ASC Conference Proceedings: Thematic Review of Considerations, Contributions and Capturing Trends in Academia and Industry

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For over half a century, the Associated Schools of Construction (ASC) conference has progressively contributed to the built environment both in academia and industry. ASC Conference uses education and practice as the main themes to channel papers that range across different built environment disciplines. Although most contributions to the ASC conference were facilitated by US-based institutions, there is a growing international interest, hence, it is vital to recognize conference considerations, contributions to academia and the industry and shed the light on future trends. This paper attempted to thematically review ASC proceedings from 2002-2021 retrieved from ASC archives with a total of 1317 manuscripts. The findings revealed that the main themes of academia and industry have been equally recognized in the ASC conference proceedings with a noticeable rise toward industry-based publications in recent years. As resulted from thematic analysis, 11 main publication disciplines were proposed. The construction management, risk management and sustainability disciplines have been mostly served among the proposed disciplines. The trend analysis highlighted the growing tendency to integrate technology features into academia and industry research. Finally, the key research findings facilitate a robust mechanism to determine future ASC conference themes while unveiling avenues to expand international outreach and exposure.

Key Words: Education, Industry, Discipline, Technology

Introduction

Construction is recognized as one of the most data/information intense industries as it includes multiple lifecycle phases with interdisciplinary integration of systems and stakeholders (Luo et al., 2022). It is noted that construction, is the leading contributor to GDP in many countries, in terms of infrastructure development, housing development and employment opportunity generation (Nguyen and Le, 2022). Therefore, knowledge sharing, and exchange has become an evitable component that enables long-term value and impact creation within such an industry. Besides national/international exhibitions, seminars and workshops, the conferences facilitate interactive environments that motivate the learning and

development process, especially in rapidly paced industries such as construction. At an international level, the International Council for Research and Innovation in Building and Construction (CIB) formed one of the earliest construction conferences in 1950, which was held in Geneva and called the Conference of Building Research (CIB, 2022), which follows by the first CIB world congress in 1965, and to this day, CIB can be seen as one of the major channels that interconnect construction research and practice worldwide. For over half a century, and simultaneously with the start of CIB's first world congress, the Associated Schools of Construction (ASC) has been one of the major hubs that connected construction professionals from the education and industry sectors (ASC, 2021) in the United States.

The ASC annual conference has the vision of inspiring excellence in construction education and research while providing robust channels for advancing and sharing good practices, driving innovation and building an international community. In recent years, with the rising attention in the construction industry, many other conferences with international outreach were established such as the Association of Researchers in Construction Management (ARCOM), International Conference on Construction Applications of Virtual Reality (CONVR), and many others including CITC, EPPM and E3C. Although the ASC Conference, compared to many other construction conferences, has a longer and well-established history, the contributions were mostly channeled by US-based institutions. More importantly, whilst the ASC lists several key themes for each conference, the proceedings are categorized into education and industry-based publications. Although this offers a tailored approach to map publications to both industry and academia, it does not provide insight into the conference's exposure and contributions across different disciplines over the years. Therefore, this research aims to thematically review ASC proceedings to identify the conference considerations, contributions and future trends with a direct emphasis to provide more tailored impact and exposure internationally.

Research Methodology

As discussed above, the main focus of this study is to conduct a thematic review of ASC conference proceedings from 2002-2021 to better acknowledge the conference trends in order to explore avenues that support boosting ASC conference outreach and impact internationally. Accordingly, three research questions were set in this study as follows.
Q1: Who were the key contributors to the ASC conference over the past two decades and which built environment disciplines have been considered over the years?
Q2: What were the contributions of ASC conference publications towards academia and the industry and what were the research technological trends that emerged over the past years?
Q3: What are the potential strategies to boost ASC conference outreach and impact internationally?

