

Exploring the Issues for Innovation Platforms for the Future of Construction Industry: Scenario Planning Approach

Ghassan Aouad
*University of Salford, Salford, UK
g.aouad@salford.ac.uk*

Carl Abbott
*Salford Centre for Research and Innovation, University of Salford, Salford, UK
c.abbott@salford.ac.uk*

Bilge Erdogan
*Salford Centre for Research and Innovation, University of Salford, Salford, UK
b.erdogan@salford.ac.uk*

Beliz Ozorhon
*Salford Centre for Research and Innovation, University of Salford, Salford, UK
b.ozorhon@salford.ac.uk*

Abstract

The construction industry needs to be responsive to the economic, social, and technological challenges that the world is facing in order to maintain its competitiveness. Innovation is accepted to be one of the key drivers of economic growth and competitiveness and so business and policy should be aligned to ensure the success of innovation. To this end, innovation platforms are a new way of working for government and business that enable the integration of a range of technologies and better coordination of policy and procurement. To be effective, an innovation platform in construction would need to be able to respond to the diverse needs of the sector and the diverse ways in which innovation can happen. Since the needs of the industry are continuously changing, identifying possible futures is a must to inform the strategic planning and programme of work for such a platform. Scenario techniques have been used as a strategic planning tool for years in order to develop a future vision and a strategic action plan. This paper proposes the use of a scenario planning approach as an enabler to develop a strategic action plan for the implementation of innovation platforms in order to realise a preferred construction future. In this respect, the need for innovation platforms and their roles/functions will be discussed and how scenario planning approach can be utilized to help develop a construction vision will be explained. Finally, the critical elements of innovation platforms within such a vision will be explored.

Keywords

Innovation platform, Construction vision, Scenario planning, Prospective thinking

1. Introduction

Construction is a vital sector contributing significantly to the economies of all countries. The construction industry should be dynamic so as to respond to the changes that the world is constantly facing. In addition

to the social, economic, and technologic challenges affecting all industries, the opportunities and problems in construction will be different from those of today. The needs and demands of clients will not remain the same, while construction materials and methods will transform the way the built environment is designed, built and maintained. The ability of the construction industry to maintain its effectiveness and competitiveness lies in its adaptability to the possible scenarios in the future. To help shape this future, a construction vision should be developed including clear objectives and strategies in order to meet the requirements of the future world.

Innovation is regarded as one of the key factors contributing to national economic growth, competitiveness, and quality of life through the creation and adoption of new knowledge to improve the value of products, processes, and services. Being a project-based and fragmented industry, the patterns of innovation in construction are different in many ways from those of others. As Barrett *et al.*, (2001) have suggested, specific research into innovation in construction must be undertaken and all generic innovation research be “envisioned, embedded and evaluated in a construction context to form a robust body of construction innovation knowledge in its own right”. Innovation can be a key source of competitive advantage for construction companies, offering the means through which a firm can achieve a client’s objectives in a specific project, or its own objectives over a range of projects (Slaughter, 2000).

In this paper, an innovation platform, that better links the resources and talent of higher education institutions to industry, is suggested to respond to the diverse needs of the construction sector and the ways in which innovation can happen. Innovation platforms are an efficient way of engaging all stakeholders in the innovation process. The main aim is to maximize the benefits that can be realized through innovation. Such a platform can be an effective solution to enhance the innovation capability at the national level. However, the establishment and management of innovation platforms should be in line with the overall construction vision. A scenario planning approach is proposed to identify the critical elements for the future of construction and to develop a strategic action plan for the implementation of innovation platforms in order to realise a preferred construction future. Scenario planning is a key technique used by futurists to develop future models in order to help this process and to develop strategic action plans and policies or to create a vision for the future (Erdogan *et al.*, 2009). In this respect, the need for innovation platforms and their roles/functions will be discussed and how scenario planning could help to develop a construction vision and how innovation platforms should be established and managed in order to realise this vision will be investigated.

2. Innovation Platform for Construction

The innovation platform suggested in this paper constitutes a loose coupled structure involving industry and academia, which would undertake a range of activities, catering for organisations with different levels of experience and capabilities. The model recognises the need to not only provide solutions and new ideas, but also to stimulate demand and develop capability (Abbott *et al.*, 2008). In this context, the scenario planning approach is proposed as a means of formulating strategic plans to effectively establish and operate innovation platforms and identifying the roles and responsibilities of different parties involved in this process. The following paragraphs discuss the innovation process in construction and the role of innovation platforms.

