

2 Exploiting e-Commerce in Construction

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The advancement in technology has provided organisations with a platform, which offers an alternative manner to deliver their services; as such, many organisations are relying on the World Wide Web (WWW) and the internet as a medium to offer their services and conduct business. e-Commerce plays an important role in construction organisations day-to-day business practices. It is considered that the e-Commerce solutions would have a greater impact on the fragmented construction industry by unifying the different stakeholders including clients, regulatory authorities, consultants, contractors and the supply chain. The use of e-Commerce in the construction industry is steadily growing when compared to other industrial sectors and in some cases it is becoming a mainstream method of transactions such as procurement and payment of commodities between companies. Thus, this chapter provides an overview of e-Commerce and e-Commerce technologies, presents extant e-Commerce literature in construction and explores the drivers and barriers to the adoption of e-Commerce within the construction industry.

2.1 e-Commerce

2.1.1 History of e-Commerce and definitions

The use of e-Commerce in the construction industry is steadily growing when compared to other industrial sectors, however, in some cases it is becoming a mainstream method of transactions such as procurement and payment of commodities between companies. The emergence of e-Commerce can be associated with Electronic Data Interchange (EDI), which was used mainly for data transfer between organisations (Bhutto *et al.*, 2005a). The development of EDI led the beginning of e-Commerce revolution in 1960s with the digital transfer of documents from one computer to another, reducing the need for sending traditional mails and faxes. Businesses including construction and building related companies transferred the order forms, invoices, and delivery information electronically from their computers to other company's computers. According to Bhutto *et al.* (2005b) EDI created the foundation for e-Commerce, yet EDI cannot be considered as an e-Commerce solution because of its configuration. The development of Electronic Funds Transfer (EFT) also enabled businesses to do the electronic transactions over the computer networks. In 1979, the American National Standards Institute (ANSI) introduced a data exchange standard, ASC X12 for sharing business documents over the computer networks. The development of communications networks such as Advanced Research

Projects Agency Computer Network (ARPANet) and the Terminal Interface Processor (TIP) helped to revolutionise the network communications in late 1970s.

With the advent of Transmission Control Protocol (TCP) and Internet Protocol (IP) and the resulting ARPANet's switch over to TCP/IP in 1982 enabled all computers to transmit information equally using an approved standard. This created the next phase in computer networking and e-Commerce. In 1990, Tim Berners Lee proposed the hypertext project to build World Wide Web using an interface called 'browser'. He also developed the hypertext mark-up language (HTML), with specifications for uniform resource locators (URLs). In 1991, National Science Foundation lifted the ban on commercial businesses operating over the Internet, paving the way for e-commerce revolution. With the arrival of graphical user-friendly browsers such as Mosaic and the HTML webpages, the web-based e-Commerce shifted to its next phase of development.

Websites such as BidCom and Cephren attempted to provide web portals for design and construction and were effective for typical project management tasks (Johnson *et al.*, 2002). Johnson and Xia (2000) discussed a number of early e-Commerce case studies in construction. One of the large architecture/engineering firms, 3D/International attempted to improve its competitive position by providing customised e-Commerce tools to clients (Johnson and Xia, 2000). Conoco, one of the global energy companies introduced standardised use of the off-the-shelf software and e-Commerce concepts to enhance productivity, allowing the organisation to easily connect with all employees and reducing the cost of both implementation and training (Johnson and Xia, 2000). Web portals such as HomeWire that provided services and tools for homeowners, builders, and contractors, and FreeMarkets that conducted online auctions for industrial parts, raw materials, and commodities allowed construction industry to embrace the web-based e-Commerce technology.

Bhutto *et al.* (2005b) suggest that there are many variations to the definition for e-Commerce in the literature and it is based on the perspective it is applied. For example Kalakota and Whinston (1997) categorise the definition of e-Commerce into three perspectives: firstly as means for delivering information, buying and selling products and (or) services. Secondly, as an approach to simplify workflows and automate processes. Thirdly, as a tool to manage and reduce operational costs and improve service delivery along with customer satisfaction. Garrett and Skevington (1999) cited in (Bhutto *et al.*, 2005b) explain e-Commerce as "trading by means of new communication technology (everything beyond voice telephony, fax and telex)". It includes all aspects of trading, including commercial market making, ordering, supply chain management, and the transfer of money". Anumba and Ruikar (2002) suggest that e-Commerce is "doing business by electronic means, typically over the Internet". This was reiterated by Kamaruzaman *et al.* (2010) suggesting that e-Commerce is the act of selling or purchasing services or products over the internet.

