MANAGING PROJECT RISKS IN THE ELECTRICITY INDUSTRY IN AFRICA

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ABSTRACT

In Africa, major projects are presently in progress to upgrade the infrastructure in the energy sector, and especially in the electricity energy sub sector. Many such projects have run into delays, quality problems and cost overruns. To overcome these challenges, effort and resources are presently being devoted to better management of energy sector projects in Africa. The hypothesis points to the many risks for projects of this nature in the energy sector in Africa. In this paper, we introduce a model that simulates the interactions of the various risks prevalent in the sector in Africa.

A literature review reveals that projects in the electricity industry can be framed as complex dynamic systems since they comprise multiple interdependent and dynamic components, and include multiple feedback processes as well as non-linear relationships. System dynamics was therefore chosen as the modelling and simulation tool in this research. In this stage of the research, the risks incorporated were identified through discussions with practitioners in the power sector in Kenya through focus group meetings that included representatives from the government, clients in the power industry and representatives from contracting firms active in the power industry in Kenya.

The research first identifies the risks prevalent in the sector in Africa such as political risk and multitasking, and then through simulation over time, studies their behaviour as they interact with each other. Experimentation on the model identifies areas with leverage that can be used in reducing the negative effects of these risks. Subsequent research will seek to develop policies aimed at improved project system behaviour in the electricity sector in Africa. Overall, the results of the research will help in reducing uncertainty in projects in Africa and other developing countries, and will be beneficial to the energy sector players in Africa, including investors in the energy sector.

Key words: Project risks, Feedback systems, Systems Thinking, System Dynamics

INTRODUCTION

Tackling the inefficiency and financial burden imposed by under-performing infrastructure in the energy sector is an important issue for developing countries. A lack of adequate infrastructure is particularly an impediment to the development of the wider economy in Sub Saharan Africa. Quality infrastructure is valuable in itself and as a multiplier, enabling further development and allowing governments to achieve social, economic and political aims. While the goal of infrastructure programming may be to produce tangible physical infrastructure, poor decisions early in infrastructure development can have significant cost ramifications.

In the recent past, there has been a remarkable growth in the number, size, and complexity of large-scale Infrastructure projects in many developing countries. Management of these projects inevitably requires dealing with uncertainties that usually arise from in the course of the projects. These uncertainties contribute to project delays and decline in organizational performance. Local governments and individual firms are therefore concerned about enhancing organizational performance for their survival in the competitive and increasingly globalized construction market. Key Issues in Africa's energy sector include low access and insufficient capacity, poor reliability and high costs. Sshortage of essential electricity infrastructure is undermining efforts to achieve more rapid social and economic development across sub-Saharan Africa. Dealing with uncertainties and risks that cause project delays and cost overruns is therefore important so as to ensure future projects in the energy sector in sub-Saharan Africa deliver value. The fact that uncertainty is at its highest and the cost for making amendments at its lowest during the early stages illustrates the great potential for improvements in the pre-planning and planning phases of projects. The primary motivation of this research is to expand the understanding of the causes and effects of risks affecting projects in electricity power industry in Sub Saharan Africa.

The results of this study should be of benefit to contractors and utilities involved in the electricity energy sector as well as to the investors in the energy sector in Africa. The key objectives of the research are twofold; using a system dynamics approach, to develop a suitable model that can be used to experiment on project variables that offer greatest leverage on expected outcomes, and to come up with policies that can guide key stakeholders and government bodies such as the ministry of energy on better and improved ways of managing projects in the sector in future subsequent research.

THEORY AND RESEARCH METHOD

Project management is one of the most important and most poorly understood areas of management. Delays and cost overruns are the rule rather than exception in construction, defence, power generation, aerospace, product development, software and other areas (Sterman, 1992). Projects often appear to be going smoothly until near the end, when errors made earlier are discovered, necessitating costly rework, expediting, overtime, hiring, schedule slippage, or reductions in project scope or quality. The result is that projects are frequently delayed to the point where the market conditions for which they were designed have changed (Sterman, 1992). This research employs the systems approach to come up with a model that helps us understand what causes this behaviour.

System Dynamics is a method to describe, model, simulate and analyse dynamically complex issues and systems in terms of the processes, information, organizational boundaries and strategies (Pruyt, 2013). Quantitative system dynamics modelling, simulation and analysis facilitates the redesign of systems and design of control structures. System dynamics starts from the assumption that the behaviour of a system is largely caused by its own structure, and that system structure consists of physical and information aspects as well as the policies and traditions important to the decision making process in a system. According to Siddiqi (2011), System Dynamics is a method that helps us learn and understand complex systems. It is fundamentally interdisciplinary and brings together tools and theories from a wide variety of traditional disciplines (Siddiqi, 2011). At its core, its foundations are on nonlinear dynamics and mathematical feedback control theory, and it draws from economics, social psychology and other sciences. Several researchers have carried out research related to construction project management with the use of system dynamics modelling, as shown in table 1.

Table 1: Applications of system dynamics in research into construction project management (Adopted from Boateng et al, 2012)

Researchers	Year	Summary
De-Marco, A. & Rafele, C.	2009	A feedback process to understand construction project performance
Nasirzadeh, Afshar and Khanzadi	2008	An approach for construction risk analysis
Ogunlana, Sukhera and Li	2003	Performance enhancement in a construction organization.
Love, Holt, Shen, Li and Irani	2002	The need for understanding of how particular dynamics can hinder the performance of a project management system.
Chritamara. S and Ogunlana. S.	2002	Modeling of design and build construction projects
Rodrigues, A. and Bowers, J.	1996	A comparative analysis between two approaches to project mnagement.

