# Micro BIM adoption: Identifying the Profiling Patterns of adoption using a Systems Thinking Approach

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## Abstract

Understanding the dynamics of Building Information Modelling (BIM) adoption in organisations – referred to in the remainder of the paper as 'micro BIM adoption' – is key to develop and implement successful BIM implementation strategies. In particular, understanding the causal chains between multiple factors driving organisations towards the decision to adopt BIM is still an area that requires further investigation. This paper investigates micro BIM adoption by considering both the multi-staged nature of BIM adoption and the interactions between such stages and an extensive array of adoption factors. By doing so, the paper is recognising the micro BIM adoption system as a complex system which can be investigated using a Systems Thinking model approach. Causal Loop Diagrams (CLD) were used to profile the adoption patterns within the UK Architecture sector. Six key feedback loops describing the key profiling patterns of micro BIM adoption are identified and described in this paper.

The identified patterns can be used to support the establishment of micro BIM adoption strategies. For example, the identified patterns can inform the development of tailored initiatives and actions that exert effect on the key nodes (i.e., adoption factors) affecting the BIM adoption system and can be used to prioritise effort (e.g., investment) in such actions.

**Keywords:** BIM, Adoption, Diffusion, System Thinking model, Causal Loop Diagrams (CLD).

## 1. Introduction

In recent years digital transformation and innovation have significantly permeated every topic within the construction sector, in both industrial and academic discourse. BIM connotation has been always on the rise since its inception; from its earliest definitions focussed on technologies and tools, BIM is now considered as the "current expression of digital innovation within the construction sector" (Succar and Kassem, 2015, p.64). This study justified the need for new studies on BIM adoption studies. This need is founded on a clear research gap, represented by the lack of studies that consider simultaneously (1) the multifaceted nature of BIM, (2) the multi-staged nature of the BIM adoption process, and (3) an extensive array of drivers affecting the BIM adoption process. This paper will address these limitations and develops Causal Loop Diagrams (CLD) for the BIM adoption process. Following the literature review that identifies the gap, the paper describes the CLD and discussed their implications.

## 2. Literature review and gap

Some of the key characteristics of existing studies on BIM adoption include: a focus on BIM diffusion - after BIM has been adopted – and on developing approaches for forecasting BIM diffusion (Gholizadeh et al., 2018). For instance, studies have used 'Bass Model' to predict the rate of BIM technologies diffusion within a certain period (i.e., 2012 – 2022) within the Chinese construction industry (Tang and Yi, 2015). There are also some shortcomings in existing BIM adoption studies include the use of key terms and concepts (e.g., implementation, readiness, adoption, diffusion) interchangeably or without a clear expression of the demarcation stance adopted for the terms. For example, (Al-Shammari, 2014), (Haron et al., 2014), and (Attarzadeh et al., 2015) have all interchangeably used the terms 'Adoption' and 'Implementation'. This blurs the distinction between interrelated concepts such as adoption, implementation, and diffusion (Ahmed and Kassem, 2018). In addition, lack of information about the position of studies in relation to the innovation adoption stages (i.e., Awareness stage, Intention stage, and Decision stage) which are proposed by Rogers (2003) in his innovation decision process. Moreover, the limited investigations of interplays between adoption factors and specific instances of some factors such as organisation size (i.e., micro, small, medium, and large) (Hosseini et al., 2016) and external isomorphic factors (e.g., market-wide BIM mandate by a government or a public agency) and how such interplays vary over time. Also, lack of investigative effort covering a whole sector (e.g., Architecture sector) within a defined market (e.g., the United Kingdom). Finally, the dispersion in investigating the BIM adoption drivers and factors – across several studies – as a result of the specific theoretical lenses embraced by researchers. For instance, a study by Cao et al. (2014) investigated the influence of only the isomorphic pressures (i.e., Coercive, mimetic, and normative pressures) in isolation from other factors (i.e., innovation characteristics and internal characteristics).

This paper aims to investigate micro BIM adoption while overcoming these limitations. It considers BIM adoption as a complex system that is multi-staged and affected by several factors whose exerted influence on a specific adoption stage may change over time. To analyse such a system, the study adopts Systems Thinking Models. The System Thinking Models were heuristically developed by exploiting the results from two types of analysis: (1) statistical analysis (from Kassem and Ahmed, 2019) between the 11 top factors (as identified in Ahmed and Kassem, 2018) influencing BIM adoption in architecture practices; and (2) classification of the top factors in cause and effect factors and their interdependency analysis using the fuzzy decision making trial and evaluation laboratory (DEMATEL) method (from Ahmed and Kassem, 2019).