On the other hand, Baladhandayutham and Venkatesh (2010) claim that e-Commerce is part of a broader term 'e-business', which includes buying and selling online along with inventory tracking, managing production, supply chain management, customer support services, and collaborative engineering. Stewart (2001) supports this explanation of e-Business; however, he suggests that it is necessary to review the processes, cultivate new skill sets, and building new relationships with customers. While Ruikar and Anumba (2009) explanation of 'e-business' bears similarity to the broader definition for e-Commerce offered by Kalakota and Whinston (1997), which can be summarised as the application of technology for automation of business transactions, the delivery of information, products/services and other online services over the internet. Drawing from these various definitions, it is apparent that e-Commerce is not only about conducting business via the internet, but also about online communication, collaboration, and commercial transactions between multiple organisations, individuals, and government agencies.

2.1.2 Classification of e-Commerce

e-Commerce can be classified into the following categories based on the parties involved in a transaction (Bhasker, 2013). Laudon and Traver (2014) included peer-to-peer (P2P) and mobile commerce (m-commerce) as additional classifications of e-Commerce.

- Business-to-Business (B2B)
- Business-to-Consumer (B2C) or Consumer-to-Business (C2B)
- Consumer-to-Consumer (C2C)
- Business-to-Government (B2G) or Government-to Business (G2B)
- Business-to-Employee (B2E)
- Peer-to-Peer (P2P) e-Commerce
- Mobile commerce (m-Commerce)

2.1.2.1 Business-to-Business (B2B) e-Commerce

Business-to-Business (B2B) e-Commerce is about facilitating business transactions electronically between two or more businesses, directly or via an intermediary. B2B e-Commerce includes all types of interactions among businesses. This includes order management, invoice and payments, and inventory management. Bhasker (2013) defines three types of B2B e-Commerce models such as buyer-centric, supplier-centric, and intermediary-centric. In a supplier-centric model, which is usually the business model for dominant suppliers, supplier creates an electronic market place for other businesses with customised pricing and solutions. In a buyer-centric model, major businesses with high volume purchasing power set-up market places for purchases of goods and services. In an intermediary-centric model, a third party creates a market place for buyers and sellers to carry out e-Commerce.

2.1.2.2 Business-to-Consumer (B2C) or Consumer-to-Business (C2B) e-Commerce

Business-to-Consumer (B2C) e-Commerce facilitates business transactions between businesses and consumers. In B2C, businesses sell goods and services directly to consumers without any need for intermediaries and the consumers have the capabilities to choose the businesses based on the quality and pricing. Businesses benefit from direct marketing and more profit, while consumers benefit from lower prices and timely delivery. On the other hand, Consumer-to-Business (C2B) e-Commerce offers the opportunity for consumers to specify the requirements and the budget for particular goods or services and then businesses match the requirements with best offers.

2.1.2.3 Consumer-to-Consumer (C2C) e-Commerce

Consumer-to-Consumer (C2C) e-Commerce facilitates business transactions among consumers. It provides market places for consumers to trade products and services to other consumers through Internet. In this model, both buyers and sellers perform transactions over the third party trading platforms such as auction sites, and have the ability to negotiate the prices and communicate directly with other consumer. The buyers often benefit from lower prices, while the sellers have the responsibility for packaging and shipping. In some cases such as blogs and reviews that target other consumers, no business transaction is carried out between consumers; however, the publishers may benefit from online advertisements and web traffic.

2.1.2.4 Business-to-Government (B2G) or Government-to Business (G2B) e-Commerce

Business-to-Government (B2G) and Government-to Business (G2B) e-Commerce refers to transactions that are performed between businesses and governments. B2G e-Commerce covers services provided to government departments by businesses in order to provide public access to government services such as tax affairs, vehicle and transport services, and local taxes. G2B e-Commerce covers the business activities that are aimed at businesses to fulfil government service requirements such as e-Tendering. B2G and G2B e-Commerce activities increased in the last decade due to governments looking to reduce the cost and increase the use of Internet to provide public services.

2.1.2.5 Business-to-Employee (B2E) e-Commerce

Business-to-Employee (B2E) e-Commerce covers intra-organisational business activities between the employees and organisation. This is mainly carried out through the company intranet and could include human resource functions such as sharing and updating personal information, financial transactions such as expenses claims and personal development activities such as booking training events. B2E e-

Commerce also facilitates the communication between the management and the employees and helps to improve the organisation-employee relationships.