Event-Oriented Thinking vs. feedback approach

According to Morecroft (1997), an event-oriented perspective is pragmatic, action oriented, alluringly simple and often myopic. Fig. 1 depicts this mind-set, reflecting the belief that problems are sporadic, stemming from uncontrollable events in the outside world. The typical thinking style here is linear, from problem as event to solution as fix. However, there are limitations to this open-loop, fire-fighting mode of intervention as experience shows that the problem often recurs after the fix. Unexpected dynamics often lead to policy resistance, which is the tendency for interventions to be delayed, diluted, or defeated by the response of the system to the intervention itself (Sterman, 2000). This is a common occurrence in projects in the energy sector in Africa.

A feedback approach is different from event-oriented thinking because it strives for solutions that are sympathetic with their organisational and social environment. Problems do not stem from events, and solutions are not implemented in a vacuum. Instead problems and solutions coexist and are interdependent (Morecroft, 1997).

Fig. 1 Causes of Policy resistance, the serial view: Event oriented world view (Sterman, 2000)

Risks in Projects

Risks in mega construction projects are usually complex and uncertain, and although risk management standards have been recommended for the best practice, there is still a lack of systematic approaches to describing the interaction among social, technical, economic, environmental and political risks (STEEP) with regard to all complex and dynamic conditions of megaproject construction for better understanding and effective management (Boateng et al, 2012). Fig. 2 depicts how these risks may interact with one another to influence relationships and generate risk landscapes of unprecedented complexities.

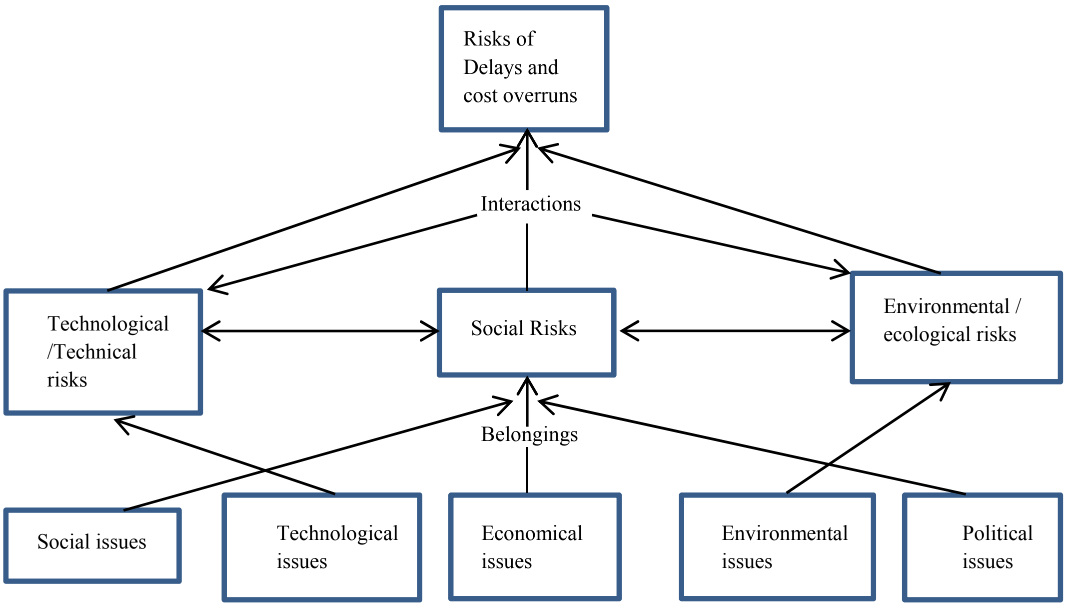

Fig. 2: The effects of Interactions and belongingness of STEEP factors in megaproject development (Adapted from Boateng et al, 2012)

In Table 2, we present a model-boundary chart of the current system dynamics model in the Sub-Saharan Africa context. Here, the endogenous, exogenous, and excluded variables are listed.

Table 2: Model-boundary Chart of the project risks in the electricity energy sector in Sub-Saharan Africa

Endogenous	Exogenous	Excluded
workforce	Initial project time remaining	Weather
Cumulative effort	Project risk index	Inflation
Remaining project tasks	Maximum productivity of testing	Acts of God
Properly completed project tasks		
Undiscovered rework		
Net hiring of personnel		
Additional cumulative effort		
Detecting undiscovered rework		
Proper completion of project tasks		
progress		

Non-linear behaviour of Systems

Linear systems can be analysed and reduced to their components and therefore linear systems, no matter how complex, can be in principle solved analytically to understand their dynamics. Linear system theory has dominated historically due to analytical tractability, but computers can now be used to simulate non-linear behaviour. Realistic systems are typically not linear. In real systems, the dominance of loops shifts over time. Complex socio-technical systems exhibit non-linearity, feedback flows and uncertainty which defines high impact low probability events. (Forrester, 1991). Frequently, a system's feedback loops will be joined together in nonlinear relationships. These nonlinear couplings can cause the dominance of a system's feedback loops to change endogenously. This particular characteristic of nonlinear feedback systems is partially responsible for their complex, and hard-to-understand behaviour (Forrester, 1991). Nonlinear systems cannot be broken down into pieces and easily solved analytically; they must be analysed as a whole. The connections between the parts of a nonlinear system are as vital to its behaviour as the pieces themselves. Although nonlinear dynamical systems do not generally have exact analytical solutions, their behaviour can be determined through simulation.

