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Coping with social complexity of infrastructure projects

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Abstract

Infrastructure projects are complex and technical complexity is dwarfed when compared with the social complexity caused by the interaction of individuals and organisations that participate and influence these projects. During conception and planning, uncertainty and conflicting motivations influence decisions that drive the solution and plans that are carried out during construction, operation and finally disposal of the system. If the need is not accurately conveyed and the solution is not properly defined, estimated and planned, infrastructure projects become subject of costs overrun and schedule delays of serious consequences, including the possibility that they may not satisfy the real need. Understanding the sources of uncertainty, what drives motivation, how private and public organisations and social groups influence each other is of great importance for planning and managing successful infrastructure projects. Although it is difficult, if at all possible, to quantify the influence that individuals and social organisations may have over the project, principles and insights taken from social and systems theories can help to create qualitative mental models that help in dealing with the inherent complexity of these large projects. This paper compiles principles and insights extracted from systems and social theories into a simple framework that can be applied by infrastructure planners and decision makers to better cope with complexity, development and managing projects with better chances of success. The paper concludes suggesting how modelling and simulation can be used to assess 'what-if scenarios' that would help in developing a better understanding of the consequences of social interaction in the success or failure of infrastructure projects.

Keywords

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Coping with social complexity of infrastructure projects

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Abstract
Infrastructure projects are complex and technical complexity is dwarfed when compared with the social complexity caused by the interaction of individuals and organisations that participate and influence these projects. During conception and planning, uncertainty and conflicting motivations influence decisions that drive the solution and plans that are carried out during construction, operation and finally disposal of the system. If the need is not accurately conveyed and the solution is not properly defined, estimated and planned, infrastructure projects become subject of costs overrun and schedule delays of serious consequences, including the possibility that they may not satisfy the real need. Understanding the sources of uncertainty, what drives motivation, how private and public organisations and social groups influence each other is of great importance for planning and managing successful infrastructure projects. Although it is difficult, if at all possible, to quantify the influence that individuals and social organisations may have over the project, principles and insights taken from social and systems theories can help to create qualitative mental models that help in dealing with the inherent complexity of these large projects. This paper compiles principles and insights extracted from systems and social theories into a simple framework that can be applied by infrastructure planners and decision makers to better cope with complexity, development and managing projects with better chances of success. The paper concludes suggesting how modelling and simulation can be used to assess 'what-if scenarios' that would help in developing a better understanding of the consequences of social interaction in the success or failure of infrastructure projects.

Key Words
Infrastructure projects, social dynamics, complexity, framework

Introduction
Large infrastructure projects are notorious for not meeting expectations of cost, schedule and delivered benefit. Case studies of 'great planning disasters' (Hall 1980), such as the 'Sydney Opera House' and 'London's Third Airport' became classic examples of infrastructure projects failure. The first was built and became a 'postcard of Sydney and Australia', although it was more than 1400% over budget and ten years late. The second was never built because it was not possible to agree on the location for the new airport. Other examples of infrastructure projects showing cost overruns and benefit shortfall were added to the list, including the 'Channel tunnel between the UK and France' and the 'San Francisco-Oakland Bay Bridge', both over budget by 100% or more and under estimated utilisation (Flyvbjerg 2005). In Australia in 2013, on average 48% of infrastructure projects failed to meet their baseline time, cost and quality objectives (CoA 2013). Projects that require new technology such as IT and software, whether for civil or defence applications, present even higher challenges and become candidates of failure. Two well-known examples of this category of projects that resulted in large financial losses due to cancellation are the National Programme for IT in the NHS in UK (Campion-Awwad et al. 2014) and the Super Seasprite Helicopter in Australia (Ferguson & Blekin 2008).