2.1.2.6 Peer-to-Peer (P2P) e-Commerce

In Peer-to-Peer (P2P) e-Commerce, the data and information are shared by users directly with other users without any intermediary or central web server. Users who are both suppliers and consumers form the nodes of the peer-to-peer network, share their computer resources such as storage space and Internet bandwidth to access, and share the data. The P2P networks have been used to share music files, videos and software, and introduced new model of user interaction, however due to copyright issues of sharing files, some of the popular P2P networks have been shut down. Since then, hybrid models have been introduced to include both peer-to-peer and client-server models.

2.1.2.7 Mobile commerce (m-Commerce)

Mobile commerce (m-commerce) covers the use of mobile devices to carry out business transactions over the wireless Internet. Businesses and consumers use mobile devices such as smart phones and tablet computers and connect to use other businesses and consumers through wifi hotspots and 3G/4G mobile Internet to conduct business operations such as money transfer, stock trading, and buying and selling product and services. With the arrival of smart phones and the mobile apps, the use of m-commerce has increased significantly in recent years.

2.2 e-Commerce in construction

2.2.1 Related studies

With the success of e-Commerce businesses such as Amazon and eBay, many businesses including construction organisations began to embrace the potentials of e-Commerce in their business operations. The construction industry is regarded as an essential contributor to the country's economy development (Bhutto *et al.*, 2005b), according to Rhodes (2015) 'in 2014 the construction industry in the UK contributed £103 billion in economic output, 6.5% of the total'. While the use of e-Commerce is also contributing towards the economy for example from 2006 up to 2010, the revenue is US\$10 trillion, with United States and Europe contributing 79% to this global revenue (Kamaruzaman *et al.*, 2010). While in the UK, according to Office for National Statistics (2015) e-Commerce sales were around £1.5 billion, which has shown 24% growth rate between 2008 and 2014. Hence, it can be argued that e-Commerce has transformed the world of business and introduced new business models. Although, the construction industry has often been slow to adopt new technologies, there are indication that

organisations tend to adopt a small subset of the current e-Commerce technologies, such as e-Procurement, e-Tendering, e-Collaboration, e-Auctions, and e-Payment. (Stewart, 2001; Anumba and Ruikar, 2009). Various research studies have been undertaken to exploit the potentials of e-Commerce in construction as shown in Table 1.

Table 1: Some of the e-Commerce research studies in construction

Construction activity	e-Commerce applications in construction	Studies
Procurement	Construction material procurement	Kong and Li (2001)
	Construction material procurement using Internet-based agent system	Hadikusumo <i>et al.</i> (2005)
	e-Procurement in construction Sector SMEs	Vitkauskaite and Gatautis (2008)
	Information sharing between e-Commerce systems for construction material procurement	Kong <i>et al.</i> (2004)
	Intelligent agents for construction procurement negotiation	Dzeng and Lin (2004)
	Geographical Information Systems System for e-Commerce application in construction material procurement	Li <i>et al.</i> (2003)
Construction alternatives	On-line decision support system for construction alternatives	Kaklauskas <i>et al.</i> (2007)
Project Management	Web-enabled Project Management	Alshawi and Ingirige (2003)
Supply chain	Construction supply chain coordination	Xue <i>et al.</i> (2007)
	Supply chain optimization in B2B construction marketplaces	Castro-Lacouture <i>et al.</i> (2007)
Bidding	e-Bidding proposal preparation system	Arslan <i>et al.</i> (2006)
Process improvement	Construction business process improvement through e-Commerce	Ruikar <i>et al.</i> (2003)
Collaboration	Project-based web platform for collaboration in social e-business model	Costa and Tavares (2012)
	e-Commerce application system for collaboration and information sharing	Wang <i>et al.</i> (2007)
	Intranet and extranet to generate a co-operative virtual workplace and business environment	Wong (2007)
Waste management	e-Commerce based waste exchange platform for demolition waste exchange	Chen <i>et al.</i> (2006)
Information management	A web- based system for facilitating construction information management and communication	Chassiakos and Sakellaropoulos (2008)

Due to the surging popularity of Building Information Modelling (BIM) in industry and academia, Ren *et al.* (2012) attempted to combine e-Commerce and BIM approaches and proposed a framework to integrate BIM and e-Commerce in a material procurement process. BIM integrates key building data in a 3D model that can be used in collaborative environment to manage product information throughout a project lifecycle. It has been considered as a game-changing technological development for the construction industry. However, the benefit of integrating e-Commerce with BIM is not yet fully realised and therefore it is unlikely to have any real impact on the e-Commerce development in the near future.