The objective of Q1 was first to identify the jurisdictions and the academic universities that contributed to the conference over the years and then to explore their commitments towards the key built environment disciplines such as construction management, project management, risk management, and sustainability to name a few. The Q2 mainly focused on identifying the contributions from the ASC conference publications to academia and the construction industry. Besides, the research trends over the years needed to be explored while determining the emerging research trends for the two decades. Thereafter, Q3 was formed to explore the strategies to uptake ASC conference outreach and impact with the identified emerging trends, opportunities and possibilities. Figure 1 presents the overall research approach followed in this study. According to Figure 1, all the ASC conference papers from 2002 to 2021 were downloaded from the ASC website and developed a database (including publication year, article title, origin, contributing university/organization based on the first author, discipline considered by the paper, contribution to the academia or the industry, and emerging trends) in order to proceed with the analysis. The collected database was visualized using Power BI and then analyzed

using thematic analysis to find out answers for Q1-Q3. Thematic analysis was beneficial in identifying the common themes underlying the papers (Vaismoradi et al. 2013) that help to understand their contribution towards research disciplines and phases while determining the new imperatives for research trends. In order to provide a focused approach towards mapping ASC proceedings to different disciplines, the authors have classified the papers against 11 disciplines (see Table 1), and this allowed a more structured and logical way of analyzing the contributions.

Table 1

Disciplines used to classify contributions from ASC Proceedings

Discipline	Areas
Construction Management	Site Management, Planning and Scheduling, Resource Management, Manufacturing and Production, Equipment Management.
Project Management	Integration and Scope Management, Quality Management, Procurement Management, Stakeholder Management.
Risk Management	Health and Safety, Procurement Risks, Safety Management.
Interdisciplinary	Academic: pedagogy, learning and review-based research. Industry: Engaging multiple disciplines.
Sustainability	Social, Environmental, Economic, Energy Efficiency.
Civil Engineering	Structural Engineering, Transportation Engineering, Water Engineering, Soil Mechanics.
Facilities Management	Operational Management, Maintenance Management.
MEP	Mechanical, Electrical, Plumbing
Cost Management	Quantity Surveying, Quantity Takeoffs, Cashflow.
Skills and Development	Soft Skills, Technical skills
Employability	Training, Internships, Careers

Figure 1: Research approach deployed in this study

Results and Discussion

This section views and discusses the results derived from the thematic analysis and Power BI visualization. In total, 1317 manuscripts were analyzed from 2002-2021 where all data was imported to Microsoft Power BI for data visualization. In order to provide a structured and logical analysis, the results are classified into three parts: ASC outreach and exposure, contribution towards different disciplines with phases, and finally ASC's future trends and potentials.

ASC Outreach and Exposure

Referring to the refined database collected prior, information related to the country of publication and origin university along with types of contribution academia/industry categories were identified and illustrated (See. Figure 2). According to Figure 2, in two decades, participants in the conference originated from fourteen different countries while the majority were from the USA (i.e. More than 80%) and in second order from the UK. A very limited number of manuscripts were submitted from the Middle East, Africa, and Australia. By marking participants' countries in the world map, it is observed that zero engagement has been recorded for South America and North Asia while in Europe with exception of the UK and Ireland no other country participated in an ASC conference since 2002. A low level of engagement from other counties could be because almost the majority of the ASC conference occurrences have been held in the USA, while in many respects travelling for attending in the USA can be hard for willing participants from another side of the world. This claim can be proved by referring to 2012 as the conference was hosted by Birmingham City University in the UK where the level of international engagement increased clearly.

Publication Origin	Academia	Industry	Total
Australia	2		2
Canada	3	1	4
China		1	1
Egypt	1	5	6
Hong Kong		4	4
Iran		6	6
Ireland	5	6	11
Jordan	1		1
South Africa	2	2	4
Sri Lanka		1	1
Turkey		1	1
United Arab Emirates	1	1	2
United Kingdom	22	22	44
United States	558	672	1230
Total	**595**	**722**	**1317**

Figure 2: ASC Conference outreach and exposure worldwide in terms of both Academia and Industry.