The resulting Causal Loop Diagrams (CLD) were used to profile adoption patterns both for the whole adoption process as a single system (i.e., without separating it into multiple stages) and for each individual stage (i.e. awareness, intention, and decision) over three time horizons (i.e. pre-2011 as the period preceding the announcement of the UK BIM mandate; 2011-2016 as the implementation and trial period; and post-2016 as the period following the mandate coming into effect). This paper describes only the patterns of BIM adoption as a single system. The CLD for this system included six key loops that are described in this paper.

## 3. Methodology and research methods

The top 11 factors (as identified in Ahmed and Kassem, 2018) influencing the BIM adoption process are used as an input into this study. These factors are: *Willingness to adopt BIM* (F1), *Communication behaviour of an organisation* (F2), *Observability of BIM benefits* (F3), *Compatibility of BIM* (F4), *Social motivations among organisation's members* (F5), *Relative advantage of BIM* (F6), *Organisational culture* (F7), *Top management support* (F8), *Organisational readiness* (F9), *Coercive pressures (Governmental mandate, informal mandate)* (F10), and *Organisation size* (F11) (Table 1). To achieve the aim of this study the findings of both the 'F-DEMATEL method' (i.e., Fuzzy Decision Making Trial and Evaluation Laboratory) (as in Ahmed and Kassem, 2019) (Table 2) – explained in next section - and the ‘correlation analysis’ (as in Kassem and Ahmed, 2019) (Table 3) will be used to develop the causal feedback loops as shown in the following sections.

*Table 1 Definitions of the 11top influencing factors/ evaluation criteria of the F-DEMATEL*

| Factor | Definition |
|---|---|
| Willingness to adopt BIM (F1) | Refers to the favourable or unfavourable attitude of organisation or a decision-making unit towards the innovation/ BIM. |
| Communication behaviour of an organisation (F2) | The degree of openness and engagement of an organisation with social groupings and networks interested in innovation adoption and promotion. |
| Observability of BIM benefits (F3) | The degree to which the results from innovation/BIM adoption are visible and tangible. |
| Compatibility of BIM (F4) | The degree to which an innovation/BIM aligns with potential adopter’s previous experiences and current needs and values. |
| Social motivations among organisation's members (F5) | The motivation to engage in behaviours that benefit others such as considering others’ perspectives, stimulating knowledge exchange, and focusing on collective goals. |
| Relative advantage of BIM (F6) | The degree to which an innovation/BIM is perceived as being better than the system/practice it replaces. |
| Organisational culture (F7) | The shared norms, beliefs, principles, and traditions - held by the members of an organisational practice – which contribute to the members’ understanding of the organisational functioning. |
| Top management support (F8) | The degree to which senior management understands the importance of the innovation/BIM function and the extent to which they are involved into promoting the system adoption. |
| Organisational readiness (F9) | The extent to which organisational members are psychologically and behaviourally prepared to implement a change, their mutual determination to perform the change, and their mutual faith in their aggregate capacity to achieve the change. |
| Coercive pressures (Governmental mandate, informal mandate) (F10) | The formal and informal forces applied to organisations by other organisations (public and private clients/employers, etc.). |
| Organisation size (F11) | The total number of full-time members of staff of an organisation (e.g., micro, small, medium, and large). |

*Table 2 The F-DEMATEL results of the whole system of BIM adoption process (11 factors)*