Political risk

Political risks are due to changes and discontinuities in the business environment due to political changes. Effects of political risks may be macro, affecting all businesses; or micro, affecting only selected industries, firms, or projects (Robock and Simmonds 1983). Kapila and Hendrickson (2001) defined political risk as the possibility that political forces may result in drastic changes in a country’s business environment affecting a firm’s profit and other goals. Examples of macro political risks include revolutions, civil wars, nationwide strikes, protests, riots, and mass expropriations. Examples of micro risks include selective expropriations, discriminatory taxes, and import restrictions directed at specific firms. Risk is something that exists when a threat and vulnerability overlap. A risk process is usually considered to begin with a risk event and end in a risk consequence (Deng et al, 2014). Political risk formation in international construction projects evolves through a process as presented in Fig. 3.

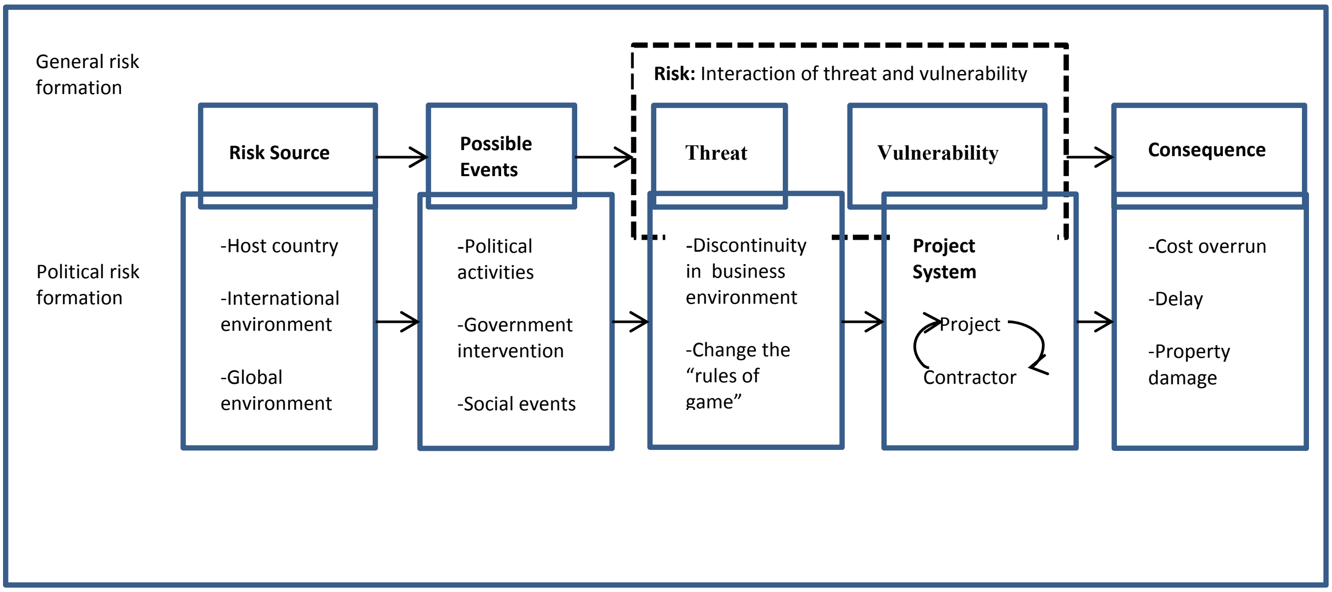

Fig. 3: Political risk process (Deng et al, 2014)

Governments are extremely influential actors in international business. To the host-government, as explained by Brink (2004), international projects can represent an important source of funds, technology and expertise that could help further national priorities such as regional development, employment, import substitution and export promotion. The government of a country, on the other hand, may also intervene in the business environment for a variety of reasons such as protecting national industries from external competition; limiting foreign exploitation and increasing national welfare. A host-government can pursue actions such as taxation restrictions; currency inconvertibility; contract repudiation; import and/or export restrictions; ownership and/or personnel restrictions; expropriation and/or confiscation and industrial espionage. These risks can be categorised as host-government risks, since they are originated by host-governments and can have unfavourable consequences upon international projects. Political risk, as suggested by Brink 2004 and Stosberg (2005), arises not only from governmental, but also societal sources.

As stated by Ofori (1993), the structural problems of construction industry in developing countries are more fundamental, more serious, more complex, and, overall, much more pressing than those confronting their counterparts elsewhere. Common problems affecting construction industry in developing countries include lack of management skills, shortage of skilled labour, low productivity, shortage of supplies, bad quality of supplies and lack of equipment. Apart from technical issues, management-related problems are one of the most important aspects facing construction contractors since they have to deal with substantial constraints such as incomplete information, unpredictable client behaviour, and uncertain project circumstances.

Research methodology

The research method used is exploratory and based on a case study method. It employs a simulation approach to enhance the understanding of the research problem under investigation. The system dynamics method is used to model the project performance. Fig. 4 gives the system dynamics modelling process as defined by Sterman (2000). Problem articulation deals with finding what problem there is and the key variables. The dynamic hypothesis lists the current theories of the problematic behaviour with causal maps created, while in formulation, a simulation model is created specifying structure and decision rules. In testing, the model is checked if it reproduces the problematic behaviour while in policy formulation and evaluation, future conditions that may arise are articulated, and the effects of a policy or strategy are analysed. Project performance is typically measured in terms of schedule, cost, quality, and scope. The modelling process by Sterman (2000) has been applied and used successfully to model various and diverse problems before, and was found suitable and is therefore used for this research. As such the system dynamics model used in this research underpins the basic research objective to expand the understanding of the causes and effects of risks affecting projects in the electricity power industry in Sub Saharan Africa and especially how they can be dynamically linked.

