

Business model innovation for Industry 4.0 agenda

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Abstract

The manufacturing industry is currently within the fourth industrial revolution. The term “Industry 4.0” refers to the automation and digitisation of the manufacturing industry with new technologies emerging. The UK infrastructure sector currently have many projects on going, upgrading existing assets and constructing new assets. Despite being in the fourth industrial revolution, the infrastructure sector is finding it difficult to adopt and implement industry 4.0 agenda as there is no direct guide or standards available for implementation, in addition organisations within the sector do not understand the requirements and competency level. This paper aims to outline the need for business model innovation within the sector to enable the adoption and implementation of industry 4.0 agenda. This study takes a case study approach and semi-structured interviews were undertaken from experts in the infrastructure sector to analyse the need for Business model innovations within the sector.

Key words

Industry 4.0, Infrastructure, Innovation.

(3000 words: max. 2 figures or tables)

Introduction

Infrastructure are basic equipment's and structures that are needed within the economy for it to function properly. For the past seven years, the production of infrastructure has been at a steady decrease (KPMG, 2015) which has taken a toll on the economy. The government has decided to invest in infrastructure for the next 20 years (HM Treasury, 2013) especially within the transport sector, however providing a fast and efficient production has always been a struggle. From collaboration to clashes during construction, costs of building infrastructure increase as the construction goes on and even after construction as maintenances are not very well organised. The stake market report published in 2014 has specified that construction clients have very little trust in digital advances and automated practices when compared to the contractors and consultants in the industry (Stake Market Report, 2014). Clients in the UK are finding it difficult to put their full trust in the new strategies which includes understanding its benefits (Hurtado & Sullivan, 2012), in addition to this the lack of knowledge on how Industry 4.0 strategies can benefit a project throughout its lifecycle and its expected value is a major issue.

The use of digitised processes and automation in the infrastructure transport sector is not clearly defined which is the reason why clients find it challenging to make the decision to invest in the use of the advanced digital solutions as the benefits are not clear to them (Hurtado & Sullivan, 2012). The UK construction industry are still to accept these technologies which is the main barrier which is sourced from lack of awareness of the possible benefits that can provide and the lack of knowledge is also an issue as a massive amount of training of Industry 4.0 applications will be required throughout the industry (Succar, 2012). Eastman et al (Eastman, 2011) has argued in his number of publications on how automation and digitisation can benefit the infrastructure transport sector, however, these arguments are more project focused as the benefits shown are benefits to the project rather than the business of the client. In terms of the Building Information Model which is one of the Industry 4.0 applications, the Smart Market Report (Stake Market Report, 2014) has linked the benefits gained from BIM to its capability and maturity level, however this is not clearly defined which is why there is a lack of knowledge on what maturity level to implement to achieve maximum benefit from BIM for an organisation. This uncertainty would become clear if there were clear guidelines available for clients to follow to allow them to gain the benefits they require from BIM.

BIM as well as the new developing Industry 4.0 applications such as Artificial Intelligence are new to the infrastructure sector, several organisations have been aware of some of these applications, however they have been mainly popular in the Architecture and Mechanical industries over the past year. With the UK government mandate of Level 2 BIM with all public sector projects, the infrastructure sector is to use BIM within their projects. To enable this mandate to go forward, obtaining a guidance will add clarification about what is required for the clients to achieve the maximum benefits from Industry 4.0 agenda in all the different areas of the project's lifecycle.

Methodological Approach

This research adopts a framework that aims to enable client organisations to adopt Industry 4.0 strategies along with a business model to clarify the business changes that are affected by the adoption of the new ways of working. This study uses a case study methodology approach to identify the challenges being faced by the infrastructure sector in terms on Industry 4.0 agenda implementation and adoption. Case studies were observed and 10 semi-structures interviews were conducted within large infrastructure organisation in the UK to gather more insight from the participants.

Case Study

As defined by Yin (2014), a case study is

“...an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident..” (Yin, 2014).

The case itself can vary where it can be a person, organisation, project etc. Adopting a case study research can mean that multiple cases can be researched. Case studies can be split into three main categories;

- *Exploratory*: These type of case studies are usually used to test the hypothesis to extract a conclusion that is logical.
- *Explanatory*: Explanatory case studies are driven by theory and can be used within the research to create a hypothesis within a large-scale research study.
- *Descriptive*: A descriptive case study is utilised to describe the cause and effect of the research as the name suggests (Yin, 2014).