| Factors | D | R | Defuzzified (D+R) | Rank | Defuzzified (D-R) | Cause/Effect |
|---|---|---|---|---|---|---|
| F1. Willingness to adopt BIM | 0.529 | 0.743 | 1.272 | 11 | -0.214 | Effect |
| F2. Communication behaviour | 0.594 | 0.678 | 1.272 | 3 | -0.084 | Effect |
| F3. Observability of BIM | 0.597 | 0.559 | 1.156 | 2 | 0.038 | Cause |
| F4. Compatibility of BIM | 0.563 | 0.535 | 1.099 | 7 | 0.028 | Cause |
| F5. Social motivations | 0.554 | 0.611 | 1.164 | 9 | -0.057 | Effect |
| F6. Relative advantage of BIM | 0.626 | 0.569 | 1.195 | 1 | 0.056 | Cause |
| F7. Organisational culture | 0.565 | 0.576 | 1.141 | 6 | -0.011 | Effect |
| F8. Top management support | 0.555 | 0.694 | 1.249 | 8 | -0.139 | Effect |
| F9. Organisational readiness | 0.582 | 0.576 | 1.158 | 5 | 0.006 | Cause |
| F10. Coercive pressures | 0.592 | 0.444 | 1.036 | 4 | 0.149 | Cause |
| F11. Organisation size | 0.553 | 0.325 | 0.878 | 10 | 0.228 | Cause |

*Table 3 Set of 39 pairs of strong positive relationships among the 11 most influencing factors*

| Rank | Pair of correlated factors | Correlation value (rs, p) |
|---|---|---|
| 1 | Social motivations ⟺ Organisational culture | (rs= .503, p=.000) |
| 2 | Relative advantage ⟺ Observability | (rs= .418, p=.000) |
| 3 | Relative advantage ⟺ Organisational culture | (rs= .382, p=.000) |
| 4 | Social motivations ⟺ Willingness | (rs= .373, p=.000) |
| 5 | Observability ⟺ Communication behaviour | (rs= .368, p=.000) |
| 6 | Compatibility ⟺ Communication behaviour | (rs= .349, p=.000) |
| 7 | Organisational culture ⟺ Willingness | (rs= .336, p=.000) |
| 8 | Organisational culture ⟺ Organisation size | (rs= .336, p=.000) |
| 9 | Relative advantage ⟺ Social motivations | (rs= .308, p=.000) |
| 10 | Social motivations ⟺ Organisation size | (rs= .302, p=.000) |
| 11 | Observability ⟺ Top management support | (rs= .297, p=.000) |
| 12 | Top management support ⟺ Willingness | (rs= .295, p=.000) |

| | | |
|---|---|---|
| 13 | Relative advantage ⟺ Organisational readiness | (rs= .283, p=.000) |
| 14 | Organisational readiness ⟺ Willingness | (rs= .282, p=.000) |
| 15 | Organisational readiness ⟺ Organisational culture | (rs= .282, p=.000) |
| 16 | Compatibility ⟺ Observability | (rs= .280, p=.000) |
| 17 | Top management support ⟺ Social motivations | (rs= .280, p=.000) |
| 18 | Top management support ⟺ Communication | (rs= .277, p=.000) |
| 19 | Communication behaviour ⟺ Social motivations | (rs= .273, p=.000) |
| 20 | Observability ⟺ Organisational culture | (rs= .267, p=.000) |
| 21 | Compatibility ⟺ Top management support | (rs= .255, p=.001) |
| 22 | Organisational readiness ⟺ Social motivations | (rs= .249, p=.001) |
| 23 | Willingness ⟺ Organisation size | (rs= .244, p=.001) |
| 24 | Communication behaviour ⟺ Organisational | (rs= .239, p=.001) |
| 25 | Organisational readiness ⟺ Organisation size | (rs= .238, p=.001) |
| 26 | Relative advantage ⟺ Communication behaviour | (rs= .236, p=.002) |
| 27 | Compatibility ⟺ Organisational readiness | (rs= .235, p=.002) |
| 28 | Relative advantage ⟺ Willingness | (rs= .230, p=.002) |
| 29 | Observability ⟺ Willingness | (rs= .221, p=.003) |
| 30 | Top management support ⟺ Organisation size | (rs= .217, p=.004) |
| 31 | Observability ⟺ Social motivations | (rs= .215, p=.004) |
| 32 | Top management support ⟺ Organisational | (rs= .214, p=.004) |
| 33 | Relative advantage ⟺ Organisation size | (rs= .214, p=.004) |
| 34 | Observability ⟺ Organisation size | (rs= .198, p=.008) |
| 35 | Communication behaviour ⟺ Coercive pressures | (rs= .176, p=.019) |
| 36 | Relative advantage ⟺ Compatibility | (rs= .165, p=.028) |
| 37 | Top management support ⟺ Organisational culture | (rs= .165, p=.028) |
| 38 | Communication behaviour ⟺ Willingness | (rs= .162, p=.031) |
| 39 | Observability ⟺ Organisational readiness | (rs= .162, p=.031) |

# 4. Systems Thinking Model of BIM Adoption Process

This section describes the development of the systems thinking model which is used to establish the causal loop diagrams involved in organisational BIM adoption within the UK Architecture sector. This model captures the interrelationship between factors affecting BIM adoption; it helps in understanding how intra-organisation BIM adoption and diffusion occur, and how the organisations make the decision to adopt BIM. Causal-Loop Diagramming (CLD) is used to illustrate these chains of causal relationships among the factors affecting the BIM adoption process (i.e., system).