Many models have been suggested to explain the causes and present failure of large infrastructure projects. Hall (1980) explains that failed projects are the result of many interconnected actors belonging to three groups named 'The Community', 'The Bureaucracy' and 'The Politicians', each with their own interests influencing actors in the other groups. To prevent projects failing Hall suggests that we need ways of ‘forecasting the future world’ and to ‘quantify the future consequences of one’s decisions’. Flyvbjerg et al. (2009) explores psychological and governance reasons to explain the difficulty in forecasting errors in large infrastructure projects and explain that the underlying reasons of all forecasting errors can be grouped in three categories: delusions or honest mistakes; deception or strategic manipulation of information or processes; or bad luck. Delusion manifests through the optimism of underestimating costs and overestimating benefits, result of the ‘inside view’, that create the conditions for the project be approved. Deception accounts for flawed planning and decision making caused by political and organisational pressures to attend specific agenda and interests. The solution proposed to Flyvbjerg is to reduce optimist delusions by adopting an ‘outside view’ for better forecasting and for creating best practices to diminish strategic deception. Innes & Booher (2009) adopt ‘complexity theory’ approach to view infrastructure projects and policy making as ‘complex adaptive systems’, where a diverse population of actors interact to reach an acceptable solution, and propose the ‘theory of collaboration rationality’ based on diversity, interdependence and authentic dialog, referred as DIAD, to address the problem by changing the system towards a collaborative environment.

Critical success factors (CSF) of Public Private Partnership (PPP), a contractual model commonly used in infrastructure projects, have been of great interest for over two decades (Osei-Key et. al 2015). Relationship management is important for the success of PPP projects and top three CFSs have been identified as (1) commitment and participation of senior executives, (2) defining the objectives for effective relationship management strategy, and (3) integration of the divisions of the organisations (Zou et. al 2014). The presence or absence of these CFSs, however, seems to be consequences of other root causes that will be explored in this paper.

The models, theories and success factors presented above suggest that success or failure depends on very complex social systems that influence the project. The proposed solutions, however, ask for two very difficult, if not impossible, things: being able to predict the future and changing the behaviour of social systems that are beyond any form of control. By showing the way, although ‘difficult to walk on’, progress has been made. Hall and Flyvbjerg have shown the source of the problem while Innes & Booher have tapped into the path for the solution. This paper will explore the root causes of success and failure of infrastructure projects and present a simple framework that could help achieve what Innes & Booher proposed. The framework is intended to ‘steer rather than control’ the social system towards the desired outcomes by creating the conditions that ‘change the system’ as proposed by Innes & Booher.

Guided by Deming’s System of Profound Knowledge (Deming 2000) this paper approaches infrastructure projects as systems and examine the sources of variations present in the social system. Rather than developing a theory to allow prediction, as suggested by Deming, the paper offers a framework as a first step towards a theory. Sections 2 and 3 present the theories behind the proposed framework addressing systemic and social aspects. Section 4 describes the *framework for steering infrastructure projects to success* and section 5 concludes the paper showing how modelling and simulation can help.

Appreciate the system

Infrastructure are complex technical systems with many interconnected components engineered by an equal complex social system, comprised of people associated in teams and organisations, bounded by relationships, roles and responsibilities, processes and contracts. Infrastructure projects are problem solving and decision-making groups searching for a solution in the infrastructure space. Performance is therefore determined by a combination of engineering, technology and social factors.

One of the central aspects in understanding systems is the concept of variety. The Law of Requisite Variety (Ashby 1957) states that for effective control, the controller must have at least the same variety as the entity, or system, being controlled. Variety in infrastructure projects is present in both technical and social systems. The social system however, is the one that defines the technical system. If the variety available in the social system in the form of human resources (e.g. political will, engineering and management skills, motivation, behaviour and attitudes) do not provide the requisite variety to engineer the solution the project is destined to fail.

Stafford Beer stated that every system has a purpose and 'the purpose of a system is what it does' (Beer 2002 p. 218) which becomes a powerful concept if not a principle. The implication this insight brings is that if 'what the system does', does not reflect the intended purpose for the system, then the system will have to be changed. For organisational systems that have an enterprise as a goal, Beer explains that changing the system is about changing the structure that makes the system do what it is required to do and changing the system is a responsibility of management. Beer's ideas about the purpose of the system and how management can bring the purpose of the system into alignment with the intended purposes conforms to principles embedded in the System of Profound Knowledge and with the solution proposed by Innes & Booher (2009).

