTP stakeholders were found to have their respective costs and benefits when adopting LS-I-BIM, presented in Table 5.

Table 5. Generalised WTP cost and benefit data map. (Refer to Table 3 and 4)

Stakeholders	Relevance		BIM life-cycle phase				Potential Costs	Potential Benefits
	Webshare	LS-I-BIM	BIM design	O&M	Upgrade Design	Upgrade Const.		
3D Team	✓	✓	✓	✓	✓	✓	C1-C14	B1-B5, B8- B9
Facility PER	✓	✓		✓			C10-C18	B2-B9
Managers	✓	✓	✓	✓	✓	✓	C10-C11, C5 - C17	B5-B9, B11-B18
Contractors	✓				✓	✓	C10-C11, C15-C18	B2-B9, B11-B18
Clients	✓				✓		C10	B12, B14, B15
Owners	✓				✓	✓	C10-C17	B1-B18
AEC Prof.	✓	✓			✓	✓	C4-C18	B1-B11, B16 -B18

Table 5 shows a data map of potential costs and benefits to a generalised WTP stakeholder group. For example, facility personnel include operators, maintenance planners, schedulers and process engineers. These specific WTP stakeholders and respective BIM costs and benefits were identified during the literature review and were validated from the other data collection methods. The data map also shows the relevance of other types of BIM tools such as webshare and the laser scanning BIM functionalities, and during BIM life-cycle phases. It shows that webshare benefits all

involved stakeholders. However, the overall relevance of BIM is distributed throughout different phases.

5 Conclusions

This research has evaluated the cost-benefit of laser-scan integrated BIM through experimentation of 3D modelling processes and other data collection and created a data map for WTP stakeholders. Despite an initial increased cost by using multiple software packages, the overall costs are significantly reduced when these are used in conjunction with each other. The benefits were shown to significantly outweigh the costs. The created BIM cost-benefit data map can be beneficial for WTP stakeholders, other water sector facilities, and future researchers interested in laser scanning BIM cost-benefit analysis.

6 Acknowledgements

The authors would like to thank the Seqwater team for their excellent support and professional insights provided during this research project.

References

1. Eastman, C.M. & ProQuest (Firm) 2011, BIM handbook: a guide to building information modeling for owners, managers, designers, engineers and contractors, 2nd edn, Wiley, Hoboken, NJ.
2. Garber, R., 1971 & ProQuest Ebooks 2014, BIM design: realising the creative potential of building information modelling, Wiley, Chichester, West Sussex, United Kingdom.
3. British Standards Institution (2013) & BIM wiki (2019) PAS 1192-2. https://www.designingbuildings.co.uk/wiki/PAS_1192-2 Accessed 23 Sept 2019
4. Moser, C (2016) Record models vs. as-built models in a world of complexity. https://www.linkedin.com/pulse/record-models-vs-as-built-world-complexity-cliff-moser Accessed 28 Sept 2019
5. Cheng, L., Chen, S., Liu, X., Xu, H., Wu, Y., Li, M. & Chen, Y. 2018, "Registration of laser scanning point clouds: A review", Sensors (Switzerland), vol. 18, no. 5, pp. 1641.
6. FARO, https://webshareclоud.com/index.html#divlogo Accessed 2 Oct 2019
7. Moscardi, L. (2017) BIM software guide. http://www.buildingincloud.net/wp-content/uploads/2017/03/BIM-Software-list.pdf Accessed 6 Sept 2019
8. Qldwater (2019-a) Total management planning: asset management-overview. https://www.qldwater.com.au/TMPs Accessed 8 Sept 2019
9. Qldwater (2019-b) Archived:total management plans. https://www.qldwater.com.au/TMPs Accessed 25 Sept 2019
10. Liu, Z., Zhang, C., Guo, Y., Osmani, M. & Demian, P. 2019, "A Building Information Modelling (BIM) based Water Efficiency (BWe) Framework for Sustainable Building Design and Construction Management", ELECTRONICS, vol. 8, no. 6, pp. 599.
11. Dodge Data & Analytics (2018) Business value of BIM for water projects. https://www.construction.com/toolkit/reports/business-value-bim-water-projects Accessed 8 Sept 2019

12. DavidKent & Smith, S. (2019) Kawana STP upgrade: Using BIM for design, construction and operation. https://www.waternz.org.nz/Attachment?Action=Download&Attachment_id=3383 Accessed 8 Sept 2019
13. Nguyen, H., Radcliffe, I. (2015) Field to Finish: Point Cloud to AutoCAD Plant 3D, https://www.autodesk.com/autodesk-university/class/Field-Finish-Point-Cloud-AutoCAD-Plant-3D-2015#handout Accessed 8 Sept 2019

Consent to Publish for Conference Proceedings
Click here to download Supplementary Material CD_A_31_03_19_05_18_04_774.pdf

Consent to Publish for Conference Proceedings

Series Title:

Sustainable Civil Infrastructures (SUCI)

Published under the imprint

Springer

Title of Book/Volume/Conference (hereinafter called "Work): 1st Joint International Conference On Smart Cities Design And Construction Of Smart Cities Components

Editor(s) name(s) (hereinafter called "Editor"): Hany Farouk Shehata

Title of the conference paper (hereinafter called "Contribution"): Costs and benefits data mapping of BIM laser scan integration: A Case Study in Australia

Author(s) full name(s) (hereinafter jointly called "Author"): Sherif Mostafa, Harold Villamor, Rodney A. Stewart, Katrin Sturm, Emiliya Suprun, Scott Vohland

Corresponding author's name, address, affiliation and e-mail: Sherif.mostafa@griffith.edu.au

When Author is more than one person the expression "Author" as used in this agreement will apply collectively unless otherwise indicated.