The CLD is based on the key variables (i.e., factors) of the systems whose interrelationships are critical to the system interpretation since they describe its dynamics (Suprun et al., 2016). The CLD also provides an additional visual comprehension of the current systemic relations among the system's components (Suprun et al., 2016; Richardson, 1986).

Constructing a causal-loop diagram (CLD) entails combining and integrating certain sets of input information (Suprun et al., 2016). Hence, the findings of both the 'F-DEMATEL method' (as in Ahmed and Kassem, 2019) (Table 2 and Figure 1) and the 'correlation analysis' (as in Kassem and Ahmed, 2019) (Table 3) were incorporated to illustrate and depict the causal feedback loops. The F-DEMATEL was used to classify the adoption factors into cause and effect factors and to identify such cause-effect factors between pairs of factors. The results are detailed in (as in Ahmed and Kassem, 2019). The correlation analysis was performed using Spearman's rank correlation coefficient analysis with a two-tailed significance test and helped identify the correlations between 11 most influential adoption factors. These correlations are summarised in Table 3.

Building upon these previous results, this paper describes the profiling patterns of BIM adoption which represents the behaviour of organisation when transiting from a pre-BIM (pre-awareness) status, through formulating the intention to adopt, to making the decision the decision to adopt. This study addresses this scope by considering the BIM adoption process as a holistic system without separating it in its constituent sub-stages and without considering different time horizons. To develop the CLD for such a system, the causal relationships among the factors (i.e., the causal diagram/digraph and the impact relation map in Figure 1) identified in the F-DEMATEL were collectively combined in multiple links that formed the feedback loops. From the correlation analysis, the resultant 39 pairs of strong relationships were used to identify the polarity of the formed feedback loops. A causal arrow between two factors indicates the direction of the change between the cause-effect pair. The polarity is denoted by (+) when two interrelated factors increase or decrease together, and by (-) when one of them increases while the other decreases. Also, a CLD may include two types of feedback loops: Reinforcing (R) loop, when two factors influence each other by two opposite (+) arrows; and Balancing (B) loop, when one arrow is (+) and the other is (-) or vice versa. Some causal link arrows may have marked with two hash (||) which denote 'delay' referring to the state when the effect takes time before it comes into place. Due to the complicated nature of interrelations among the factors of the developed system, it would be impractical and unfeasible to consider influence at all levels. Hence, this study has adopted a widely used approach in the literature (as in López-Ospina et al., 2017; Carpitella et al., 2018) which establishes a threshold value for the influence as an exclusion criterion and to avoid taking into account negligible effects. This threshold is calculated as the average of all the elements in matrix T (of the DEMATEL).