2.1 Innovation in Construction

Slaughter and Shimizu (2000) defined innovation as “the actual use of nontrivial improvements in products, processes or system that are actually used and are novel to the organisation developing and/or using them”. As DTI (2003) put it forward:

“The creation and commercialization of new knowledge is a final and crucial source of dynamic improvements in productivity. For advanced economies, innovation is a matter of pushing the world frontier of knowledge. For developing countries technology assimilation is the central challenge”.

Innovation has a number of outcomes, including (Barrett and Sexton, 1998):

- the renewal and enlargement of products and services, and their associated market,
- new methods of production, supply and distribution, and
- new organisational and work forms and practices.

Being project-based, construction is often perceived as being among the low innovative industries. Commentators have labelled the sector as being ‘extremely conservative’ (Rosenberg, 1982), ‘low tech’ (Reichstein *et al.*, 2005) and ‘an industry of the old type (Landes, 1969). There are many characteristics of the industry that are put forward as the ‘cause’ of this lack of dynamism and innovation. According to Barrett *et al.*, (2007) these characterisations can be distilled into three strands. Firstly, the temporary project-based nature of the industry is seen as constraining innovation (Gann and Salter, 2000). Secondly, the structure of the industry with its preponderance of small firms employing less than five people gives rise to an associated limited capacity to innovate (Sexton and Barrett, 2003). Lastly, the adversarial nature of the industry with associated short-termism and opportunism does not encourage long term solutions.

However, construction is a very diverse sector and there is not one single way in which innovation occurs. Much of this reputation is undeserved as current measures of innovation do not reflect the way in which innovation occurs in the sector (Barrett *et al.*, 2007). In addition, the organizational context of construction innovations differs significantly from a great portion of manufacturing innovations (Slaughter, 1998). According to Lansley (1996) the occurrence of innovation within the construction industry is often characterised by the widespread adoption of new practices as a result of advances in technological and business processes. Innovative activities and effects of innovation depend extensively on the why innovation takes place (drivers) and who innovates (actors) as well as the external environment the innovation takes place.

2.2 The Role of Innovation Platforms

An economy’s rate of innovation depends on a range of activities and the links between them. Companies may take the lead, but do not innovate in isolation. Most innovations involve a multitude of organizations. In order to manage innovation process at the national level, a systems view should be adopted. The National Systems of Innovation (NSI) approach studies innovating firms in the context of the external institutions, government policies, competitors, suppliers, customers, value systems, and social and cultural practices that affect their operation (OECD and Eurostat, 2005). NSI provides a framework in which the whole innovation process can be analyzed in detail.

The Sainsbury Report (Turville, 2007) places innovation activity in the context of an innovation ecosystem within which the *“innovation rate depends on inter-linked activities which include: industrial research; publicly funded basic research; user-driven research; knowledge transfer; institutions governing intellectual property and standards; supply of venture capital; education and training of scientists and engineers; innovation policies of government departments; science and innovation policies of RDAs; and international scientific and technological collaboration”.*

In the national context, the concept of the innovation platform is being adopted by the UK government. Innovation Platforms are being developed nationally by Department for Business Enterprise and Regulatory Reform (BERR). According to BERR, innovation platforms are a new way of working for government and business that enable the integration of a range of technologies and better coordination of

policy and procurement, resulting in a step-change in UK performance. BERR define the key features of innovation platforms as follows (BERR, 2008). Innovation Platforms:

- engage with business and the research community,
- bring together government stakeholders/funders,
- identify the appropriate levers to use,
- seek to align funding streams from separate sources, and
- links research to market through procurement opportunities.

2.3 An Innovation Platform for Construction

The understanding of the nature of innovation in an increasingly service oriented economy has developed to encompass a much wider conception. This wider view accepts that innovation differs from sector to sector and from organization to organization. To respond to the modern business environment, companies are increasingly looking to more open innovation models, developing and exploiting new ideas in conjunction with a range of partners in a non-linear fashion. Innovation platforms are a new way of working for government and business that enable the integration of a range of technologies and better coordination of policy and procurement. An innovation platform must be responsive to this reality and be capable of playing its part in an overall innovation ecosystem that will change and develop over time.

Despite this desire for more collaboration between industry and academia, there is still much to be done. As pointed out by Gann (2001), universities and firms remain very different in terms of the ways in which they generate and manage knowledge. University research has typically been discipline-based, focusing mainly on long-term research issues for the advancement of knowledge and the training of new generations of researchers. The model below implies a gradual development of capacity and capability for organisations that engage with universities through the platform (Figure 1).