Infrastructure projects originate in the Situation Domain, where a need exists and can be expressed by a set of artefacts in the Situation Domain. The need leads to the definition of the problem as another set of artefacts in the Problem Domain. The solution that resolves the problem comprises a set of artefacts in the Solution Domain. The transformations of artefacts from need to problem and then to solution require human resources with knowledge and skills specific of each domain (Peculis et al. 2007a). Ideally, the process should occur as shown in Figure 1, where the need is accurately expressed, the problem is well defined; the solution is correctly implemented and satisfactorily addresses the need.

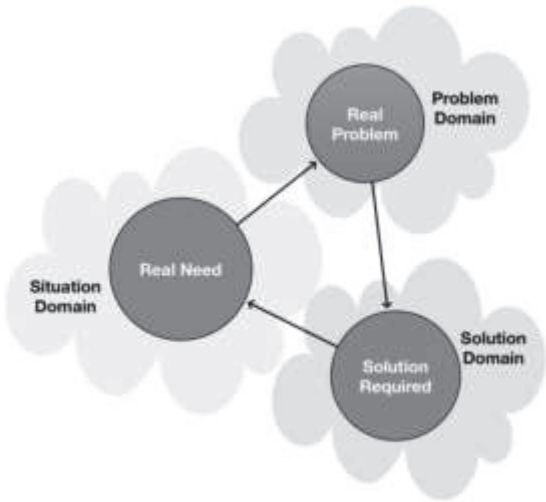

Figure 1 – Ideal Process

If the requisite variety is not available distortions occur which in turn reduce quality of the solution. To bring quality to acceptable levels often increases costs and schedule. The management challenge is then to envisage ways to provide requisite variety without increasing cost and schedule, which is not always possible. Figure 2 shows the reality of infrastructure projects when requisite variety is not satisfied (Peculis et al. 2007a).

Within the Situation Domain, divergence occurs as the 'Real Need' is interpreted into the 'Perceived Need'. As the latter becomes the 'Expressed Need' it incurs further distortion. Thus, within the Problem Domain, the derived 'Expressed Problem' carries the sum of all these distortions to the Solution Domain. The resulting 'Solution Implemented' and 'Solution Applied' are quite unlikely to satisfy the Real Need. Distortions occur because people in the social system, limited by their own knowledge, skills, cognition, emotions, moved by personal and corporate goals and bounded by their roles in the organisation, are responsible for the execution of transformations between and within domains. The process is a sequence of transformations where distortions, errors and omissions that occur in the previous transformations are carried to the next transformation as in a *Chinese Whispers* effect (or 'telephone' in the United States, see http://en.wikipedia.org/wiki/Chinese_whispers).

Among the causes of infrastructure projects' failure are inaccurate estimation and changing requirements. Lack of knowledge and skills are drivers of poor estimation and planning. Lack of knowledge and skills are often present in engineering and in management: lack of domain and engineering knowledge to find and acceptable solution before implementation starts; and lack of management knowledge and skills to recognise that there is a deficiency in domain and engineering knowledge to adequately estimate, plan and manage this deficiency.