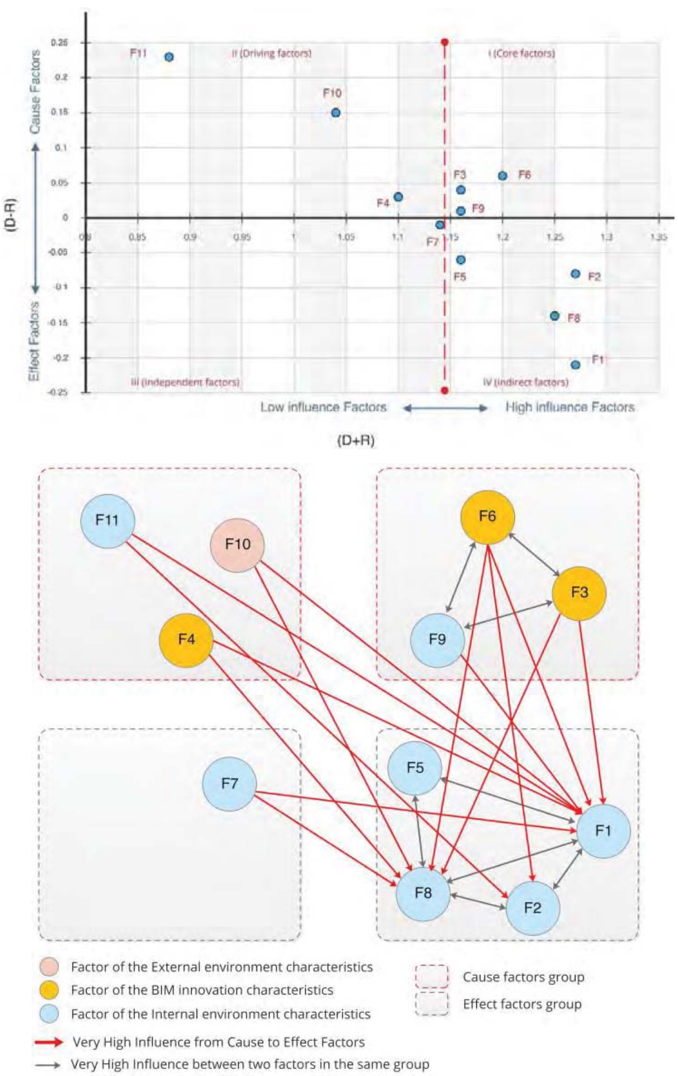


*Figure 1 (**bottom**) Impact Relation Map depicting cause and effect relationships and interdependencies among leading factors affecting BIM adoption; (**top**) Adoption factors classified in cause and effect factors*

In this case the threshold is 0.052. Moreover, this study focusses on the loops starting with a cause factor (i.e., identified in Quadrants I and II of the Impact Relation Map in the DEMATEL analysis) as this helps to address both the usefulness and the readability of the results. The systems thinking model focusses on the 'Decision to adopt BIM' as an outcome and aims to analyse the independencies between factor that lead to such an outcome.

# 5. Causal Loop Diagrams of BIM Adoption Process

This section demonstrates the possible CLDs that describe the BIM adoption process within the UK Architecture practices. The reported loops are those: including relationships above the influence threshold level (i.e., 0.052) adopted in the DEMATEL analysis; starting with a cause factor as identified in the DEMATEL's Digraph (Figure 1b) and involving the highest number of interrelated variables/factors within each loop. Figure 2 shows six reinforcing loops (i.e., positive feedbacks) that are denoted by R1, R2, R3, R4, R5, and R6. The first four loops (i.e., R1, R2, R3, R4) start with the *cause group (influencing factors)* which are Relative advantage of BIM (F6), Observability of BIM (F3), Organisational readiness (F9), and Compatibility of BIM (F4), respectively. These factors were identified in quadrants I and II in the digraph of the F-DEMATEL (Figure 1b). The other two loops (i.e., R5, R6) also influence, through their effect factors [i.e., Willingness/ intention to adopt BIM (F1) and Social motivations among organisation's members (F5), respectively], the decision to adopt BIM. These loops can be explained as follows:

Loop R1 (i.e. entitled 'Benefits of BIM innovation') suggests that organisational readiness can be promoted by persuading senior managers about the anticipated benefits of adopting BIM (*Table* 4). This loop indicates that improving the perceived benefits obtained from adopting BIM (F6) stimulate the intention of the potential adopter to adopt BIM (F1). In turn, this contributes to an increase in the shared norms, beliefs, and traditions (F7) held by the members of the organisational practice. These shared values are reflected by the motivation of the organisation's members who increase their engagement in behaviours that benefit others (e.g., stimulating knowledge exchange, and focusing on collective goals) (F5). These higher social motivations lead to increased openness and engagement of the organisation with social groupings and networks interested in BIM adoption and promotion (F2). Such communication behaviours improve the observability of BIM from successful BIM adoption (F3). Higher visibility of BIM benefits improves the perception of BIM as an innovation that is aligned with the potential adopter's previous experiences and current needs and values (F4) which in turn, invites more executive support (F8). The support from senior management nurtures the organisation members' psychological readiness to implement BIM and their mutual determination to perform the change (F9). This, in turn, reinforces the perceived benefits obtained from adopting BIM (F6) (Figure 2 and *Table* 4). Other loops (R2 to R6) are summarised in Table 5.