As the majority of published papers in ASC conferences originated from the USA (i.e. a total of 1220 out of 1317), it was interesting to know how participating universities located in the USA tend submitting papers covering academia or the industry sector. A bar chart was created to assess the count of the sector against the USA-based university (based on 1st Authorship). Among eleven USA-based universities engaged in the ASC conferences series, Auburn University has been recorded with the highest number of papers with an almost equal level of engagement in both academia and industry (Figure 3). The same attitude was observed at Texas A&M University, Clemson University, California State University and East Carolina University. Universities like Colorado State University, Arizona

State University and Brigham Young University reported a higher contribution toward industry in comparison to academia, while on other hand California Polytechnic State University, Purdue university and the university of Oklahoma has submitted manuscripts majority covering areas related to academia.
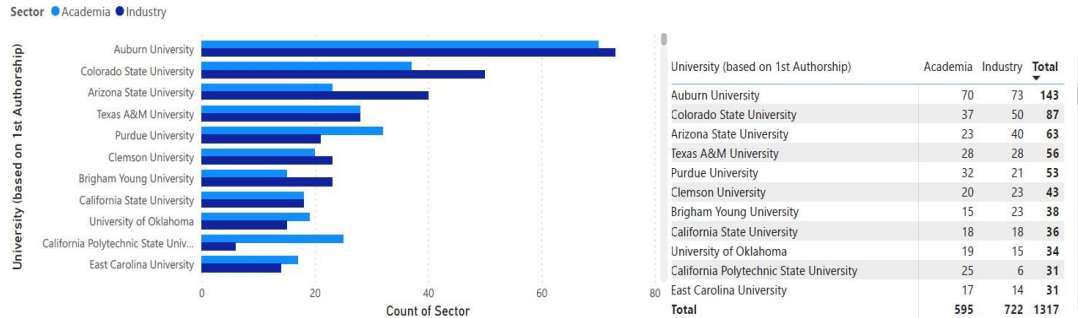

Figure 3: Organizational contribution towards ASC Conference

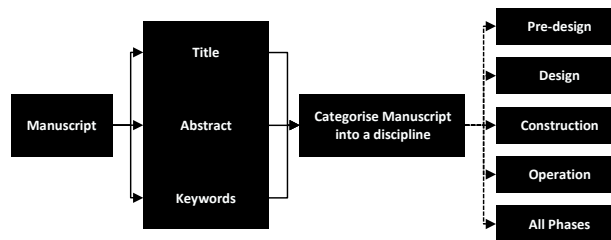*ASC Contribution to different Disciplines and Phases (2002-2021)*

Figure 4: Process followed when classifying manuscripts to disciplines and phases.

From the database generated, and as shown in Figure 4, the authors have mapped the manuscripts to 11 disciplines (explained in the methodology) and contextualized the discipline (where possible) to one or multiple phases in the lifecycle of a construction project. To provide more focused insight, the authors have only shown the disciplines that received most contributions (see figure 5). It was found that from 2002-2021, the disciplines that received the most attention, in both academia and industry, within the ASC conference are Construction Management, Risk Management and Sustainability. In terms of Construction Management, it is noticed that most efforts were within the construction phase including planning and scheduling (e.g. Woods, 2006), manufacturing methods (e.g. Olsen and Ralston, 2013), resource management, site management and equipment management. In the context of the United States, this can be reasoned by the fact that Construction Management is one of the most common programs across U.S. institutions, and the vast collaborations between academia and industry which provides solid and sustained knowledge transfer that resulted in many industry-based contributions. It is also noted that most international contributions were within the Construction Management discipline and were more industry-based. Similar to contributions within the Construction Management discipline, contributions within Risk Management are considerably and mostly focused on areas within the construction phase. The analysis noted that a high number of contributions were within health and safety and safety management. In the case of both Construction Management and Risk Management, the high number of contributions was mostly contextualized within the construction phase, which is recognized as an attractive thread of continual and progressive research in the United States. According to a study by Lee et al. (2013), it was noted that research within construction management in universities attracts an average of USD 250K, and in some universities can reach up to USD 1$. Another study indicated