On the other hand, the retail industry is fast adopting the Internet of Things (IoT) technology, which is a network of connected objects that can communicate with each other wirelessly. The IoT has been predicted as a technology to push e-Commerce to the next level and therefore could prove to be a significant technology for e-Commerce development in construction industry. Manyika *et al.* (2015) predict that B2B applications of IoT have greater economic potential than consumer applications and estimate that the economic impact of IoT applications could be from \$3.9 trillion to \$11.1 trillion per year in 2025 (Manyika *et al.*, 2015). However, in order to realise the full potential of e-Commerce and any emerging technologies, construction sector has to innovate itself by improving its processes, upskilling its workforce, investing in research and development, taking calculated risks and embracing new technologies.

2.2.2 Technologies for e-Commerce in construction

The e-Commerce has challenged the traditional business models and introduced new ways of conducting businesses. The popularity of e-Commerce models and their successes are made possible by its unique features as discussed by Laudon and Traver (2014). These eight dimensions of e-Commerce technologies are listed in Table 2.

Table 2: e-Commerce technologies for construction, adopted from Laudon and Traver (2014)

Unique features of e-Commerce	e-Commerce technologies
Ubiquity	<ul style="list-style-type: none"> • Internet and Web technology such as TCP/IP and HTML • Devices such as personal computers, laptops, smart phones and tablet computers • Broadband, 3G/4G mobile technologies
Global Reach	<ul style="list-style-type: none"> • Internet and Web technology such as HTTP, SSL, Web browsers • Web servers and clients • Internet telephony - Voice Over Internet Protocol (VOIP)
Universal Standards	<ul style="list-style-type: none"> • Internet and Web standards and languages such as HTML, XML, CSS, DOM, ECMAScript, URLs and SSL • Web accessibility standards
Richness	<ul style="list-style-type: none"> • Video, audio and text via Internet and Web • Streaming media delivering audio/video • Databases and database servers
Interactivity	<ul style="list-style-type: none"> • Web and interaction technologies such as 3D and animation • Video conferencing and teleconferencing • Tele-immersion such as virtual and augmented reality
Information Density	<ul style="list-style-type: none"> • Communication and collaboration technologies such as e-mails and web chats • Intelligent databases and data mining techniques • Search engines and intelligent agents • Intranets (located within a single organisation) and Extranets (can be accessed by outsiders)
Personalisation/ Customisation	<ul style="list-style-type: none"> • Communication technology, standards and tools such as personalised emails, instant messaging and chats

	<ul style="list-style-type: none"> • Customisable user interfaces with touch-screen capabilities
Social Technology	<ul style="list-style-type: none"> • Communication and mobile technologies • Big Data and analytical technologies • Cloud computing and storage technologies

The construction organisations can benefit from e-Commerce technologies in various ways. The benefits are discussed according to the identified e-Commerce features.

- **Ubiquity:** Construction organisations are able to access Internet and World Wide Web from anywhere anytime through the personal computers and mobile devices. This enables them to conduct commerce, communicate, and collaborate with other business, consumers, and governments around the clock from any part of the world.
- **Global Reach:** Construction organisations can communicate, collaborate, conduct business operations, and carry out commercial transactions with other businesses, consumers, and governments across the world without any boundaries. This provides them with global market for their products and services and offers access to global supply chain of manufacturers and suppliers.
- **Universal Standards:** Construction organisations can conduct business transactions and communicate across the globe seamlessly and securely without any modification. This reduces the cost and time of business operations and improves productivity and efficiency. Businesses can also develop web-based business applications that can be used by anyone and are built with forward and backward compatibilities in evolving Web standards.
- **Richness:** Rich media including video and audio can be produced by the construction businesses and streamed to partners and clients for purposes such as marketing and communication. This increases the consumer experience and can reach out to wider audiences. Rich media can also be used to provide training to employees through videos and facilitate face-to-face meetings with video conferencing.
- **Interactivity:** Construction businesses can benefit from rich and personalised interaction with other businesses and consumers through online mediums. Organisations are able to provide face-to-face experience to their partners and clients on a global scale through 3D and animated graphics. Businesses can also deliver visualisation and interaction capabilities such as 3D building models about the products and services through virtual and augmented reality techniques.
- **Information Density:** Construction organisations benefit from reduced cost and time to process and store complex business and financial data by using intelligent databases and data mining techniques. Businesses can also improve the quality and accuracy of information and provide up-to-date information to employees, partners and clients. Using the internal networked

information such as Intranets, organisations are able to supply data and information to the right people at the right time using information retrieval capabilities.