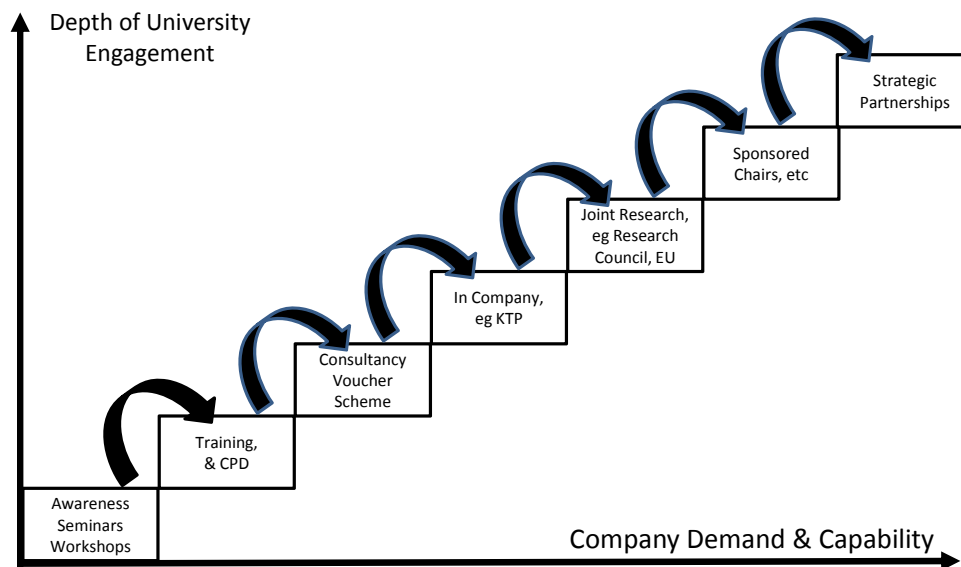


Figure 1: Seven Stage Model for an Innovation Platform (Abbott *et al.*, 2008)

Increasing the demand for university engagement should be the underpinning activity of an innovation platform. Awareness raising, as detailed above, is important. The simplest level of engagement for a company with a university could be attendance at workshops, training or continuous professional development (CPD) accredited activity where such activity already exists. An innovation platform can

play a role in co-ordinating and documenting all such activity but also through industrial membership lead the development of more such activity in response to a better understanding of demand. The development and promotion of training in innovation as a discipline in its own right should be considered here. Familiarity and trust, established through awareness raising and training activity, can lead to the better understanding of university capabilities and the consequent identification of a university as a partner in solving pressing business problems. The proposed innovation voucher scheme here could provide a useful demand led system. Other alternatives worthy of consideration in terms of targeted funding would be mini Knowledge Transfer Partnership (KTP, <http://www.ktponline.org.uk/>) schemes. Embedding researchers within companies as part of existing research activity is another method of universities emerging themselves within business contexts and problems. Stages 5-7 assume a higher degree of collaboration based around the mutual development of work and research. Jointly developing and bidding for research projects, particularly under schemes such as the UK Technology Strategy Board would be likely. A portfolio of successful activities at the Stage 5 level can lead to a more formal 'framework' type agreement. In this way, long-term collaboration is agreed with the recognition that the university and companies are strategic partners. The final stage of this process is a culmination of all other stages. Both sides will be seen as key strategic partners in the development of their respective business.

All of the above implies an open system with a loose central co-ordination structure and strengthened regional brand. In this way the innovation platform can support and enhance individual initiative and growth rather than to control and constrain. The roles and responsibilities of the parties involved within the innovation platform should be identified to be able to respond to changes in the external environment, and an action plan should be set based to address different possible future scenarios. The next section introduces and explains the scenario planning approach which will be followed by how to develop strategic action plans for establishing and effectively managing innovation platforms in construction.

3. Scenario Planning

From the earliest times, there has been an interest to know what the future might bring. At the organizational level, anticipating the future is considered as a useful way to align and improve current strategies. This interest has been reflected in future studies, strategic planning, scenario thinking and planning, foresight, and futurology. The term scenario is a fuzzy concept with many different definitions and many different meanings attached to it. According to Porter, a scenario is "*an internally consistent view of what the future might turn out to be- not a forecast, but one possible future outcome*" (Porter, 1985). Selin (2006) defines scenarios as stories describing different but equally plausible futures that are developed using methods that systematically gather perceptions about certainties and uncertainties. According to Godet (1987), scenarios should aim to detect the key variables that emerge from the relationship between the many different factors describing a particular system, especially those relating to the particular actors and their strategies.

Due to its aid to understand the nature and impact of most uncertain and important driving forces affecting our world, scenario planning is considered as a strategic planning tool enabling the development of flexible long-term plans (JISC, 2008). According to Wack (1985), scenario planning is a discipline for rediscovering the original entrepreneurial power of creative foresight in contexts of accelerated change, greater complexity, and genuine uncertainty. Scenario planning does not focus on accurately predicting the future (Hodgkinson and Wright, 2002) but rather is a process that produces a number of possible futures that are credible and yet uncertain (Brauers and Weber, 1988; Simpson, 1992; Schoemaker, 1995; Schwartz, 1996; van der Heijden *et al.*, 2002).