§ 1 Rights Granted

Author hereby grants to **Springer International Publishing AG** (hereinafter called **"Publisher"**) the exclusive, sole, permanent, world-wide, transferable, sub-licensable and unlimited right to reproduce, publish, distribute, transmit, make available or otherwise communicate to the public, translate, publicly perform, archive, store, lease or lend and sell the Contribution or parts thereof individually or together with other works in any language, in all revisions and versions (including soft cover, book club and collected editions, anthologies, advance printing, reprints or print to order, microfilm editions, audiograms and videograms), in all forms and media of expression including in electronic form (including offline and online use, push or pull technologies, use in databases and data networks (e.g. the Internet) for display, print and storing on any and all stationary or portable end-user devices, e.g. text readers, audio, video or interactive devices, and for use in multimedia or interactive versions as well as for the display or transmission of the Contribution or parts thereof in data networks or search engines, and posting the Contribution on social media accounts closely related to the Work), in whole, in part or in abridged form, in each case as now known or developed in the future, including the rig**h**t to grant further time-limited or permanent rights. Publisher especially has the right to permit others to use individual illustrations, tables or text quotations and may use the Contribution for advertising purposes. For the purposes of use in electronic forms, Publisher may adjust the Contribution to the respective form of use and include links (e.g. frames or inline-links) or otherwise combine it with other works and/or remove links or combinations with other works provided in the Contribution. For the avoidance of doubt, all provisions of this contract apply regardless of whether the Contribution and/or the Work itself constitutes a database under applicable copyright laws or not.

The copyright in the Contribution shall be vested in the name of Publisher. Author has asserted his/her right(s) to be identified as the originator of this Contribution in all editions and versions of the Work and parts thereof, published in all forms and media. Publisher may take, either in its own name or in that of Author, any necessary steps to protect the rights granted under this Agreement against infringement by third parties. It will have a copyright notice inserted into all editions of the Work according to the provisions of the Universal Copyright Convention (UCC).

The parties acknowledge that there may be no basis for claim of copyright in the United States to a Contribution prepared by an officer or employee of the United States government as part of that person's official duties. If the Contribution was performed under a United States government contract, but Author is not a United States government employee, Publisher grants the United States government royalty-free permission to reproduce all or part of the Contribution and to authorise others to do so for United States government purposes. If the Contribution was prepared or published by or under the direction or control of Her Majesty (i.e., the constitutional monarch of the Commonwealth realm) or any Crown government department, the copyright in the Contribution shall, subject to any agreement with Author, belong to Her Majesty. If Author is

an officer or employee of the United States government or of the Crown, reference will be made to this status on the signature page.

§ 2 Rights retained by Author

Author is permitted to self-archive a pre-print and post-print of the Contribution.
a) A pre-print is the Author's first version of the manuscript submitted to the Publisher ("**Pre Print**"). Prior to acceptance for publication by the Publisher, Author retains the right to make a Pre-Print of the Contribution available on any of the following platforms: their own personal website; a legally compliant, non-commercial pre-print server such as but not limited to arXiv, bioRxiv, CoRR and HAL. Once the Contribution has been published, Author should update the acknowledgement and provide a link to the definitive version on the Publisher's website: "This is a pre-print of a contribution published in [insert title of book and name(s) of Editor(s)] published by [insert name of Publisher]. The definitive authenticated version is available online via https://doi.org/[insert DOI]". The DOI (Digital Object Identifier) can be found at the bottom of the first page of the published Contribution.
b) A post-print is the version accepted by the Publisher for publication, but prior to copyediting and typesetting ("**Post-Print**"). Author retains the right to make a Post-Print of the Contribution available on any of the following 12 months after first publication ("**Embargo Period**"): their own personal website; their employer's internal, legally compliant and non-commercial website; their institutional and/or funders' legally compliant and non-commercial repositories for public release. An acknowledgement in the following form should be included, together with a link to the published version on the Publisher's website: "This is a pre-copyedited version of a contribution published in [insert title of book and name(s) of Editor(s)] published by [insert name of Publisher]. The definitive authenticated version is available online via https://doi.org/[insert DOI]".
For the avoidance of doubt Author shall not use the publisher's final published version (in pdf or html/xml format) for the purpose of the above described self-archiving.

Additionally, Author retains, in addition to uses permitted by law, the right to communicate the content of the Contribution to other research colleagues, to share the Contribution with them in manuscript form, to perform or present the Contribution or to use the content for non-commercial internal and educational purposes, provided the original source of publication is cited according to current citation standards.