- **Personalisation/Customisation:** Construction businesses can benefit from personalised products and services delivered to consumers and partners. This will provide them with effective communication and collaboration mechanisms with other businesses and consumers. Manufacturers and builders are able to supply customised products, services, and orders based on individual specifications according to clients' budgets.
- **Social Technology:** Construction organisations can utilise the social content created by consumers to support the business planning and business intelligence. Social technology can be used to understand consumer demand, preferences, and market trends. Peer reviews and ratings that are provided by users can be used to improve the business processes and promote the products and services. Business can also benefit from the access to social networks for potential consumers and businesses and for e-marketing purposes.

2.3 Drivers and barriers for e-Commerce adoption in construction

2.3.1 Drivers for e-Commerce adoption

Bhutto *et al.* (2005b) argue that the construction industry cannot afford to lag behind in the adoption of e-Commerce technologies, which can be utilised to address competitive market conditions, constant price fluctuation and the need to provide sustainable and innovative project delivery strategies along with procurement practices. There are several initiatives to promote the adoption of technology solutions within the construction industry (Smyth, 2010), as a means to improve performance and make the industry more competitive. Some of these initiatives within the UK construction industry date back to 1998, for example the Egan *et al.* (1998) report, which proposed several measures to 'advance the knowledge and practice of construction best practice', developing trust and respect with the construction supply chain, measuring performance, etc. Despite this earlier initiative, there have been little progress, as reported in the HM Government (2013) construction 2025 report, which sets a vision that "Construction in 2025 is no longer characterised, as it once was, by late delivery, cost overruns, commercial friction, late payment, accidents, unfavourable workplaces, a workforce unrepresentative of society or as an industry slow to embrace change". This implies there is still a lag in the construction industry when it comes to the adoption of technology that can improve the construction industry's efficiency and effectiveness.

In context of this chapter, drivers are regarded as the factors that encourage the adoption of e-Commerce technologies within the construction industry. There are several studies (Love *et al.*, 2001; Stewart, 2001; Ruikar, 2004; Eadie *et al.*, 2007; Eadie *et al.*, 2010; Lou and Goulding, 2010; Isikdag *et al.*, 2011;

Laryea and Ibem, 2014) that have explored the drivers and barriers for e-Commerce technologies adoption in the construction industry. These drivers as in Table 3 have been identified from the above-published work and are used to provide context to the discussion of promoting e-Commerce adoption.

Table 3: Drivers of e-Commerce

Drivers of e-Commerce	
Service/process trends	Streamlined supply chain Integrated service
Organisational	Increased process transparency and visibility Continuous innovation
Technology advancements	Enterprise applications: connect the organisation Infrastructure convergence: merge voice, data and video Information access and connectivity

It is understood that the construction industry is more project driven and have various stakeholders working towards a single project (Goulding and Lou, 2013), with the possibility spanning multiple clients, suppliers, contractors etc. Optimising the business processes and providing a flexible fulfilment and delivery, which could result in integrated services that would potentially offer consistent and reliable information and effective communication channels. In addition, process re-engineering can lead to transparency and visibility across all business sector, which could lead to more co-operation and collaboration, along with establishing business relationships. According to Lou and Alshawi (2009), having the ability to collaborate and share information with stakeholders is a sought after trait in any industry. This reflects on the organisations' stability, which in return could lead to the organisation gaining a competitive edge.

With the advancements and technology infrastructure, it is regarded as a significant enabler of e-Commerce and an indicator for growth. Taking advantage of the technological trends could lead to high market diffusion, which could open-up multiple channels for conducting business, this could be through provide end-to-end connectivity with all stakeholders, which could improve company's image to external environment (community and corporate). Thus, it is postulated that the adoption of e-Commerce would result in cost reduction, performance improvement, competitive edge and efficient procurement process, improve project planning, supply chain management, logistics and document management (Anumba and Ruikar, 2009; Aboelmaged, 2010; Baladhandayutham and Venkatesh, 2012). These factors could be utilised as the baseline for assessing the need for change, especially when considering adopting e-Commerce technologies to support the construction industry.

2.3.2 Barriers for e-Commerce adoption

Barriers refer to the commonly found obstructions to e-Commerce within the construction industry. The hesitation to adopt the e-Commerce solution can be associated with the stakeholders' mind-set

(Lindsley and Stephenson, 2008). This has been a main concern that has been highlighted in previous studies, for example (Ruikar, 2004) indicated the need for construction industry to embrace change and move away from its traditional working practices. In fact, Ruikar (2006) suggest that when it comes to stakeholders opinion about adoption of e-Commerce in constructions industry, there are two school of thoughts: those who are in support and those who are against e-Commerce technologies. Those in support of e-Commerce face stiff competition to provide detailed reasoning to support the change from traditional methods that most people are used too. Possibly this could be associated with lack of understanding of the benefits that can be brought about by embracing new approaches or maybe fear of being replaced with technological solutions (Love *et al.*, 2001).