Scenario building helps (Fahey and Randall, 1998):

- augment understanding by helping to see what possible futures might look like, how they might come about, and why this might happen.
- produce new decisions by forcing fresh considerations to surface.
- reframe existing decisions by providing a new context within which they are taken.
- identify contingent decisions by exploring what an organisation might do if certain circumstances arise.

Scenario planning leads to strategic actions through improving the decision-making process within the companies. Chermack (2004) presented a model that specifically outlines how scenario planning can improve the decision-making process. The model relied on several items to improve decision making: reduced bounded rationality, the consideration of exogenous and endogenous variables, reduced information stickiness, increased knowledge friction, and alternative mental models.

3.1 Development of Scenario Planning

Scenario building has been used in a variety of situations such as European Commission future planning, the global telecommunications industry, East Asian economic emergence, the French iron and steel industry, the US defence industry, new business models, British Airways, Cable and Wireless, ICL, United Distillers and the UK National Health Service (Ringland, 1998). Scenario planning started to be used strategically after the World War II. Herman Kahn, who coined the phrase “thinking about the unthinkable”, is considered as the founder of scenario based planning. After Kahn, further research in the USA on scenario based planning resulted in a number of alternative approaches. These approaches can be categorized under three major groups (Huss and Honton, 1987):

- Intuitive logics-described by Pierre Wack and used in Stanford Research Institute (SRI) International and Shell;
- Trend-Impact Analysis practiced by The Futures Group;
- Cross-Impact Analysis practiced by Center for Futures Research (INTERAX) and Batelle (BASICS).

The second major thrust for scenario planning research has been in France. Here, scenario planning research mainly focused on the ‘scientific and political foundations of future’. In 1950s, Gaston Berger, a French philosopher, founded the Centre d’Etudes Prospectives and developed a scenario approach to long-term planning, which is known as prospective thinking or La Prospective. In the mid-1970’s, the French School gained a new member, Michel Godet, who developed a mathematical and computer-based probabilistic approach to scenario development and classified problem solving methods (some were developed by himself) for different stages of the prospective scenario planning approach (Godet and Roubelat, 1996; Bradfield *et al.*, 2005). The prospective approach generally focuses on an integrated scenario planning and strategic planning approach. Figure 2 shows the complete process of this integrated approach proposed by Godet (2000). This research follows a modified version of the prospective approach.

3.2 Scenario Planning Approach to Develop a Vision for Construction Industry

As discussed in the previous sections, a seven-stage model was suggested for developing an innovation platform in construction (Abbott *et al.*, 2008). In order to explore the related issues of the innovation platform and to accomplish the objectives of the seven-stage model, proper strategies are needed. In this respect, scenario planning approach will be followed to identify the possible futures of construction and to develop a vision for the construction industry. In order to realize this vision, strategies will be developed and innovation platforms will play a key role whilst carrying out the strategic action plans. The scenario planning approach recommended in this research is the same approach followed for the ICT Vision Development, a research project carried out in the Salford Centre for Research and Innovation (SCRI) in University of Salford. The aim of the project was to anticipating the possible futures the construction

industry and construction IT may face and to develop a preferred construction IT vision considering the forces driving the future (Erdogan *et al.*, 2009). It followed a modified prospective scenario planning approach according to the aims of the research.