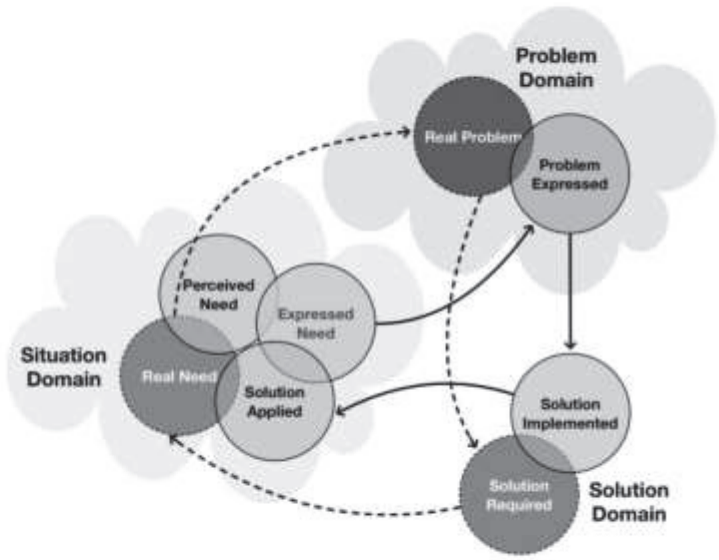

Figure 2 – Real Process

Complex adaptive systems (CAS) (Holland 1995) are open systems with components interacting with other components and with the environment and by doing so they change themselves, causing changes in the system. This form of change is called 'adaptation'. Social systems are complex adaptive systems where adaptation occurs by learning what works and what does not, and then selecting behaviours that lead to better results, often a process of trial and error. Infrastructure projects are CAS (Innes & Booher 2009).

Systemic structure in social systems is created by conditions that drive beliefs and motivations that make the people in the system behave in certain ways. The behaviour of social systems is determined by how people behave. What people in the system often don't realise is that they can influence and change the system structure by changing their own behaviour and as a consequence the behaviour of the system, as suggested by Innes & Booher (2009).

Psychology, social behaviour and variation

Variations in people's knowledge, skills, experience, behavioural style and motivation are the drivers that cause variation in in cost, schedule and quality of infrastructure projects. The way people are motivated and behave, cooperate and compete, learn and share knowledge is dynamically influenced by the way people interact with each other. Therefore, knowledge of psychology and social behaviour is relevant to reduce uncertainty associated with planning and managing infrastructure projects. Management is about managing people and for effective management, knowledge of psychology is essential (Deming 2000).

Understanding what motivates people helps create the conditions to motivate them to perform well in doing what they are supposed to do. What motivates managers differs from what motivates engineers and what motivates politicians differ from what motivates the community and bureaucrats. Managers are motivated by responsibility for meeting cost, schedule and contractual obligations; engineers are motivated by the challenge to develop high quality products that require learning, new technologies and creativity (Linberg 1999; McConnell 1996; Procaccino, Verner & Lorenzet 2006); politicians are motivated by re-election and perpetuating their names in history, while bureaucrats are motivated to maintain the 'status quo' and their jobs (Hall 1980). Conflict of motivations can explain why it is difficult to reach consensus agreement in infrastructure projects.

Behaviour is any noticeable change, response or action of a person or a system. Behaviour is driven by motivation resulting in action intended to fulfil a need. The theory of behaviour aims to provide ways to predict the likely behaviour of a person in accordance with a classification of personality. Infrastructure project systems will behave as the result of the collective behaviour of individuals. The behaviour of the system is not expected to respond linearly to individual behaviour, as one individual may influence the behaviour of others, and can even feedback, changing the behaviour of the individual that started the process of change.

Several theories exist to classify people in accordance with personality types. Personality types help to describe personal characteristics and predict how a person may behave and perform under certain circumstances. Three theories have been considered: Myers-Briggs Type Indicator (MBTI) (Briggs & Myers 1980), Keirsey Temperament Scale (KTS) (Keirsey & Bates 1984) and the Life Styles Inventory (LSI) (Lafferty in Cooke & Rouseau 1983). LSI assesses twelve life styles attributes that form a continuum correlated with the four areas of concern and three characteristics of behaviour defined as 'Constructive', 'Passive' and 'Aggressive'. The life styles are also classified in accordance with their interaction style as Aggressive, Passive or Constructive.