§ 3 Warranties

Author agrees, at the request of Publisher, to execute all documents and do all things reasonably required by Publisher in order to confer to Publisher all rights intended to be granted under this Agreement. Author warrants that the Contribution is original except for such excerpts from copyrighted works (including illustrations, tables, animations and text quotations) as may be included with the permission of the copyright holder thereof, in which case(s) Author is required to obtain written permission to the extent necessary and to indicate the precise sources of the excerpts in the manuscript. Third Party Material (including without limitation quotations, photographs, pictures, diagrams, drawings, tables, graphs or maps, and whether reproduced from print or electronic or other sources) may only be included in the Contribution with the prior agreement of the Publisher. In this case the Author must obtain (at the Author's expense) all necessary permissions to enable the Publisher to use the Third Party Material in the Contribution and shall provide the Editor of the Work and the Publisher with: (i) copies of all such permissions, and (ii) sufficient information to enable the Publisher to make appropriate acknowledgements.
Author warrants that Author is entitled to grant the rights in accordance with Clause 1 "Rights Granted", that Author has not assigned such rights to third parties, that the Contribution has not heretofore been published in whole or in part, that the Contribution contains no libellous or defamatory statements and does not infringe on any copyright, trademark, patent, statutory right or proprietary right of others, including rights obtained through licences; and that Author will indemnify Publisher against any costs, expenses or damages for which Publisher may become liable as a result of any claim which, if true, would constitute a breach by Author of any of Author's representations or warranties in this Agreement.
Author agrees to amend the Contribution to remove any potential obscenity, defamation, libel, malicious falsehood or otherwise unlawful part(s) identified at any time. Any such removal or alteration shall not affect the warranty and indemnity given by Author in this Agreement.

§ 4 Delivery of Contribution and Publication

Author shall deliver the Contribution to the responsible Editor of the Work on a date to be agreed upon, electronically in Microsoft Word format or in such form as may be agreed in writing with Publisher. The Contribution shall be in a form acceptable to the Publisher (acting reasonably) and in line with the instructions

contained in the guidelines and Author shall provide at the same time, or earlier if the Publisher reasonably requests, any editorial, publicity or other form required by the Publisher.
Publisher will undertake the publication and distribution of the Work in print and electronic form at its own expense and risk within a reasonable time after it has given notice of its acceptance of the Work to Author in writing.

§ 5 Author's Discount for Books and Electronic Access

Author may obtain copies of the Work for personal use at a discount of 40% off the list-price if ordered directly from Publisher. Furthermore, Author is entitled to purchase for his/her personal use (directly from Publisher) other books published by Publisher at a discount of 40% off the list price for as long as there is a contractual arrangement between Author and Publisher and subject to applicable book price regulation. Resale of such copies is not permitted.
Publisher shall provide electronic access to the electronic final published version of the Work on Publisher's Internet portal, currently known as springer.com and/or palgrave.com, to Author, provided Author has included his/her email address in the manuscript of the Work. Furthermore, Author has the right to download and disseminate single contributions from the electronic final published version of the Work for his/her private and professional non-commercial research and classroom use (e.g. sharing the contribution by mail or in hard copy form with research colleagues for their professional non-commercial research and classroom use, or to use it for presentations or handouts for students). Author is also entitled to use single contributions for the further development of his/her scientific career (e.g. by copying and attaching contributions to an electronic or hard copy job or grant application).
When Author is more than one person each of the co-authors may share single contributions of the Work with other scientists or research colleagues as described above. In each case, Publisher grants the rights to Author under this clause provided that Author has obtained the prior consent of any co-author(s) of the respective contribution.

§ 6 Termination

Either party shall be entitled to terminate this Agreement forthwith by notice in writing to the other party if the other party commits a material breach of the terms of the Agreement which cannot be remedied or, if such breach can be remedied, fails to remedy such breach within 28 days of being given written notice to do so.
On termination of this Agreement in accordance with its terms, all rights and obligations of Publisher and Author under this Agreement will cease immediately, except that any terms of this Agreement that expressly or by implication survive termination of this Agreement shall remain in full force and effect.

§ 7 Governing Law and Jurisdiction

If any difference shall arise between Author and Publisher concerning the meaning of this Agreement or the rights and liabilities of the parties, the parties shall engage in good faith discussions to attempt to seek a mutually satisfactory resolution of the dispute. This agreement shall be governed by, and shall be construed in accordance with, the laws of Switzerland. The courts of Zug, Switzerland shall have the exclusive jurisdiction.

Corresponding Author signs for and accepts responsibility for releasing this material on behalf of any and all Co-Authors.

Signature of Corresponding Author: **Date:**

…… ……25/04/2020……..

☐ I'm an employee of the US Government and transfer the rights to the extent transferable (Title 17 §105 U.S.C. applies)
☐ I'm an employee of the Crown and copyright on the Contribution belongs to Her Majesty

For internal use only:

Order Number:

GPU/PD/PS:

Legal Entity Number: 1128 Springer International Publishing AG

Springer-C-CTP-12/2016