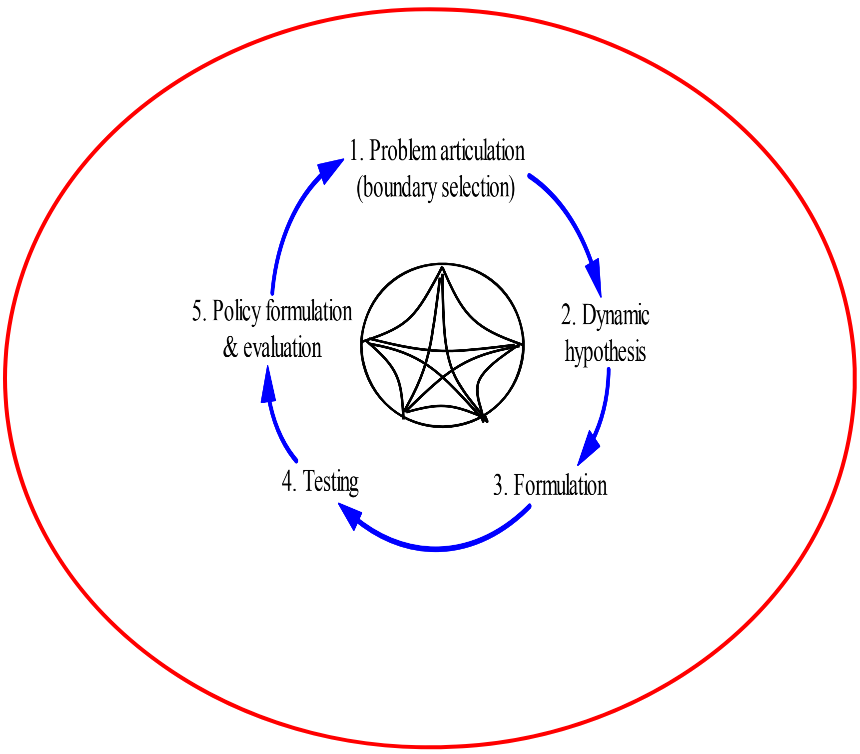

Figure 4: The modelling process (Sterman, 2000)

Warren, (2013) offers an exception to the process as given by Sterman (2000) as a further solution, the agile model development process that uses standard structures to complement the other processes. This involves re-using known, rigorous structures such as project management, supply-chain, or fisheries structures as the backbone for a new model. This research uses the agile method to complement the process by Sterman (2000).

MODELLING ELECTRICITY PROJECT DYNAMICS IN KENYA

Project planning and implementation is a successful system dynamics application field (Pruyt, 2013). The model developed in this research is based on a modified version of project models by Richardson (2013) which incorporates the rework cycle. The rework cycle is the most important single feature of system dynamics project models in which rework generates more rework that further generates even more rework (Lyneis and Ford, 2007). It is the source of many project management challenges, and was first developed by Pugh Roberts Associates. The majority of system dynamics studies that focus on project dynamics include a simulation model of project evolution and the core feature of these models is the rework cycle (Cooper, 1993).

While most of the original work in projects is usually finished early in the project, delays are usually caused by the need to rework that original work. By considering defects, quality and testing through rework cycle; many path-dependent reinforcing loops are generated that critically impact the fate of projects. Almost all dynamic project models have a rework cycle in some form (Lyneis and Reichelt, 1999). The model developed in this research uses the rework cycle, essentially because many projects in the power industry in Sub Saharan Africa suffer from rework that results into project delays.

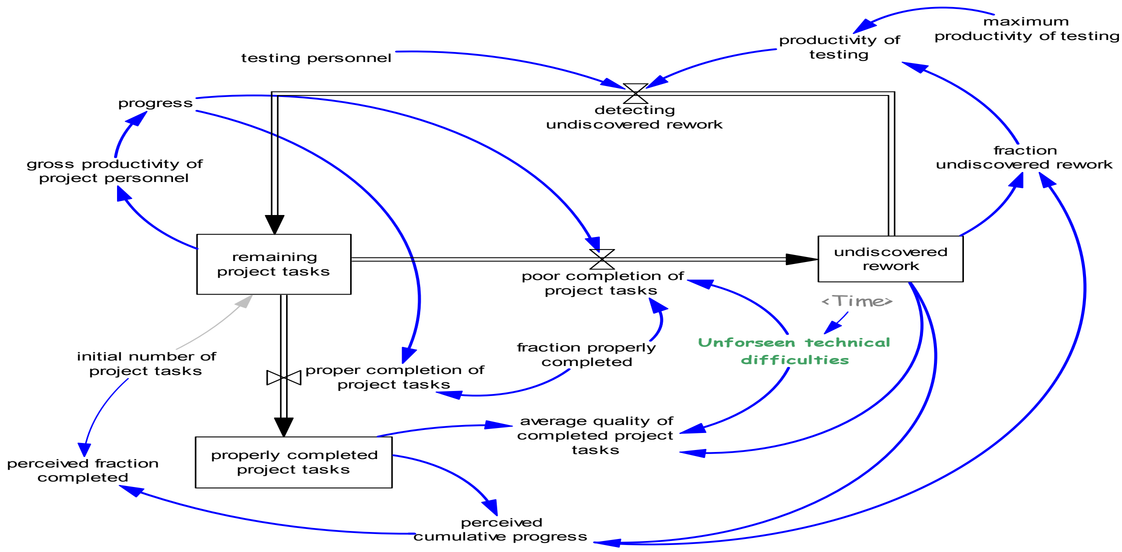

Fig. 5: Conceptual model of the Project rework dynamics in electricity sector in Sub Saharan Africa (Adopted from Richardson, 2013)