*Table 4 Loop R1 explaining the causal chain leading to the decision to adopt BIM by Organisations*

| Loop | Loop name | Interdependent factors | Indication |
|---|---|---|---|
| **R1** | Benefits of BIM innovation | Relative advantage of BIM (F6) ⟶ Willingness/ intention to adopt BIM (F1) ⟶ Organisational culture (F7) ⟶ Social motivations among organisation's members (F5) ⟶ Communication behaviour of an organisation (F2) ⟶ Observability of BIM benefits (F3) ⟶ Compatibility of BIM (F4) ⟶ Top management support (F8) ⟶ Organisational readiness (F9) ⟶ Relative advantage of BIM (F6). | BIM benefits can lead through its influence on a number of organisational characteristics (willingness to adopt BIM, organisational culture, social motivation, and communication behaviour) to an appreciation of the benefits of BIM and its compatibility, hence, inviting top management support which improve the organisation readiness and lead to the decision to adopt BIM. |

*Figure 3 shows a tree diagram that provides a simplified visualisation and analysis of model dynamics. It shows in a single direction which variables cause a particular variable to change. This representation captures the several intersections between the CLDs identified earlier. Only two levels are represented in Figure 3 but these could be extended to represent the whole CLD as a tree diagram. These simplified causal chains, when they are followed from the left to the right side, show how the decision to adopt BIM is reached within organisations.*

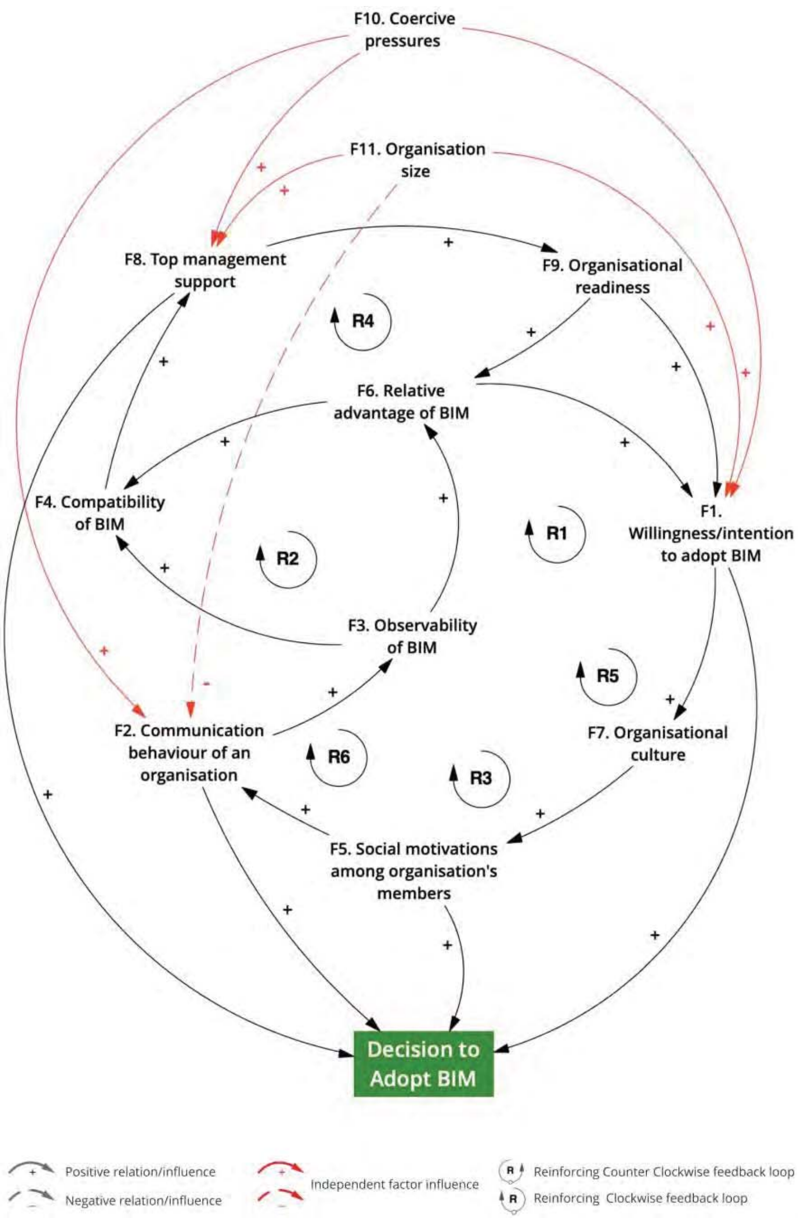


*Figure 2 The Systems Thinking Model of Whole BIM Adoption Process (time-independent)*