Although, Baladhandayutham and Venkatesh (2012) suggest e-Commerce solutions could aid in potential performance improvement, Lou and Alshawi (2009) list several factors that can hinder the adoption of e-Commerce. These are industry's structure; fragmented supply chain; few 'champions' limited support. Another study conducted by Ruikar (2004) establishes the barriers for the adoption of e-Commerce technologies within the UK construction sector, these are: technology capabilities, telecommunication networks, trust & reliability and regulatory issues. Love *et al.* (2001) explored barriers for e-Commerce adoption in Australian construction industries. They established several barriers and categorised these drivers into four main categories: organisational (such as lack of employee knowledge), financial (such as the cost of system requirements and maintenance), technical such as (risks associated with security and authentication) and behaviour (such as fear of job lost). Several other studies have examined the barriers of e-Commerce adoption, such as (Eadie *et al.*, 2007; Eadie *et al.*, 2010; Isikdag *et al.*, 2011; Laryea and Ibem, 2014), extending the literature by providing alternative barriers to the adoption of e-Commerce.

Most of these studies categorised these drivers into either external environment, internal environment, organisation, or technology to provide a more holistic perspective to the effect of these drivers. Although there are numerous studies and variation of the different barriers classification, these barriers are inter-related and are interdependent to each other. For example, technology capabilities could be influenced by the external environment such as suppliers and customers. Al-Somali *et al.* (2015) utilises T-O-E framework to explore e-Commerce adoption and suggest the framework would assist in explaining the inter-relationship between the different barriers. Additionally Rowe *et al.* (2012) suggests that the T-O-E framework an established framework to study adoption of technology within organisation. In the Technology-Environment-Organisation (T-O-E) framework, Tornatzky and Fleischer (1990) suggest that the adoption of technology is influenced by external, internal and technology factors. The T-O-E framework offers three contexts: technology, organisation, and environment. The technology context represents existing and new technologies relevant to the organisation, including their benefits, compatibility, and complexity. Organisational context describes the internal measures such as scope, size, managerial support, and availability of resources.

Environmental context refers to the field in which the organisation operates; this includes elements such as government legislation. Although in this section the T-O-E constructs are not adopted, the categories are utilised as a means to offer a more generic categorisation of the barriers identified from the different studies mentioned above, in order to establish commonality between the barriers and their interactions. Table 4 summarises the different barriers identified from previous studies into technology, organisation, and environment context.

Table 4: Summary of e-Commerce adoption barriers

Studies	Categories	Barriers
Love <i>et al.</i> (2001); Ruikar (2004); Rankin <i>et al.</i> (2006); Eadie <i>et al.</i> (2007); Isikdag <i>et al.</i> (2011); Oyediran and Akintola (2011); Laryea and Ibem (2014)	Technology	Lack of widely accepted e-Commerce solutions Compatibility issues Integration of e-Commerce with other systems Interoperability of e-Commerce systems Lack of Flexibility Security issues Infrastructure
	Organisation	Management support Cultural Issues Lack of technical expertise Low or lack of awareness Operational cost Issues
	Environment	Loss of business relationship with costumers Legislative /government support Complicated procedures and extended relationships Ownership of information

2.3.2.1 Technology barriers

This categorisation refers to the role of technology in the adoption of e-Commerce. While the advancement of technology is always considered to be an advantage to the any industry, Flanagan and Marsh (2000) suggests the important element is how organisations leverage these technologies. The advancement of technology introduces its own challenges as such as integration of the different systems such as e-Procurement, e-Tendering, e-Collaboration, e-Auctions, e-Payment etc. As there is no holistic e-Commerce solution, integration becomes an on-going challenge that organisations need to consider and support with relevant knowledge of the technologies. The challenges of integration may also result in interoperability issues when different application are utilised. However, Eadie *et al.* (2007) highlights the availability of approve packages for Construction Industry Trading Electronically (CITE) and some supporting open source software, as means to address this barrier. However, still argues that interoperability between applications to be a concern for e-Commerce adoption. This also may result in aligning the processes with the technology offerings, in fact according to Love *et al.* (2001) the identification of which technology to be used to match the organisation’s requirements is one of the major barriers. This has be reiterated in Lou and Alshawi (2009) where it was suggested that the barriers to e-Commerce is process alignment with technology functionality. For example, Love *et al.* (2001) cite one of the respondents suggesting that when technology adopted are not aligned to the requirements it may lead to added costs and loss to the business.