that internationalized disciplines such as Construction Management have a certain amount of 'interpretive flexibility', which allows them to be shaped or mutated in different ways allowing both academics and practitioners more opportunities to continue research (Harty and Leiringer, 2017) On the contrary, contributions within the Sustainability discipline, although less when compared to Construction Management and Risk Management, was recognized to be more overarching and touched across different phases across the whole lifecycle. Whilst this reflects a great and well-sustained impact of contributions on sustainability across different phases, future considerations should be tailored to map contributions against Sustainability Development Goals (SDGs) to illustrate more impactful research for both academia and practice. From another perception, contributions within Project Management and Interdisciplinary disciplines had a noticeable impact period. It is imperative to recognize that contributions in both Project Management and Interdisciplinary research, despite discontinuity when compared with other disciplines, are the most interconnected with different phases in a lifecycle of a project. Whilst project management contributions have recognizably fallen following 2010, a major peak in contributions has risen in Interdisciplinary Research from 2010 onwards. The exponential rise in Interdisciplinary research can be reasoned by many factors including the technological wave and industry 4.0 (Schonbeck et al., 2021), and the adaptation of different approaches, tools and processes from other industries (Connaughton and Collinge, 2021). In fact, interdisciplinary research allowed more channels for impactful research contributions within the ASC conference by integrating multiple disciplines to generate value and interconnect a wider range of stakeholders.
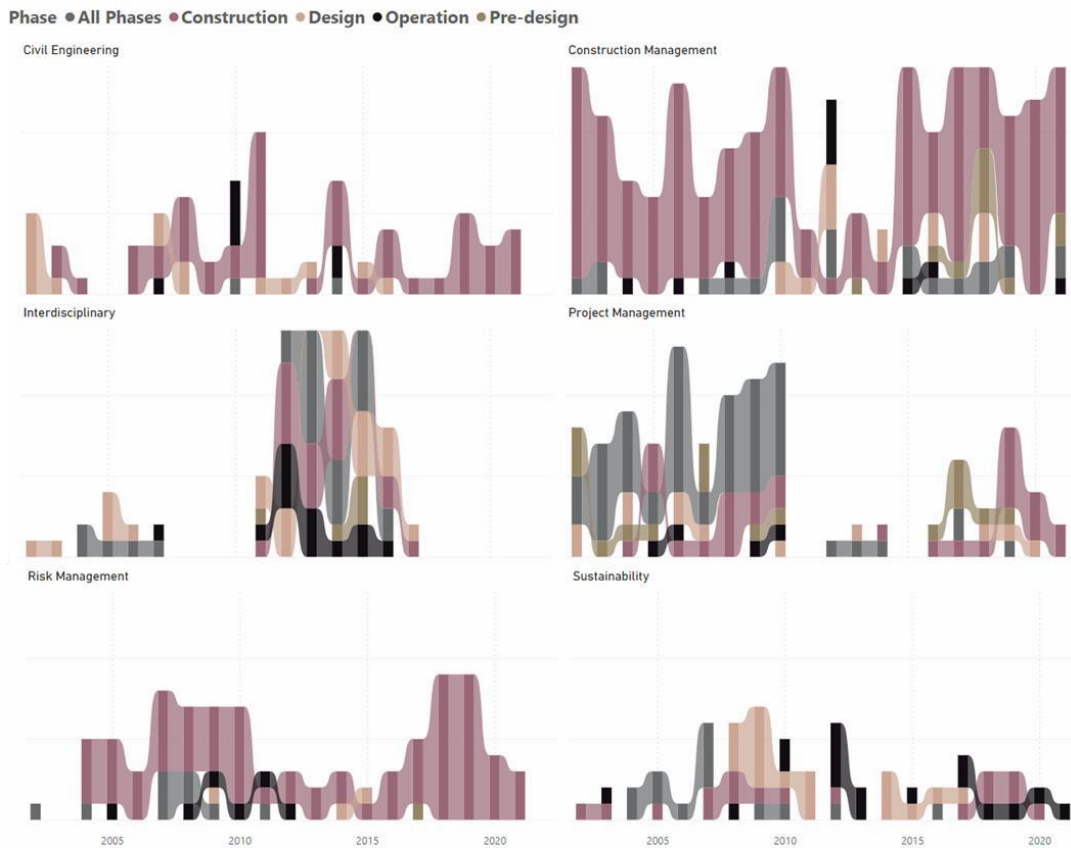