Yin claims that in terms of the different types of case studies, explanatory studies are useful in identifying the “how” and the “why” whereas exploratory case studies aid in identifying the “what”. This proves that case studies can be used to provide a wider insight for this particular study.

Semi-Structured Interviews

Analysts have pointed out that semi-structured interviews are the most commonly used by qualitative researchers (Alshenqeeti, 2014). This type of interview also has set questions similar to the structured interviews which have been prepared by the researcher, however when this interview is being conducted the structure of it is mainly dependent on the responses provided by the interviewee. The questions asked by the researcher are based on the topic at hand however the interviewee is free to explore beyond the research question allowing flexibility to gather more in-depth information for the researcher (Adhabi & Anozie, 2017). As the nature of this form of interview is flexible, they can be conducted either on a personal level or within a group, however conducting this form of interview in with individual interviewees will provide a more in-depth interview where the researcher can highlight personal opinions.

Group semi-structured interviews are also beneficial to a researcher as having a group discussion on the topic will allow the researcher to gather more information and opinions as a collective, with this being said, it is acknowledged that semi-structured interviews are an ideal method of collecting data for qualitative researches (DiCicco-Bloom & Crabtree, 2006).

For this study, a total of five large organisations within the UK infrastructure sector took part. 10 experts took part in the interviews, a summary of the organisations are demonstrated in Table 1:

Table 1: Summary of organisations taking part in study

<i>Organisation</i>	<i>Size (No of employees & revenue)</i>	<i>Operation Nature</i>	<i>Industry 4.0 Agenda Adoption</i>	<i>No of Interviews</i>
<i>Organisation A</i>	38,000 176.8 B SEK	Engineering Construction	Medium	3
<i>Organisation B</i>	20,000 £1.67 B	Buildings Highways Engineering	Low	2
<i>Organisation C</i>	3500 £1.49 B	Civil Engineering Construction	Medium	2
<i>Organisation D</i>	26,000 £8,405 M	Civil Engineering	Low	2
<i>Organisation E</i>	71,000 Euros 13.508 M	Building and Construction	Medium	2

Key insights

In this study, an overpowering 78% of the interviewees indicate that the lack of understanding and knowledge is the biggest challenge of adopting and implementing industry 4.0 strategies within the infrastructure sector. The general key themes were identified as to why there are barriers in the adoption of industry 4.0 strategies and are demonstrated in Figure 1.



Figure 1: Challenges on Industry 4.0 agenda adoption

Software and hardware (interoperability)

Aside from lack of understanding and knowledge being mentioned by the interviewees frequently, other factors that have created barriers of adopting and implementing Industry 4.0 strategies mentioned by the interviewees include a lack of guidance, resistance to change and Software and Hardware challenges. For instance, one of the interviewees noted:

“Some software may not be available which leads to people losing interest. We had design managers ask for something which they have done on previous projects, however with this not being available on the current project people shy away from adoption and implementation.”

As Masood and Egger (2019) mentioned there are a lot of interoperability barriers that come with Industry 4.0 strategies, software capabilities and competency within the sector is a major struggle as users will not have knowledge, for example be able to adapt to user interface of the new software's and hardware (Masood & Egger, 2019). Panetto et al (2019) also highlights challenges such as interoperability. Panetto et al stresses the importance on interoperability in terms of cyber-physical manufacturing enterprises not just between softwares and hardware but interoperability between humans and machines for technologies such as Artificial intelligence which may need human to machine interaction. Panetto et al (2019) stated modern technologies are used to enhance the cognitive and physical possibilities of the worker and make the execution of process more effective. For this collaboration of loosely coupled systems, interoperability of the execution of tasks by humans and by artificial agents needs to be assured. (Panetto, Iung, Ivanov, Weichhart, & Wang, 2019).

Lack of Knowledge and understanding

As briefly mentioned, in this study 78% of the interviewees have cited that there is a big lack of understanding and knowledge within the infrastructure sector on Industry 4.0 strategies. One of the interviewees noted that:

“I would say upskilling and making people aware because there are many things we can do as a team however the wider team are lacking in knowledge on this field. So I would say the lack of knowledge is the main challenge within our organisation and projects.”