The frequent technology advancement, may also lead to systems not being compatible with each other, for example if one of the stakeholder within the supply chain is on the latest technology, and the other stakeholders are using outdated systems, it may result in compatibility issues, which could lead to information not being transferred appropriately. Additionally, there is growing concern for security and confidentiality of the information during transmission (Eadie *et al.*, 2007), as with any internet system, the data is transferred to multiple network providers. Thus, there is an extra effort required to ensure no tempering of information is done and the e-Commerce infrastructure are secured and not easily hacked. Therefore it is essential for organisation to evaluate the benefits of technology before adopting it, however each organisation perceives benefit differently, and what one organisation considers valuable may not be similar to another organisation. Therefore, most organisations gauge the benefits of e-Commerce based on its usefulness and effectiveness to streamline the processes, improve performance, and reduce operational costs.

2.3.2.2 *Organisation barriers*

The organisation barriers refer to internal factors that hinder the adoption of e-Commerce; these include management support, cultural issues, lack of expertise and operational costs. Normally, the adoption of e-Commerce would result in processes change (Ruikar, 2004), that aims to align the technology to the organisation requirements. This ensures the organisation adapts to the new medium of delivering their services and market conditions. In order to support these transformations, there is a need to eliminate redundant processes and re-engineering some of the existing processes or formulate new processes. These results in organisation requiring invest in experts or re-training their staff in order to ensure they can take full advantage of the new technology (Love *et al.*, 2001; Eadie *et al.*, 2007). Additionally, when contemplating adoption of any technology, it is important to gain top management involvement and support as it plays a significant role in the decision. For example, when the top management are in support, these projects will be given priority and assigned realistic timelines and resources. The cases where management support is not attained, there is very little possibility for such projects to be given any considerations. Therefore management buy-in is very critical, as it shows the level of encouragement to use new technology to support the organisations operations (Al-Somali *et al.*, 2015). However, in order to gain this buy-in a clear justification which outlines the benefits and return on investment needs to be provided in order to persuade the top management (Stewart, 2001). According to Ruikar *et al.* (2006) and Chen *et al.* (2013) people play an important role in supporting change, as they could be resist technology changes in fear of their jobs or simply because they have no expertise to use the technology. In their study Kheng and Al-Hawamdeh (2002) report that 60% of their respondent preferred other solutions when compared to e-Procurement. According to Eadie *et al.* (2007) the resistance to change can be addressed providing effective leadership and creating an organisational culture that is in favour of change. Additionally, to promote change, there is a need to understand the

need for change, the training requirements, along with communicating these to all levels of employees and stakeholder, in order to create inclusiveness and identifying change champions within the organisation.

2.3.2.3 *Environmental barriers*

According to Chaffey *et al.* (2009) environment barriers include consideration of both macro-environment and micro-environment that hinder the adoption of e-Commerce. These normally include the various stakeholders, such as suppliers, consumers, partners, and legal entities. The interaction and collaboration of these stakeholders are vital for the success of these projects that these stakeholders work in cohesion (Goulding and Lou, 2013). Thus, it can be argued that the stakeholder's can hinder the adoption of e-Commerce, especially if some of them are still operating using traditional methods. For example, if an organisation implements an e-Commerce solution there is a possibility to hinder collaboration with others, as the information would still be required to be submitted manually to those using traditional methods. Thus, for an effective e-Commerce adoption, all the partners need to be convinced to adopt the technologies. This could explain why organisations avoid changing from the traditional ways of operating or just utilise some aspect of the e-Commerce technologies such as e-Tendering, and e-Procurement (Stewart, 2001; Anumba and Ruikar, 2009), which assist with the daily routine. In addition, e-Commerce technologies rely on the internet as a medium to conduct business; hence, the different or lack of national approaches and strategies (Carayannis and Popescu, 2005), could hinder the adoption within the global collaboration environment. Therefore, in order to be effective and truly borderless, there is a need for a global standardisation of the strategies, where unique standards are followed globally in order to ease the adoption of e-Commerce solutions. However, the manner in which construction industries operate is very complex and is governed and informed by regulatory bodies and institutional policies to become competitive. This implies that there is a need for evaluating the legal risks, according to Ismail and Kamat (2006), these legal risks include contract formation, attribution, privacy, conflict of laws, authentication etc., prior to adopting any technology in order to comply with the regulations and standards. For example Eadie *et al.* (2007) report in their finding that “only 26% of respondents agreed that ICT was acceptable as admissible written proof during construction”. Thus, indication the level of awareness of the advantages offered by e-Commerce and technology as a whole is still limited, specifically when it comes to regulatory and legislative issues, which may result in some stakeholders being reluctant to adopt e-Commerce solutions.