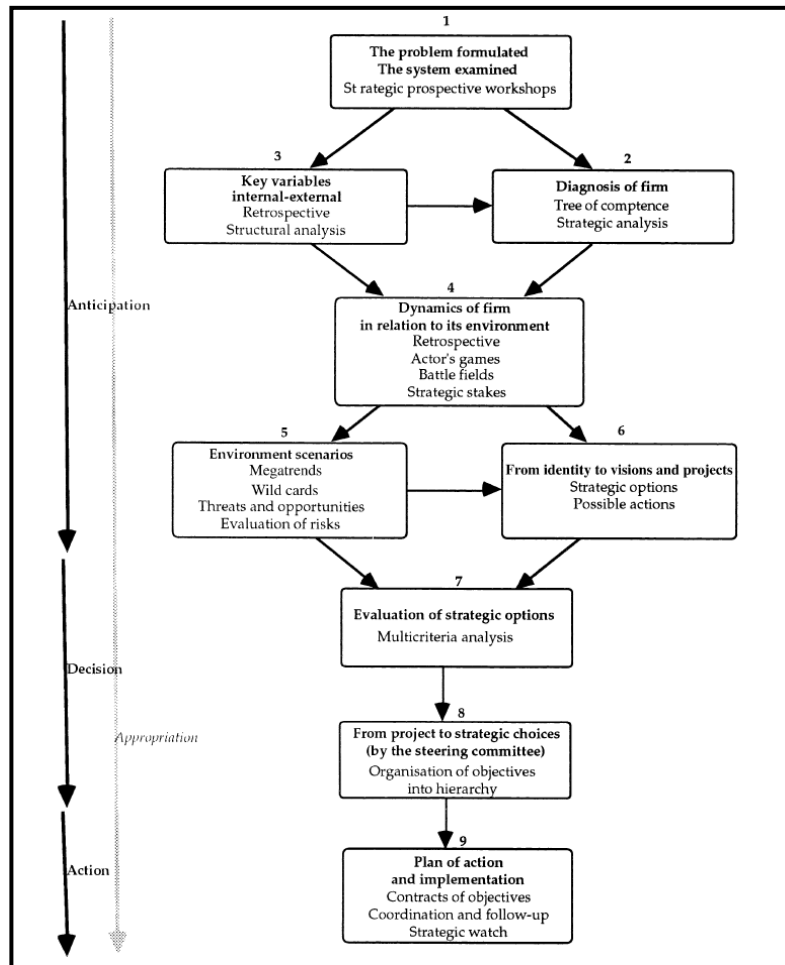


Figure 2: Godet's Scenario Planning: Complete Process (Godet, 2000)

For the innovation platforms research, it was decided to follow the same steps as the ICT vision planning research carrying out some modifications related to innovation platforms. Through these steps, it is aimed to identify possible futures, to formulate strategies through scenarios and to define the roles and missions of relevant parties within the innovation system in order to realize the construction vision. These steps are shown in Figure 3 and explained below.

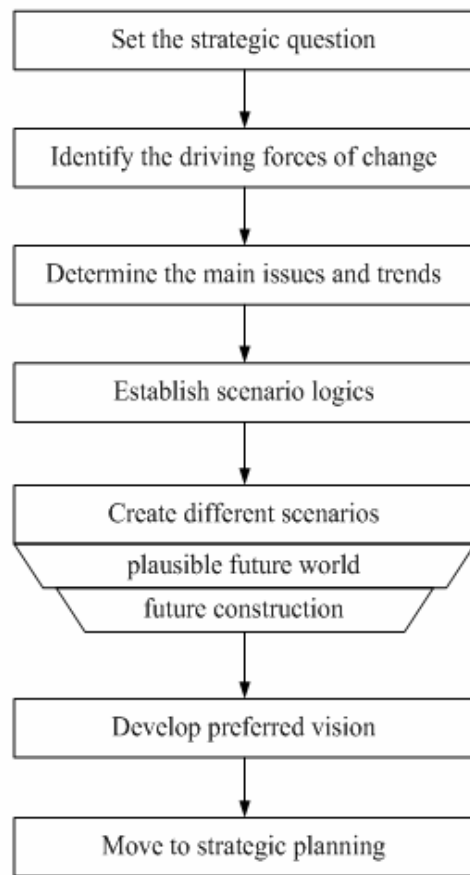


Figure 3: Scenario Planning Approach for Developing a Vision for Construction Industry (adapted from Erdogan *et al.*, 2009)

1. Set the strategic question

The first stage aims to identify the problem posed and define the system under examination. The strategic question in this study is determined as “what will be the possible futures construction industry might face and how should innovation platforms be shaped to achieve a preferred vision whilst being prepared for the possible issues and events that might affect the future”. Such a platform should be capable of addressing the changes in the global environment as well as the construction industry in order to effectively manage innovation. After the strategic question is defined, the research proceeds to the other stages through the scenario planning workshops and ongoing interviews with key actors. Starting from the second step, some recommendations are provided how to achieve the objective of each step.

2. Identify the driving forces of change

The driving forces of change can be identified by continuous monitoring through ‘horizon’ or ‘environmental’ scanning; in-depth interviews with acknowledged experts; targeted questionnaire surveys; and brainstorming workshops at the start of the prospective process (Kelly *et al.*, 2004). In the proposed study, the driving forces will be determined in a number of scenario planning brainstorming workshops, which will have participants from academia and industry. The driving forces will be categorized according to DEGEST categorization (Demographic, Economic, Governance, Environmental, Societal and Technological) and their interrelationships will be investigated in the workshops.

3. *Determine the main issues and trends*

This stage will focus on the main issues and trends that might shape the construction industry's future considering the drivers of change identified in the previous stage. The workshop participants will be asked to identify the main issues and trends and the associated impacts and uncertainties. This will be followed by the clustering process where the forces, issues and trends are grouped into a number of high level concepts. Clustering is a critical part of this stage since it informs the scenario logics.