The effectiveness of problem-solving groups depends on the group interaction style (Cooke & Szumal 1994), which defines the style of the group as a whole unit, as a system, resulting from the dynamic interaction of its members in accordance with their roles and individual personality styles. The group interaction style reflects the atmosphere of the group, the group's own personality that will promote cooperation or persuasion in finding the solution for the problem. Group members with more power, e.g. in management or leadership roles, or with stronger personality styles are likely to influence other members in the group (Cooke & Szumal 1994). Across problem-solving groups, solution quality increases when the group shows a constructive interactive style and decreases with a passive interaction style; and the acceptance of the solution increases with a constructive interaction style and decreases with both passive and aggressive interaction styles. The dynamics of group interaction styles tells us that constructive behaviour promotes constructive behaviour, and aggressive behaviour suppresses constructive and promotes passive behaviours; that is aggressive behaviour promotes passive behaviour altogether (Cooke & Szumal 1994).

Projects that depend of problem-solving to find a solution can be viewed as a process of knowledge acquisition and ignorance reduction, and can be classified in five orders of ignorance (Armour 2000, 2004). At Zero-Order of Ignorance (Zero-OI) there is no ignorance and all is known; at First-OI there is some lack of knowledge which can be acquired; at Second-OI there lack of knowledge exists and there are 'unknowns' which can be revealed through an available processes of discovery; projects at Third-OI are like Second-OI without suitable processes of discovery; at Fourth-OI projects are at 'meta-ignorance' as they are not aware of the five Orders of Ignorance. Armour argues that each of the Orders of Ignorance requires a different type of process. Processes only allow things to be done that are already known, therefore well-defined and detailed processes are applicable to projects that are at Zero-OI and to some degree and with fewer details to projects at the First-OI and maybe Second-OI. Projects that are at Third-OI require a completely different kind of process, that is, a process to discover 'what we don't know that we don't know'. For infrastructure projects most of the 'unknowns' have to be resolved during planning, when the need must me understood and an appropriate solution to satisfy the need must be found and adequately costed. For projects at the Third-OI a learning-based process is required and the project would move to the Second-OI.

The development of infrastructure systems calls for specific domain knowledge to solve the problem, and knowledge of engineering and other technologies to create the solution. These two types of knowledge, however, are necessary but not sufficient. Individuals and even organisations in isolation will not possess all the knowledge. Part of the knowledge is available and distributed among the stakeholders. Knowledge distribution can be defined in terms of 'who has what type of information' (Rulke & Galaskiewicz 2000). Other required knowledge may be non-existent or not easily obtained. Cooperation and collaboration is therefore necessary to share and combine existing distributed knowledge into collective knowledge. As a consequence, knowing how to work as a team is also necessary (Chan, Jiang & Klein 2008). The team members must be knowledgeable about learning-based processes, how the knowledge is distributed, and willing to collaborate and cooperate. Learning behaviours such as seeking feedback, sharing information, asking for help, talking about errors and experimenting, enhance team performance and team satisfaction (Yeh & Chou 2005).

A framework for steering infrastructure projects to success

As suggested by Deming's System of Profound Knowledge this paper combined and developed knowledge of infrastructure projects that could be transformed into a theory and acknowledges that this knowledge is not unquestionable evidence of truth. The knowledge here conveyed, however, can contribute towards the development of a theory that explains the root causes of success and failure of infrastructure, until such time as they are disproved, whereupon it would be revised.

Rather than to be so bold as to claim a theory where there is a clear and falsifiable hypothesis, this paper applies its findings to formulate a *framework*, as a structure of principles, assumptions, concepts, values, and practices that constitutes a way of viewing reality of infrastructure projects. After validation in practice the framework would lead to a detailed theory.

Decision makers, managers and leaders of infrastructure projects often try to control a system that cannot be controlled. Rather, the system should be *steered* towards the alignment of both intended and intrinsic aims, and a *framework for steering infrastructure projects to success* can guide this task. The essence of the proposed framework is captured by two statements about what a system truly is:

'System is a network of interdependent components that work together to try to accomplish the aim of the system' (Deming 2000 p. 50)*; and 'The purpose of a system is what it does*' (Beer 2002 p. 218).