2.3.3 Exploiting e-Commerce in construction

The use of e-Commerce in the construction industry could lead the industry in the right direction of fulfilling the construction 2025 vision and be in line with the recommendations of the Egan report. As the adoption and use of e-Commerce technologies could result in performance improvement, integrated supply chain and lean construction (Laryea and Ibem, 2014). However, the adoption of e-Commerce is a complex undertaking, and the decision is dependent on balancing the interaction of numerous technological, organisational, and environmental barriers, along with understanding the benefits. One key observation from previous studies for example (Bhutto *et al.*, 2005b; Ruikar, 2006; Laryea and Ibem, 2014), is that the construction industry is still lagging behind in the adoption of e-Commerce technologies. Probably creating an awareness of the e-Commerce benefits and its application could be vital in promoting its adoption. Some of the barriers can be overcome by readily available solutions. For example, the issue of security can be addressed with the implementation of firewalls, and other security measures to reduce the risks of security breaches. Hence, it can be argued that more attention should be given to identify strategies to enable and promote the realisation and leveraging of the benefits of e-Commerce.

To date, there are several studies proposing models and frameworks, such as Ruikar *et al.* (2006) proposed VERDICT, Chen *et al.* (2013) proposed a Strategic E-Business Framework and Al-Somali *et al.* (2015) advocated a Stage-Oriented Model (SOM) for E-Commerce Adoption, all these studies aimed to support organisations to evaluate their E-readiness. According to Lou (2010) the evaluation of E-readiness is a global agenda, however it is still not fully explored. Ruikar *et al.* (2006) and Chen *et al.* (2013) focused their effort on the construction industry, and it is argued that the use of these E-readiness tools would provide an in-depth understanding on the need to change and identify the skills and knowledge gaps, along with exploring the external environment factors that could hinder the adoption of e-Commerce solution. Thus, such an approach would allow the organisation to demonstrate the level of its readiness to adopt and establish the opportunities and benefits for adopting e-Commerce. This could be a step forward in promoting e-Commerce adoption. However, it should be noted that the adoption of e-commerce varies depending on the company size and type of service offered. Therefore, any model for adoption should take into consideration the business needs and the organisation ability of leveraging the potential of e-Commerce technologies.

The IoT applications could potentially revolutionise the construction sector, from applications in construction sites for equipment maintenance and health and safety of workers, to energy management in buildings, to human productivity applications using the augmented-reality devices (Manyika *et al.*, 2015). Bitcoin, which is a digital currency and a peer-to-peer payment system that allow payments to be sent directly from one party to another without going through a central authority could revolutionise IoT based e-Commerce in construction (Noyen *et al.*, 2014). By combining e-Commerce with IoT, the

management and ordering of construction materials and supplies could be automated, the building energy usage could be reduced with smart thermostats and appliances, and the status of construction equipment can be monitored, maintenance and repair services can be arranged and the invoices can be settled automatically. Turber et al. (2014) and Porter and Heppelmann (2014) proposed new business models based on IoT and construction organisations have to embrace the possibilities offered by the IoT in their current and future business models. However extant literature in construction discipline have not yet provided effective methods for such considerations or implementations.

2.4 Summary and conclusions

It is evident from the success of e-Commerce in retail and other sectors that e-Commerce technology has the potential to provide several benefits to construction industry. However, the adoption and implementation of e-Commerce technologies in construction industry are limited compared to other sectors. This is due to several challenges and issues as discussed in terms of technology, organisation and environment factors. This chapter discussed e-Commerce and the related benefits to construction businesses. Through e-Commerce, construction organisations can communicate, collaborate, conduct business and carry out commercial transactions with other businesses, consumers, and governments across the world. Businesses are able to provide face-to-face experience to their partners and clients on a global scale through visualisation and interaction capabilities. However, the decision to adopt e-Commerce is dependent on balancing the interaction of numerous technological, organisational and environmental barriers. This chapter argued that more attention should be given on identifying strategies to promote the realisation and leveraging of the benefits of e-Commerce in construction sector. It is also argued that the use of E-readiness tools would provide necessary understanding on the need to change and explore the external factors that could hinder the adoption of e-Commerce solution.

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