*Table 5 Loops explaining the causal chain leading to the decision to adopt BIM by Organisations*

| Loop | Loop name | Interdependent factors | Indication |
|---|---|---|---|
| R2 | Visibility of BIM benefits | Observability of BIM benefits (F3) ⟶ Relative advantage of BIM (F6) ⟶ Compatibility of BIM (F4) ⟶ Top management support (F8) ⟶ Organisational readiness (F9) ⟶ Willingness/ intention to adopt BIM (F1) ⟶ Organisational culture (F7) ⟶ Social motivations among organisation's members (F5) ⟶ Communication behaviour of an organisation (F2) ⟶ Observability of BIM (F3). | The more visible and tangible the BIM benefits to an organisation, the more the organisation perceives BIM as a compatible innovation. BIM compatibility in turn invites top management support that reflects upon their willingness to adopt BIM whose effect sequentially cascade down through a number of organisational characteristics (F7, F5, and F2) reinforcing the visibility of BIM benefits, and resulting in the organisation making the decision to adopt BIM. |
| R3 | Organisational readiness to perform a change | Organisational readiness (F9) ⟶ Willingness/ intention to adopt BIM (F1) ⟶ Organisational culture (F7) ⟶ Social motivations among organisation's members (F5) ⟶ Communication behaviour of an organisation (F2) ⟶ Observability of BIM benefits (F3) ⟶ Relative advantage of BIM (F6) ⟶ Compatibility of BIM (F4) ⟶ Top management support (F8) ⟶ Organisational readiness (F9). | The organisation members' mutual determination to implement a change has a cascading effect, channelled through a number of organisational characteristics (F1, F7, F2) and innovation characteristics (F3, F6, and F4), on senior management support which reinforces the organisational readiness, and results in the organisation making the decision to adopt BIM. |
| R4 | Aligning BIM with experiences and needs | Compatibility of BIM (F4) ⟶ Top management support (F8) ⟶ Organisational readiness (F9) ⟶ Relative advantage of BIM (F6) ⟶ Compatibility of BIM (F4) | The alignment of BIM with current and future needs helps to secure top management support which in turn improve the readiness of the organisation to adopt BIM. This in turn increase the perceived benefits of BIM which reinforces its compatibility resulting in the in the organisation making the decision to adopt BIM. |
| R5 | Shared norms and beliefs among organisation' members | Organisational culture (F7) ⟶ Social motivations among organisation's members (F5) ⟶ Communication behaviour of an organisation (F2) ⟶ Observability of BIM benefits (F3) ⟶ Relative advantage of BIM (F6) ⟶ Willingness/ intention to adopt BIM (F1) ⟶ Organisational culture (F7) | Shared norms and beliefs among the members of the organisation help the organisation members engage in behaviours that promotes common goals. This in turn reflects upon openness and engagement of the organisation with social groupings and networks interested in BIM innovation adoption and promotion. Subsequently, this leads to improved visibility of BIM benefits by the organisation and an understanding of its relative advantage which further reinforces the shared norms and beliefs among the organisation's members, and lead to the decision to adopt BIM. |
| R6 | Organisational communication behaviour with BIM-centric social networks | Communication behaviour of an organisation (F2) ⟶ Observability of BIM benefits (F3) ⟶ Relative advantage of BIM (F6) ⟶ Willingness/ intention to adopt BIM (F1) ⟶ Organisational culture (F7) ⟶ Social motivations among organisation's members (F5) ⟶ Communication behaviour of an organisation (F2) | Engaging in behaviours that benefit others (e.g., stimulating knowledge exchange, and focusing on collective goals) can be motivated by expanding the organisation's involvement with social networks interested in adopting BIM to understand its benefits, and can lead to the organisation making the decision to adopt BIM following a causal chain combining innovation characteristics (F3 and F6) and organisation characteristics (F1, F7, and F8). |