Fig. 5 shows the conceptual model developed illustrating the rework dynamics prevalent in the electricity sector in Kenya. In addition to the variables in previous models as exemplified in the model by Richardson (2013), as well as through discussions, focus group meetings and mining of data from previous projects in the electricity sector in Kenya, four additional variables came out as prevalent risk factors in the sector. These are multitasking, political risk, project management competence and unforeseen technical difficulties. These risks were identified from focus group meetings that included representatives from the government, clients in the power industry and representatives from contracting firms active in the power industry in Kenya. The risks have therefore been added into the previous project model by Richardson (2013). Fig. 6 shows the conceptual model of the workforce dynamics in electricity energy projects, incorporating political risk, Multitasking and Project Management competence.

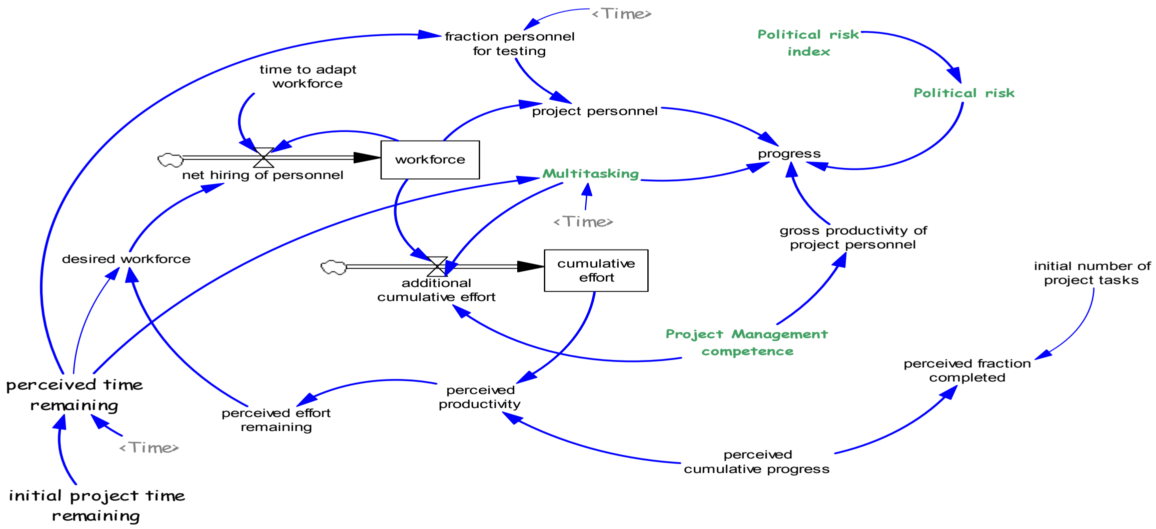

Fig. 6: Conceptual model of workforce Project dynamics in electricity sector in Sub Saharan Africa

Fig. 7 combines the two conceptual models to come up with a model representative of the dynamics at play in projects in the electricity energy sector in Kenya.

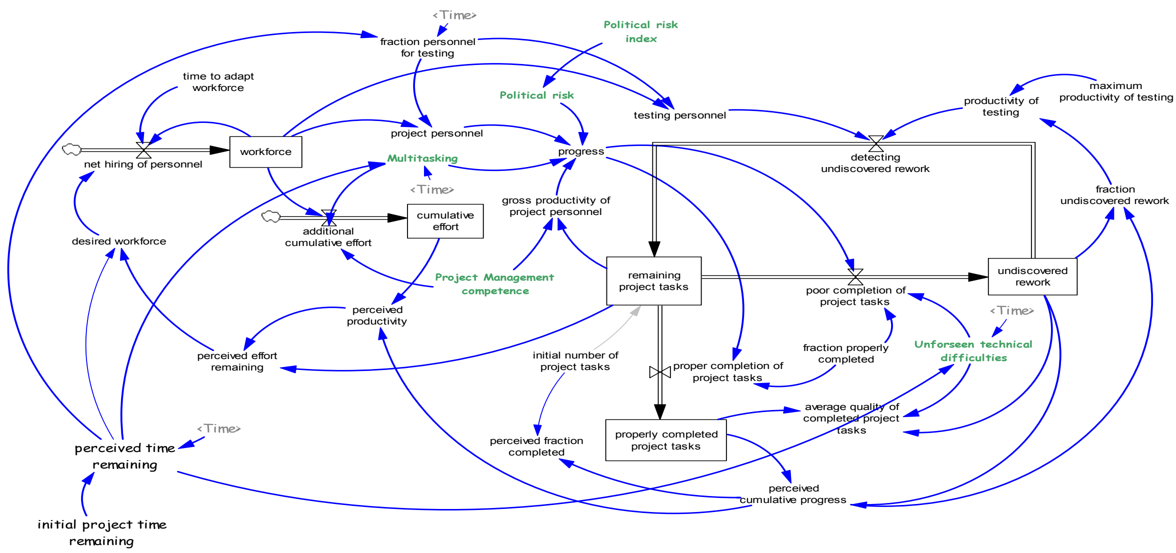

Fig. 7: Model of the interacting project risks in the electricity sector in Sub Saharan Africa

Model Equations generation

The equations used to develop the system dynamics model portrayed in Fig. 7 in vensim are discussed in this section. Where appropriate, motivation for relationships as well as model data determined from focus group discussions and other project data sources is discussed alongside the equation development.