The *framework for steering*, rather than attempting to control *infrastructure projects to success* highlights awareness about the importance of understanding infrastructure projects as socio-technical systems and their intrinsic complexity, and can be applied as a process to improve understanding about some of the aspects of infrastructure projects, moving from higher Orders of Ignorance to the Second-OI, i.e. *some of the required knowledge is available, but not all; the kind of knowledge to be acquired is unknown, but there is a suitable process of discovering in place* (Armour 2004).

This paper showed that without the required experience and knowledge infrastructure projects are likely to experience schedule delays and cost overruns, and deliver solutions that do not satisfy the real need. The paper also showed that leadership that motivates the members of the organisation towards constructive-learning behaviours are central aspects of successful projects, confirming Lawson's observation that successful projects take social aspects into consideration, and are focused on the character and behaviour of the people involved in the project (Lawson 2005).

Supported by Deming, Beer and Lawson, and adopting the simplicity principle suggested by Popper (1959), the proposed *framework for steering infrastructure to success* contains one principle about the *system and its aims* and three integrated management processes of *knowledge*, *behaviour* and *motivation* that together address the variations in the system and align the aims of, and for, the system.

The principle that guides the *framework for steering infrastructure projects to success* is stated as follows: *Infrastructure projects succeed when the **intended aim for the system** is aligned with the **intrinsic aim of the system**.*

The *intended aim for the system* is what is expected the system will be able to do, while the *intrinsic aim of the system* is what the system really does. The intended aim for the system is determined by the development of an acceptable solution for an expressed need within parameters of cost schedule and quality. The intrinsic aim of the system is determined by what the system is capable of achieving in accordance with the capacity of people and organisations, in the form of their knowledge, experience and skills within the context of the work to be performed, combined with their motivations and behavioural styles. The gap between what the system is and what it should be to achieve the intended goals must be reduced to acceptable levels for a successful project. The three processes supporting the framework are integrated and applied to align the intrinsic aim of the infrastructure project system with the intended aim for the system.

The Process of Knowledge Management

There are two distinctive perspectives about knowledge management in infrastructure projects. First is *management knowledge*, as the knowledge needed to understand the system, its variations, constraints and aims. *Management knowledge* includes theories that allow prediction about the behaviour of the system, as suggested by the System of Profound Knowledge, and brings an understanding of what are the *intended aim for the system* and the *intrinsic aim of the system*. Management knowledge provides the prediction suggested by Hall (1980). Managers, leaders and decision makers in the infrastructure project process must possess the required *management knowledge* to ascertain what the system can and cannot do, and for making the necessary changes in the system to steer it towards the intended goals, addressing what was proposed by Innes & Booher (2009). Lack or management knowledge is likely the root cause of poor *integration of the divisions of the organisations*, the third CSF identified by (Zou et. al 2014). The *framework for steering infrastructure projects to success* is a contribution to *management knowledge.*

The second aspect of knowledge in infrastructure project is the *engineering knowledge*. The process of engineering infrastructure solutions calls for three domains of knowledge: domain knowledge to find a solution for an expressed need; knowledge of infrastructure systems, whether in transport, energy, water, waste management, etc.; and knowledge about learning processes and how to work in a collaborative team which is essential to achieve 'collaboration rationality' proposed by Innes & Booher (2009).

It is expected that infrastructure projects start with a large knowledge gap, as the difference between the available knowledge and experience and what is needed to engineer and develop the infrastructure solution. The Process of Knowledge Management applies the concepts from the Five Orders of Ignorance as a model for understanding the process of learning (Armour 2004).

The process of Management Knowledge proposes the adoption of a specific Knowledge Management Plan (KMP) to document the strategy and processes to reduce the existing knowledge gap (Peculis et al. 2007b). The KPM identifies the knowledge required for the project; the knowledge available in the system and where the knowledge is, i.e. 'who knows what'; the known gap of knowledge; the process to discover 'what we don't know that we don't know' and developing a plan to implement the knowledge management strategy. The KPM also includes the cost and time required to fill the gap of knowledge and the risks involved if the gap is not resolved.