4. *Establish scenario logics*

Scenario logics refer to a logical rationale and structure for the scenarios enabled by intuition, insight and creativity (Ratcliffe, 2000). With this stage, the themes for a scenario are defined. The scenario logics might be articulated by laying-out in simple narrative form, or by using the 2x2 matrix approach, or by depicting the logics and their interactions or relationships diagrammatically showing causal connections (Ratcliffe and Sirr, 2003). The scenario logics will be decided according to the results obtained in the previous stages and the number of scenarios will be restricted to a maximum of five or six.

5. *Create different scenarios*

Scenarios can be created in many different ways depending on the circumstances, timescales, organizational or sectoral cultures, facilitation methods and available resources. Regardless of the method of generation, each scenario should have four characteristics (Vanston *et al.*, 1977): plausibility; self-consistency; inclusion of all critical, relevant factors; and similarity to other scenarios in form and scope.

Scenarios will initially be developed by the participants attending the brainstorming workshop. Each scenario will have an approximate timeline, early indicators of change and a memorable title describing the essence of the scenario. The scenarios will start from the global view and will present the images of the future world. They will then focus on the construction industry and will imagine how the future world will shape the construction industry. The scenarios will then be revised during the subsequent workshops.

6. *Develop a preferred vision in construction*

This stage aims to develop a single preferred future for construction. It is based on the principle that the future can be influenced if we know what we want it to be. The previous exercises to identify the drivers, trends and issues and their relationships and to develop scenarios enable thinking outside the box and will initiate the development of a preferred construction vision.

7. *Move to strategic planning*

This stage will focus on how innovation platforms can be used to achieve the preferred vision defined in the preferred stage. For this reason, the barriers and enablers of the construction vision will be identified considering the innovation perspective, strategic policy and action areas for the innovation platforms will be determined. In addition, the roles and missions of relevant parties within the innovation system will be defined in order to realize the construction vision. The mind map developed for the issues related to an innovation platform will be used as a basis for the action plans. This mind map is shown in Figure 4. The framework of the strategic plan will be developed during the first brainstorming workshop and will be detailed during the follow-up workshops, where action plans will be formulated for each issue in order to achieve the preferred vision.