Figure 5: Disciplines that received most contributions in the ASC Conference

Emerging technologies in ASC conference proceedings

Figure 6 presents the 'technological' trend of the publications towards industry and academia. It is not surprising to see that Building Information Modelling (BIM) has received the highest attention from both academia and the industry and facilitating leading-edge technological innovation and contribution. The first paper related to BIM was published in 2006 (Gier et al., 2006) and it mainly contributed to academia in terms of teaching productivity analysis. In the following years, published research on BIM became more industry-focused. Not only limited to identifying advantages and challenges in BIM implementation in different construction disciplines such as construction management (Goucher and Thurairajah, 2012) and facilities management, the conference focus has been extended towards integrated project delivery (Mayouf et al., 2019), site planning and management, risk management, sustainability and interoperability of BIM. Besides, the latest trend is on the integration and interoperability of BIM as shown in the recent ASC publication of 'BIM-GIS: Analysis and Integration for Contractors'. It is important to note that some publications have tailored BIM towards sustainability across different phases, and this supports different interventions related to sustainability challenges, especially for the industry. BIM studies in academia were more interdisciplinary research that captured developing pedagogies, capstone projects and undergraduate education. This is recognized particularly in published research from 2013/2014 where ASC experienced a peak in interdisciplinary research. Besides major contributions towards BIM, another significant interest of the conference contributors was in laser scanning and robots and drones. Laser scanning and drones are important technologies in earthmoving operations and surveying work and the publications were appropriately in the same disciplines. Indeed, the utilization of robots in construction progress monitoring was an interesting paper which drags the attention of the readers to recent industry innovations. Concerning tracking technologies, barcodes and RFID technologies were assessed in recent years. The mixed reality was inclusive of augmented and virtual reality and their combinations. 3D printing, another emerging technology was studied for its feasibility in Spall Damage Rehabilitation. Emerging trends in manufacturing technologies were also found since 2011 and are mostly towards modular construction development which is highly demanded by the industry.
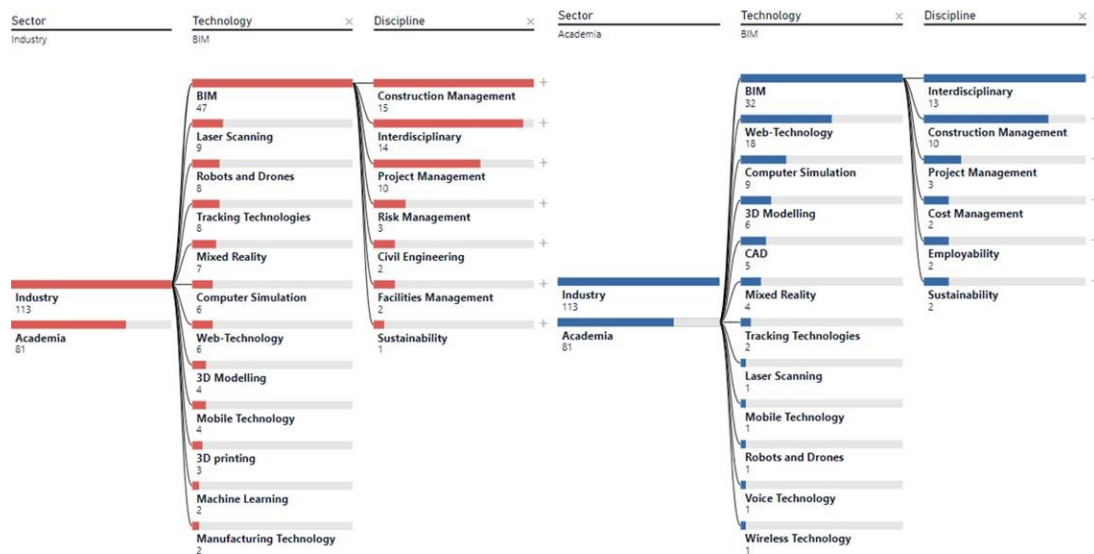