The Process of Behaviour Management

The objective of the *process of behaviour management* is to improve infrastructure projects outcomes through the way that people interact in groups. The *process of behaviour management* aims to maximise constructive behaviours, promote cooperation and increase the effectiveness of the *process of knowledge management*. The *process of behaviour management* contributes to achieve 'collaboration rationality' proposed by Innes & Booher (2009).

The *process of behaviour management* applies principles from the dynamics of group interaction and the impact of group interaction style on problem-solving (Cooke & Szumal 1994). Infrastructure projects are problem-solving groups that tend to increase their effectiveness through constructive behaviours that promote cooperation and learning. The dynamic of group interaction tells that constructive behaviour promotes constructive behaviour, and aggressive behaviour suppresses constructive and promotes aggressive-passive behaviours. Passiveness will manifest inside groups with hierarchic structures. Aggressive politicians could make bureaucrats assume passive behaviours, while community groups are likely to become aggressive and unwilling to negotiate when facing aggressive opposition from politicians and bureaucrats. Group members with more power, as in management or leadership roles, or with stronger personality styles are likely to influence other members in the group (Cooke & Szumal 1994). Autocratic leaders can be correlated with power-aggressive/non-constructive behaviour, and transformational leaders demonstrate constructive behaviour. While constructive behaviour is likely to impel cooperation, non-constructive interaction styles can undermine attempts at knowledge sharing and achieving knowledge management goals (Balthazard & Cooke 2004).

The *process of behaviour management* proposes the adoption of a specific Behaviour Management Plan (BMP) to develop strategies and set targets for managing stakeholders, individual and group behaviour and organisational culture (Peculis et al. 2007b). Stakeholder management is essential for effective project management (Bourne & Walker 2003). The Stakeholder Circle (Bourne & Walker 2006) is an example of a stakeholder management tool used to identify, prioritise and develop a stakeholder engagement strategy that better suits the project and objectives. Tools like the Life Styles Inventory (LSI) (Lafferty 1973, in Cooke & Rouseau 1983), Group Style Inventory (GSI) (Cooke & Lafferty in Cooke & Szumal 1994) and the Organisational Culture Inventory (OCI) (Cooke & Szumal 2000) can be used to assess individual and organisational behaviours and the effectiveness of the *process of behaviour management,* by comparing the results of periodic assessments against the behaviour and cultural transformation targets defined in the BMP.

When applied to infrastructure projects, behaviour management should be extended to all teams, groups and organisations, i.e. community groups, bureaucrats and politicians, involved in the project to be able to produce effective results. Every organisation in the project is a component of the socio-technical system that should be aligned towards the intended aims for the system. Only with consistent constructive attitudes will it be possible to influence the system to align both intrinsic and intended aims.

The Process of Motivation Management

The *process of motivation management* aims to identify motivators and provide incentives to individuals and organisations to behave and act in ways that steer the infrastructure towards the intended objectives. The theory of motivation shows that at the individual level *motivation* is the intervening process or internal state of a person that drives their behaviour or impels them into action (Reber & Reber 2001). The *process of motivation management* proposes the adoption of a specific Motivation Management Plan (MMP) to develop strategies for motivating stakeholders in ways that would produce the behaviours and actions that would better serve the project as a whole and aligns with what Flyvbjerg et al. (2009) ask to reduce optimist delusions and creating best practices to diminish strategic deception.