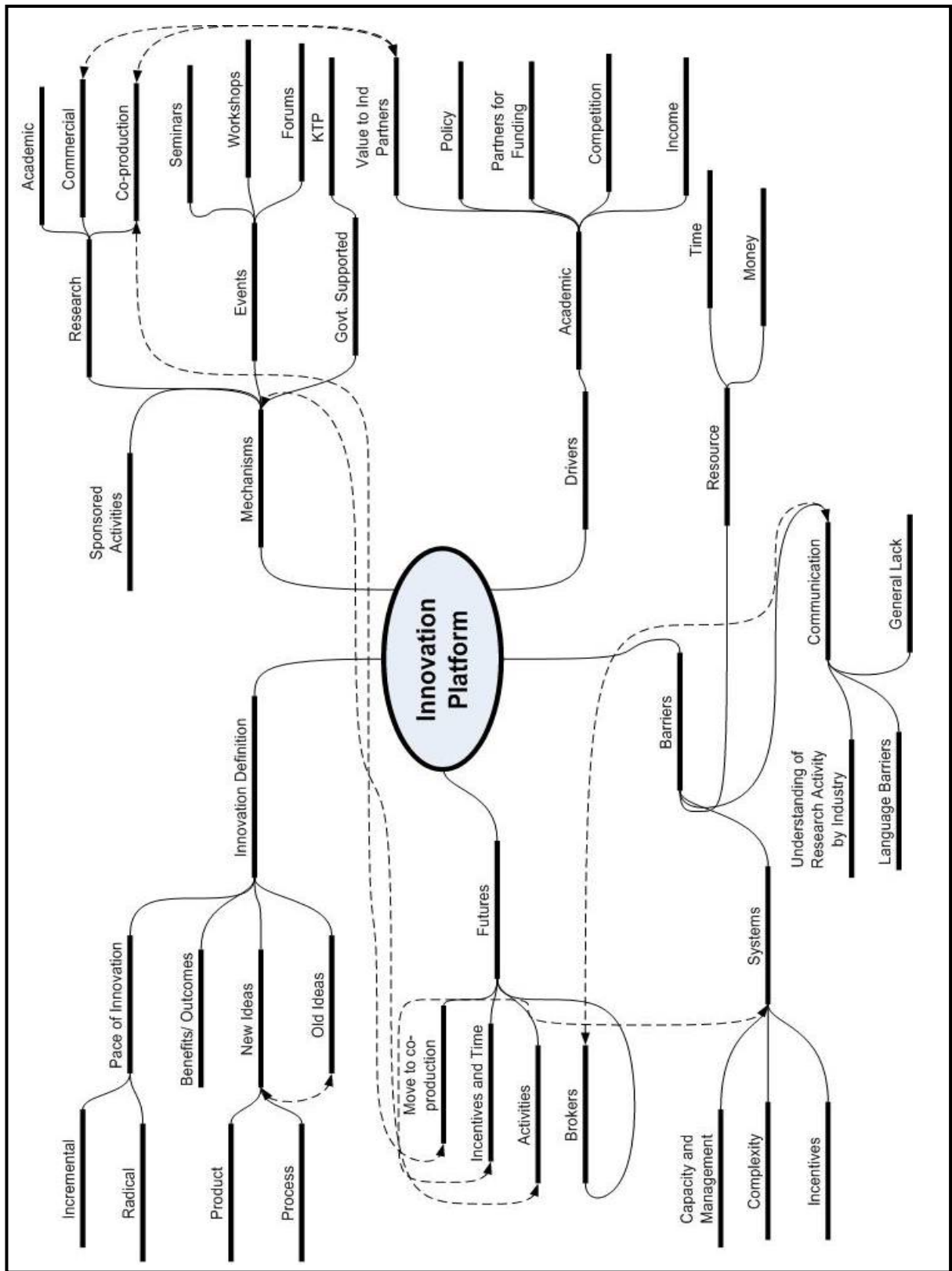


Figure 4: Mind Map Classifying Issues Related to an Innovation Platform for Construction (Abbott *et al.*, 2008)

4. Conclusions

Given the constant changes in the business environment, the competitiveness of the construction industry is highly dependent on its dynamism and adaptability to possible scenarios in the future. Due to its contribution to performance at the firm, sector and national levels, innovation has become a central issue for all industries and countries. Although construction is often perceived as being among the low innovative sectors, effective management of innovation is essential to create value for construction companies. Within the context of this study, innovation platforms are proposed to be an effective way of managing the innovation process by maximizing the stakeholder involvement. Innovation platforms enable the integration of a range of technologies and better coordination of policy and procurement. In this paper, the conceptual framework for an innovation platform in construction is presented, major issues related to this model are identified, and necessary steps for implementing an effective platform are determined. However, the establishment and management of innovation platforms should be in line with an overall construction vision that would respond to the emerging needs of the world and construction industry in the future. A scenario planning approach is proposed to identify the critical elements and to develop a strategic action plan for the implementation of innovation platforms in order to be prepared for what future might bring to construction industry and to realise a preferred construction future.

5. References

- Abbott, C., Aouad, G., and Madubuko, L. (2008). "An innovation platform for construction", NWUA Pilot Project to Develop Innovation Platforms in Non-science Research Disciplines Salford Centre for Research & Innovation, University of Salford.
- Barrett, P., and Sexton, M. (1998). "Integrating to Innovate: Report for the Construction Industry Council", DETR/CIC, London, UK.
- Barrett, P., Sexton, M.G., Miozzo, M., Wharton, A., and Leho, E. (2001). "BaseReport: Innovation in small construction firms", University of Salford, Salford, UK.
- Barrett, P., Abbott, C., Ruddock, L., and Sexton, M. (2007). "Hidden innovation in the construction & property sectors", *RICS Research Series Papers*, pp. 1-21.
- BERR (Department for Business, Enterprise and Regulatory Reform). (2008). Innovation platforms, http://www.berr.gov.uk/dius/innovation/technologystrategyboard/tsb/innovation_platforms/index.html, 31/07/2008.
- Bradfield, R., Wright, G., Burt, G., Cairns, G., and Van Der Heijden, K. (2005). "The origins and evolution of scenario techniques in long range business planning", *Futures*, Vol. 37. No. 8, pp. 795-812.
- Brauers, J., and Weber, M. (1988). "A new method of scenario analysis for strategic planning", *Journal of Forecasting*, Vol. 7, pp. 31-47.
- Chermack, T. (2004). "Improving decision-making with scenario planning", *Futures*, Vol. 36, pp. 295-309.
- DTI. (2003). "Innovation Report, Competing in the global economy: The innovation challenge", The Stationery Office, London, UK.
- Erdogan, B., Abbott, C., and Aouad, G. (2009). "Scenario planning: A glance at the history", 6th SCRI International Research Symposium, 27-28 January, 2009, Manchester, UK.
- Fahey, L., and Randall, P. (1998). *Learning from the future*, Wiley, New York.
- Gann, D. (2001). "Putting academic ideas into practice: technological progress and the absorptive capacity of construction organizations", *Construction Management and Economics*, Vol. 19, No. 3, pp. 321-330.
- Gann, D., and Salter, A. (2000). "Innovation in project-based, service enhanced firms: The construction of complex products and systems", *Research Policy*, Vol. 29, No. 7-8, pp. 955-972.
- Godet, M. (1987). *Scenarios and strategic management*, Butterworths, London, UK.