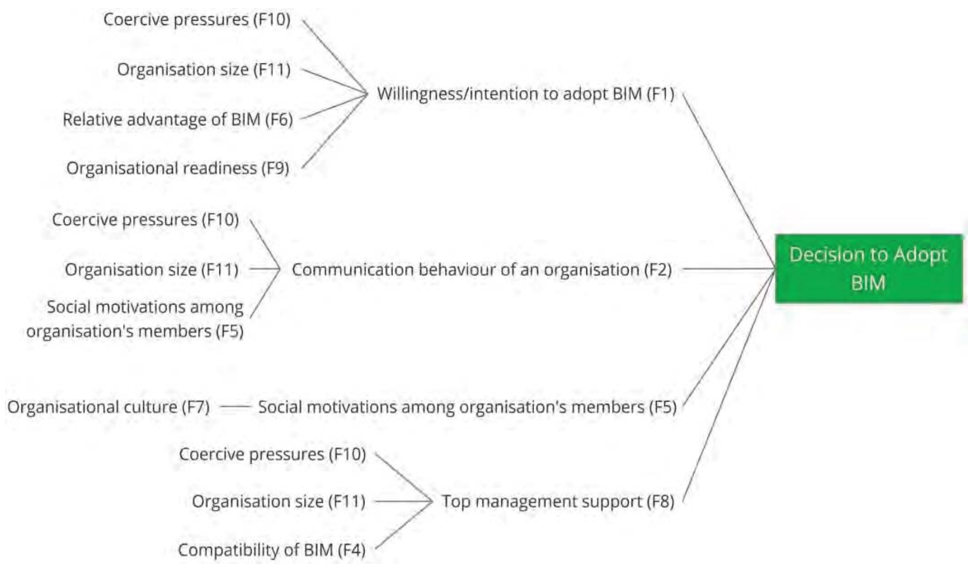


*Figure 3 Tree diagram showing causal chains leading to the 'decision to adopt BIM' (time-independent)*

# 6. Discussions and Conclusions

All the identified six feedback loops contribute to the organisational decision to adopt BIM by including a causal effect on four factors: willingness to adopt BIM (F1), communication behaviour of an organisation (F2), social motivations among organisation's members (F5), and top management support (F8). In addition to these six loops, some additional contribution to the decision to adopt BIM comes from certain independent factors and it is important to be highlights. In particular, two independent factors [i.e., Coercive pressures such as governmental mandates and client informal mandate/expectation), and organisation size (F11)] have a contributing effect on the decision to adopt BIM through their direct influence on some of the four effect factors (i.e., F1, F2, and F8). Greater coercive pressures (as either governmental mandate, or industry and client expectation/requirement) (F10) help inducing a favourable change towards BIM adoption through changes in: the willingness to adopt BIM (F1), communication behaviour of an organisation (F2), and the top management support (F8). The organisation size (i.e., micro, small, medium, and large) has a varying influence on specific factors. For example, larger organisations, compared to small organisations, have more willingness to adopt BIM, enjoy more senior management support, and are characterised by limited openness and engagement with social groupings and networks interested in innovation adoption and promotion.

The six feedback loops that resulted from the CLD model of the whole BIM Adoption Process (time-independent) represent the prominent profiling patterns of the behaviour that drive organisations to adopt BIM. These patterns can help in analysing, understanding, and informing tailored policies, and action plans for micro BIM adoption within the architectural sector, when links are made between the driving factors involved in each of the loops/patterns and the implementation activities. As a result, this model contributes to promote BIM adoption by clarifying the dynamics and patterns underpinning the BIM adoption process while focussing on the leading drivers for adoption: the benefits of BIM innovation (Loop R1), visibility of BIM benefits (Loop R2), organisational readiness to perform a change (Loop R3), aligning BIM with experiences and needs (Loop R4), shared norms and beliefs among an organisation' members (Loop R5), and Organisational communication behaviour with BIM-centric social networks (Loop R6). The future extension of this work will aim to create links between these leading adoption factors and the industry stakeholders' groups. Implementation activities that can be exerted by each industry stakeholder group on these leading adoption factors will be used to create such links.

## Acknowledgements

This work has been sponsored by the Iraqi Ministry of Higher Education and Scientific Research (MOHESR) jointly with the University of Technology, Baghdad, Iraq.

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