Through discussions with the practitioners as well as ministry of energy officials, political risk was perceived to affect progress of projects in the energy sector by slowing progress. Data over the past five years of the Political Risk Index (Political Risk Services, 2013) gives an average index of 67% for Sub-Saharan Africa, with countries with the lowest risk index ranked at 100%. The average time frame for mega projects in the electricity industry in Kenya at bidding is 36 months. Political risk index changes minimally during this period, and therefore the political risk index is modelled as a constant of 0.67.

Political risk index = 0.67 (units: dimensionless)

Projects in the energy sector in Kenya witness multitasking by the contractors due to shortage of skilled staff, and this is prevalent from 12 months, and peaks at about 30 months. In the model, multitasking is modelled as a non-linear function of time, as a Lookup function.

Multitasking = WITH LOOKUP (Time,

([(0,0)-(52,10)],(0,1),(4,1),(8,1),(12,0.85),(16,0.75),(20,0.7),(24,0.7),(28,0.65),(32,0.65),(36,0.75),(40,0.8),(44,1),(48,1),(52,1),(200,1)) (Units: dimensionless)

Project Management competence is modelled as a constant at 60% (0.6). This result came from the focus group meetings with stakeholders, as well as in analysis of data on previous projects in the energy sector in Kenya.

Project Management competence = 0.6 (units: dimensionless)

In the energy sector projects in Kenya, results of focus group meetings indicate that unforeseen technical difficulties are prevalent, and problems related to this effect become pronounced between 24 months and 30 months. Unforeseen technical difficulties are therefore modelled as a non-linear function of time.

Unforeseen technical difficulties = WITH LOOKUP (Time,

([(0,0)-(60,10)],(0,1),(2,0.99),(6,0.98),(10,0.97),(14,0.96),(16,0.95),(20,0.9),(24,0.8),(26,0.8),(28,0.92), (30,0.95),(36,0.97),(36,0.97),(38,0.98),(40,1),(44,1),(48,1),(52,1),(54,1),(60,1),(200,1))

(Units: dimensionless)

A typical project in the energy sector in Kenya consists initially of 600 project tasks to be completed. A typical project model thus starts with a stock of 600 remaining project tasks. During the project, project tasks that are properly completed become part of the properly completed project tasks. At the start of a project, the number of properly completed project tasks is 0. The project tasks that are properly completed are a function of the progress made during the project and the fraction of tasks properly completed which is about 50%.

initial number of project tasks = 600 (units: dimensionless)

*Proper completion of project tasks = progress * fraction properly completed (units: tasks/month)*

Remaining project tasks = INTEG(detecting undiscovered rework-poor completion of project tasks-proper completion of project tasks) (units: Tasks)

Properly completed project tasks = INTEG (proper completion of project tasks) (units: Tasks)

Progress made during the project is equal to the gross productivity of project personnel times the size of the workforce assigned to the project. In our model, this is also affected by political risk and Multitasking, which tend to slow down the progress.

*Progress = gross productivity of project personnel*project personnel*Political risk*Multitasking (units: Tasks/month)*

The gross productivity of project personnel depends on the number of remaining project tasks: with a project of, say, 600 tasks to be completed, the gross productivity of project personnel is maximum say 100% from 600 remaining tasks until there are some 100 remaining tasks, after which the gross productivity of project personnel decreases to 95% at 75 remaining tasks, 85% at 50 remaining tasks, to 20% at 0 remaining tasks. The gross productivity of project personnel is however impacted by project management competence, such that when project management competence is low, the gross productivity of project personnel is depressed and vice versa.

*gross productivity of project personnel= WITH LOOKUP (remaining project tasks*Project Management competence,*

([(0,0)-(600,1)],(0,0.2),(50,0.85),(75,0.95),(100,1),(200,1),(600,1)) (units: Tasks/person/month)

The workforce assigned to a particular project increases and decreases through net hiring of personnel equal to the difference between the desired workforce and the workforce, divided by the time to adapt the workforce.

net hiring of personnel = (desired workforce – workforce)/time to adapt workforce

(units: person/month)

Workforce = INTEG (net hiring of personnel)   (units: person)

The time to adapt the workforce is a constant and ordinarily, the time to adapt the workforce would be 0.5 Month, assumed for this case.

time to adapt the workforce = 0.5   (units: Month)

The desired workforce is modelled as the perceived effort remaining divided by the perceived time remaining.

desired workforce = perceived effort remaining / perceived time remaining   (units: person)

We model the perceived time remaining as initial project time remaining minus ‘Time’ with the delay time needed to adjust the project schedule. In the model, the perceived time remaining is at least a month: experience shows that such projects always have a time overrun of at least a month.

perceived time remaining = MAX(1, initial project time remaining - Time)   (units: month)

The initially remaining project time of such projects typically amounts to 36 months. The perceived effort remaining equals the remaining project tasks divided by the perceived productivity, and in the model, we avoid dividing by zero by using the ‘MAX’ function.

perceived effort remaining = remaining project tasks/MAX(perceived productivity,1)

(units: person/Month)

The perceived productivity corresponds to the perceived cumulative progress over the cumulative effort delivered.

perceived productivity = perceived cumulative progress/cumulative effort

(units: tasks/person/Month)

The perceived cumulative progress in the model is equal to the amount of properly completed project tasks plus undiscovered rework.