- Godet, M. (2000). "The art of scenarios and strategic planning: Tools and pitfalls", *Technological Forecasting and Social Change*, Vol. 65, No. 1, pp. 3-22.
- Godet, M., and Roubelat, F. (1996). "Creating the future: The use and misuse of scenarios", *Long Range Planning*, Vol. 29, No. 2, pp. 164-171.
- Hodgkinson, G., and Wright, G. (2002). "Confronting strategic inertia in a top management team: Learning from failure", *Organization Studies*, Vol. 23, pp. 949-977.
- Huss, W.R., and Honton, E. J. (1987). "Scenario planning - What style should you use?", *Long Range Planning*, Vol. 20, No. 4, pp. 21-29.
- JISC. (2008). Scenario Planning, <http://www.jiscinfonet.ac.uk/tools/scenario-planning>, 09/10/2008.
- Kelly, R., Sirr, L., and Ratcliffe, J. (2004). "Futures thinking to achieve sustainable development at local level in Ireland", *Foresight*, Vol. 6, No. 2, pp. 80-90.
- Landes, D. (1969). *The unbound Prometheus*, Cambridge University Press, Cambridge.
- Lansley, P. (1996). "Innovation: The role of research, education and practice", in Harlow, P. (Ed.), *Construction Papers*, No. 59, CIOB, Ascot, UK.
- OECD (Organisation for Economic Co-operation and Development) and Eurostat. (2005). *Oslo Manual*, 3rd edition, OECD/Eurostat, Paris/Luxembourg.
- Porter, M. E. (1985). *Competitive advantage*, Free Press, New York.
- Ratcliffe, J. (2000). "Scenario building: A suitable method for strategic property planning?", *Property Management*, Vol. 18, No. 2, pp. 127-144.
- Ratcliffe, J. S., and Sirr, L. (2003). The prospective process through scenario thinking for the built and human environment: a tool for exploring urban futures, <http://www.thefuturesacademy.ie/sites/default/files/Futures-thinking-for-the-built-environment-and-human-environment.pdf>, 20/09/2008.
- Reichstein, T., Salter, A., and Gann, D. (2005). "Last among equals: A comparison of innovation in construction, services and manufacturing in the UK", *Construction Management and Economics*, Vol. 23, No. 6, pp. 631-644.
- Ringland, G. (1998). *Scenario planning: Managing for the future*, John Wiley and Sons, Chichester, West Sussex, UK.
- Rosenberg, N. (1982). *Inside the black box: Technology and economics*, Cambridge University Press Cambridge.
- Selin, C. (2006). "Trust and the illusive force of scenarios", *Futures*, Vol. 38, No. 1, pp. 1-14.
- Sexton, M., and Barrett, P. (2003). "Appropriate innovation in small construction firms", *Construction Management and Economics*, Vol. 21, No. 6, pp. 623-633.
- Schoemaker, P. (1995). "Scenario planning: A tool for strategic thinking", *Sloan Management Review*, Vol. 36, No. 2, pp. 25-40.
- Schwartz, P. (1996). *The art of the long view: Planning for the future in an uncertain world*, Doubleday, New York.
- Simpson, D. (1992). "Key lessons for adopting scenario planning in diversified companies", *Planning Review*, Vol. 20, No. 3, pp. 11-18.
- Slaughter, S.E. (1998). "Models of construction innovation", *Journal of Construction Engineering and Management*, Vol. 124, No. 3, pp. 226-231.
- Slaughter, S.E. (2000). "Implementation of construction innovations", *Building Research and Information*, Vol. 28, No. 1, pp. 2-17.
- Slaughter, E., and Shimizu, H. (2000). "Clusters of innovation in recent long span and multi-segmental bridges", *Construction Management and Economics*, Vol. 18, No. 3, pp. 269-280.
- Turville, L.S. (2007). *The race to the top*, HM Treasury, London.
- van der Heijden, K., Bradfield, R., Burt, G., Cairns, G. and Wright, G. (2002). *The sixth sense: Accelerating organizational learning with scenarios*, John Wiley New York.
- Vanston, J. H., Frisbie, W. P., Lopreato, S. C., and Boston, D. L. (1977). "Alternate scenario planning", *Technological Forecasting and Social Change*, Vol. 10, No. 2, pp. 159-180.
- Wack, P. (1985). "Scenarios: uncharted waters ahead", *Harvard Business Review*, Vol. 63, No.5, pp. 73-89.