Another interviewee stated that:

“Lack of understanding, there are still many people in the organisation that are fascinated by things that are already adopted by other organisations for years due to their lack of awareness, I think there should be a more proactive approach rather than waiting for client demand in adopting these technologies.”

New technologies introduce new processes which can be a challenge to explain and make people aware of the new way of working. These new technologies and strategies are complex in the way they work compared to traditional practices as there may be many systems that need to be integrated with pre-existing content with the new technologies (Masood & Egger, 2019).

Resistance to change

Resistance to change has always been a huge issue within the infrastructure sector especially around innovation and technology. The construction industry as a whole has a lot of staff members that have been in the industry for years, due to the traditional practices and methods being used along the years,

staff members resist the change to new processes and practices as they are already comfortable with the old processes that they have adopted and implemented for years. One of the participants states:

“Getting the supply chain to be on board, such as the engineers, for example trying to get them to use even virtual reality for training purposes is challenging due to reluctance most people always want to go back to their paper copies.”

42% of the participants noted that resistance to change is a major challenge within their organisation and as to why Industry 4.0 applications and strategies have either not been adopted and implemented fully or at all.

Resistance to change is a major challenge with any new process as new ways of working can be daunting for most staff as they are used to the processes that they have been used to for years. In addition having competent people within organisations and within the industry can allow these new processes to be implemented better and allow the ability to have people within the organisation who can guide others with less knowledge on these new processes.

This brings us to another challenge which is widely popular within the industry. Competency is a major challenge when it comes to the adoption and implementation of new technologies and processes. This challenge will be further described in the following section.

Competency

In this study, 49% of the participants have noted that there is a lack of competency within their organisation as they do not have the right skill across their employees to adopt and implement these new Industry 4.0 technologies and strategies. One of the participants explains on how a lot of staff members in their organisation need upskilling to follow new processes associated with the new strategies and technologies. One of the interviewees states:

“the biggest challenge we have come across I would say upskilling and making people aware because there are many things we can do as a team however the wider team are lacking in knowledge on this field”

Competency is a major challenge especially for new upcoming technologies with staff members needing the training and skills knowledge to assist the organisations goal of adoption and full implementation of these new processes and technologies. Masood and Egger (2019) also mentions competency and lack of education of staff members being a key issue within organisations when it comes to the adoption and implementation of new technologies and processes such as Augmented Reality (Masood & Egger, 2019), Tariq et al (2021) states:

“On the other hand, it causes substantial organisational changes. This can relate to the processes supported by AR itself, the organisational structure and employee education, or the user acceptance.”

After analysing the challenges being currently faced in the infrastructure sector in terms of Industry 4.0 agenda adoption, the interviewees were asked if in their opinion if there is a need for Business Model innovations for Industry 4.0 agenda within their organisation.

Within this study, a 86% of the respondents stated that the development of an innovative business model is necessary to aid their adoption and implementation of Industry 4.0 strategies. The remaining 14% of participants however, despite agreeing that an innovative business model would assist their

organisation in the implementation of Industry 4.0 strategies also mentions that this would be a disruptive process for the entire organisation.

Discussion and conclusions

The fourth industrial revolution is changing businesses worldwide. Organisations within the infrastructure sector are aware of Industry 4.0 and are motivated to adopt these new technologies and strategies, however the best way of implementation is not clear. According to organisations taking part in this research study, Industry 4.0 means digitisation and automation within the infrastructure sector.

Despite quite a few Industry 4.0 agenda being adopted and implemented within the sector, there have been many challenges highlighted by the organisations that took part in this study. Software and hardware are big issues as most digital means require licences which would need funding to adopt and implement, if senior leaders do not see the clear benefits, the funding would not get signed off leading to the adoption of Industry 4.0 technologies not go ahead. In addition to software and hardware lack of knowledge and understanding is a major barrier with Industry 4.0 adoption. With the adoption of new processes, this changes the entire workforce, if there is a lack of knowledge for multiple members of staff, the processes would require training to upskill the workforce to be competent in the new strategies adopted. There is also a resistance to change for some workforce as most staff within the industry have been using traditional methods for years there is a fear in change in processes.

Participants have highlighted the need for Business Models on Industry 4.0 agenda as with the provision of guidance on the best way to implement and adopt industry 4.0 agenda will be helpful for their organisation. As mentioned by a few participants, the infrastructure sector is behind in entering the fourth industrial revolution compared to other sectors.

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