Perceived cumulative progress = properly completed project tasks + undiscovered rework

(units: tasks)

The cumulative effort delivered initially only amounts to 0.1%. The cumulative effort delivered increases by means of the additional effort delivered by the workforce, but is slowed down both by Multitasking of key skilled staff and the poor levels of Project Management competence. The additional cumulative effort therefore simply equals the workforce times Multitasking times the level of Project Management competence prevailing.

*additional cumulative effort = workforce*Multitasking*Project Management competence*

*(units: person*Month)*

*Cumulative effort = INTEG (additional cumulative effort) (units: person*Month)*

We model the perceived fraction completed as the perceived cumulative progress divided by the initial number of project tasks.

perceived fraction completed = perceived cumulative progress/initial number of project tasks

(units: fraction)

From the rework cycle, the detection of undiscovered rework depends on the number of testing personnel times the average productivity of testing.

*detecting undiscovered rework = productivity of testing*testing personnel (units: tasks/Month)*

Poor completion of project tasks goes hand in hand with progress and we model it as proportional to (1- fraction properly completed), while it is also a function of unforeseen technical difficulties, and generates undiscovered rework. The fraction properly completed is assumed as 50% for this case.

poor completion of project tasks = progress(1 - fraction properly completed)*Unforeseen technical difficulties (units: tasks/Month)*

fraction properly completed = 0.5 (units: dimensionless)

undiscovered rework = INTEG (poor completion of project tasks – detecting undiscovered rework)

(units: tasks)

The productivity of testing is modelled as equal to the fraction of undiscovered rework times the maximum productivity of testing of 2 tasks per person per month assumed for this case.

*productivity of testing = maximum productivity of testing*fraction undiscovered rework*

*(units: tasks/ (person*Month)*

Maximum productivity of testing = 2 (units: dimensionless)

Average quality of completed project tasks is impacted by unforeseen technical difficulties such that the higher the rate of unforeseen technical difficulties, the lower the average quality of completed tasks. Therefore average quality of completed project tasks is modelled as properly completed project tasks times unforeseen technical difficulties divided by properly completed project tasks plus undiscovered rework, with the MAX function applied to the denominator so that it may not equal zero.

*Average quality of completed project tasks = (properly completed project tasks*unforeseen technical difficulties)/MAX ((properly completed project tasks + undiscovered rework), 1) (units: dimensionless)*

The fraction undiscovered rework is modelled as equal to undiscovered rework divided by perceived cumulative progress, and the perceived cumulative progress is modelled with a 'MAX' function so that the denominator cannot be equal to zero.

fraction undiscovered rework = undiscovered rework/MAX (perceived cumulative progress, 0.01)

(units: dimensionless)

The amount of the testing personnel is equal to the fraction of personnel for testing multiplied by the total workforce assigned to the project.

*testing personnel = fraction personnel for testing*workforce (units: person)*

We model the fraction of personnel for testing as an endogenous function of a model variable 'reported fraction detection undiscovered rework', going through the following couples (0,0.1), (0.1,0.09), (0.2,0.1), (0.3,0.14), (0.4,0.16), (0.49,0.2), (0.59,0.24), (0.68,0.26),(0.76,0.27), (0.87,0.28), (0.99,0.3), (200, 0.3).

fraction personnel for testing = WITH LOOKUP (reported fraction detection undiscovered rework,

([(0,0)-1,1)],(0,0.1), (0.1,0.09), (0.2,0.1), (0.3,0.14), (0.4,0.16), (0.49,0.2), (0.59,0.24), (0.68,0.26),(0.76,0.27), (0.87,0.28), (0.99,0.3), (200, 0.3).) (units: dimensionless)

Simulation results

All the Vensim System Dynamics simulation results shown in this section for the model portrayed in Fig. 7 have been obtained using numerical integration with the fourth order Runge Kutta method and time intervals of 0.0078125 year.

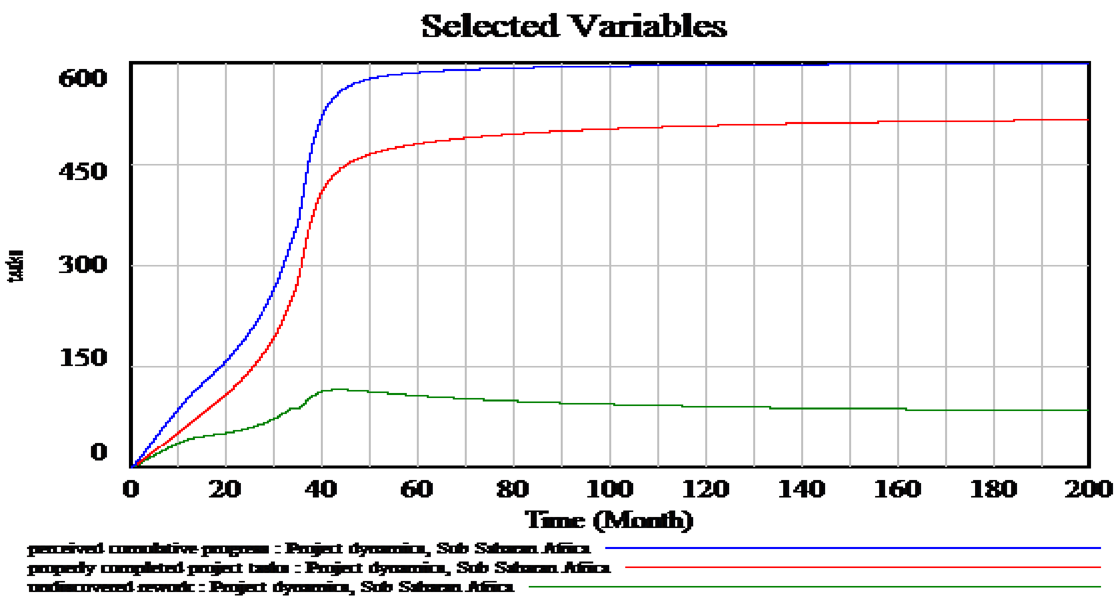

Fig. 8: Comparison of trends of perceived cumulative progress, properly completed project tasks and undiscovered rework.