The different nature of engineering and management tasks, and conflicting motivations, creates tension between engineering and management (Aslaksen 1996). People are differently motivated by intrinsic and extrinsic factors (Ryan & Deci 2000) and managers should be aware of an individual's motivation factors to be able encourage their employees to learn from each other (Xiao-qing & Nan 2010). Conflicting motivation could be the root cause of *poor commitment and participation of senior executives*, the first CSF identified by (Zou et. al 2014). Finding the individual motivation strategy that best fits a particular infrastructure project system is part of the *process of motivation management.*

Conclusions

The root causes of success or failure of infrastructure projects lie in the attributes of motivation, behaviour and knowledge of those people who take part in the project. People in different groups such as the community, bureaucrats and politicians, often have different interests and conflicting motivations that are likely to create difficulties to realistically estimate costs and benefits for the project. Quite often these conflicts make it nearly impossible to reach a consensus agreement in selecting an appropriate solution to satisfy the real need. People influence, are influenced, change and adapt as part of a complex and dynamic social system that identify, specify and engineer the also complex technical system.

Figure 3 shows the dynamics of motivation, behaviour and action created by the three processes of the *framework for steering infrastructure projects to success*. Motivation influences behaviour which in turn influences the way people learn and share knowledge. Lack of knowledge, skills and experience extend schedules and increase costs and often causes aggressive behaviour that is unlikely to address the root cause of the problem. Instead, aggressive attitudes coming from participants with higher power are answered with aggressive-passive behaviours that worsen the situation. Constructive behaviours, instead, foster learning and cooperation and contribute to reduce existing gaps of knowledge, which in turn increases and aligns the motivation of individuals, teams and organisations and improves the project as a whole. The consistent and integrated application of the three processes will foster the development of conditions in the social system that steer the infrastructure project towards the intended goals. The processes of motivation and behaviour management should aid to address the second CSF identified by (Zou et. al 2014) in *defining the objectives for effective relationship management strategy*

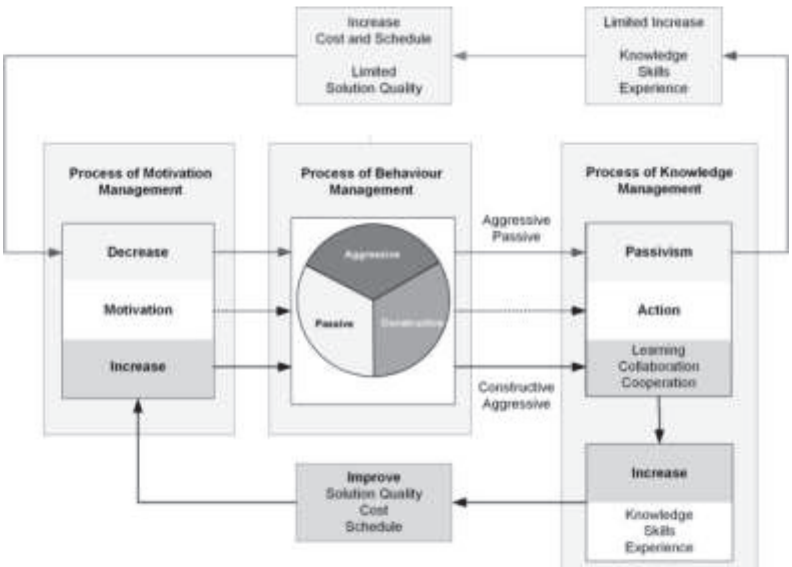

Figure 3 – Motivation, Behaviour and Action

The proposed *framework for steering infrastructure projects to success* is the first step towards a theory, yet to be developed. Until then, the insights conveyed by the framework could help community leaders, politicians and decision makers better understand the reality of large infrastructure projects. In addition, the framework can be applied and tested through models and computer simulation. Agent-Based Modelling (ABM) techniques can be used to test 'what if scenarios' where various levels of motivations, behaviour styles and knowledge availability could be created by populations of virtual agents (Peculis et. al, 2008; Peculis, 2011). By using these models, and preferably taking part in the development of such models, managers, decision makers and other stakeholders would learn a great deal about the systems of which they are part and would be better prepared to create necessary conditions to steer them toward desirable results. Modelling and simulation applied to the *framework for steering infrastructure projects to success* are subject for future work.

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