Figure 6: Capturing 'technological' trends of ASC conference publications

In academia, web technology has received the second topmost interest as a result of the significant implementation of web conferencing and other web-based systems for learning, education, planning industry operations, and simulation purposes. Deployment of web technology was urged and demanded by both academic and industrial organizations to cope with the Covid-19 emergence and disruptions caused by the pandemic. Computer simulations including computer games are other thought-provoking areas that are covered in the conference with great significance in construction education. All these simulation studies recreate similar virtual environments and are highly supportive of learning, education, and training. Undoubtedly, the future interest of the conference would be even more on BIM, mixed reality, web technologies, computer simulation, 3D printing and modelling, manufacturing technologies and robotics. However, it is much more exciting to see the conference publications are directed and focused beyond productivity and efficiency as the sole goals and boost the role and the contribution of industry to society which is emphasized in industry 5.0. Therefore, human-centric design tools and sustainable and resilient technologies would emerge as appealing technologies without reinventing the wheel. Finally, the country-specific priorities (such as net-zero Carbon strategy implementation in the UK) could be identified by extending the geographic horizons of the conference.

Conclusions and future research directions

To sum up, this research aimed to thematically review ASC proceedings to highlight consideration, contributions and capturing trends. A total of 1317 manuscripts were analyzed from the period 2002 (the first ASC online published proceedings) to 2021. As the conference originated in the U.S., it was expected that contributions were 80% from the U.S. based institutions and organizations where Auburn University was identified as the most contributing university. Internationally, most contributions were industry-based papers, and the United Kingdom (UK) was identified with the highest number of contributions in both education and industry papers. To identify and tailor contributions from both Academia and Industry papers, 11 disciplines were identified where each paper was classified according to the relevant discipline, and where applicable, each paper was contextualized to a phase within the lifecycle of a construction project. It was found that among the proposed disciplines, construction management, risk management and sustainability disciplines had the most contributions. It was also found that there is a major growing interest in interdisciplinary research, and this portrayed great potential to encourage the integration of such themes in future ASC conferences. Finally, when looking into emerging technologies within the ASC conference, it was found that BIM had the top attention in both academia and industry since 2010. In Industry-based papers, it is recognized that there is a growing interest in autonomous technologies such as robots and drones, mixed reality and also laser scanning whilst academia-based papers revealed an ongoing progression to demonstrate the impact of web-based technologies, computer simulations and also mixed reality. One of the major implications of looking into emerging technologies within the ASC conference is recognizing their impact across different disciplines, and more importantly, using the findings as a benchmark to integrate technologies with a higher impact in future ASC conferences. It is essential that, for future ASC conference, to encourage contributions into disciplines that are positioned within the operational phase such as facilities management, building performance and smart systems. Although this research elicited many interesting findings especially in highlighting the different impacts of the ASC conference, it is important to highlight potential limitations, which can be addressed in future conferences. The first limitation is the abstraction of disciplines, which mainly relied on the title of the papers, keywords and abstract, hence future research may look into further and perhaps more overarching classification. Another limitation is the contextualization of different manuscripts across phases, which primarily relied on the interpretation of the authors. Future work looks into deeper and more insightful disciplines with the most contributions to providing more informative directions for the upcoming ASC conferences.

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