The trend analysis in figure 8 shows that as the project progresses towards the planned completion time of 36 months, undiscovered rework tends to rise to about 115 tasks, and this depresses the properly completed project tasks since the tasks requiring rework would feed into remaining project tasks. This trend invariably leads to project delays.

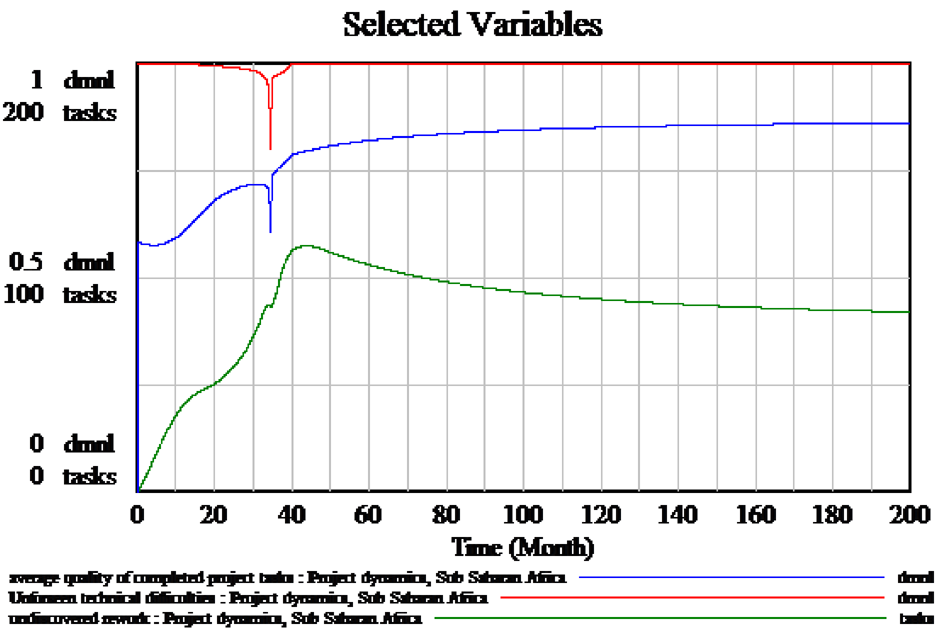

Fig. 9: Comparison of trends of average quality of completed project tasks, unforeseen technical difficulties and undiscovered rework

The trend analysis in figure 9 shows that as the unforeseen technical difficulties become prominent between month 30 and month 40, the average quality of completed project tasks also dips down before recovering again as the technical difficulties are attended to by the project team. This period between month 30 and month 40 in the life cycle of the project also sees the undiscovered rework to a peak of about 115 tasks, and as the rework is detected and attended to by the project team, the average quality rises further.

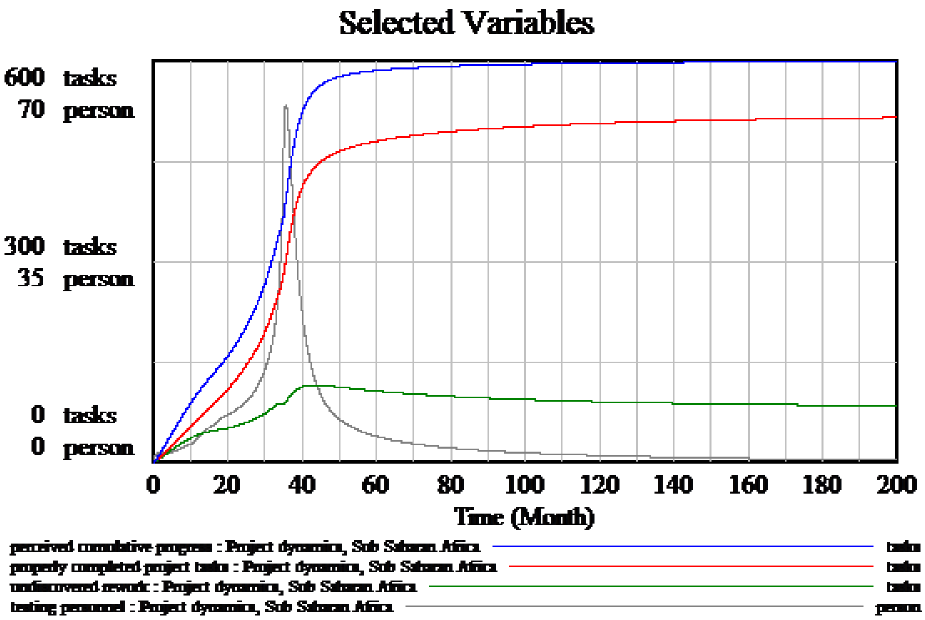

Fig. 10: Comparison of trends of perceived cumulative progress, properly completed project tasks, undiscovered rework and testing personnel

The trend analysis in figure 10 shows that the perceived cumulative progress rises with the rise in the number of properly completed project tasks. This is driven by the significant rise in the number of testing personnel between month 30 and month 40, which is the resource critical in detecting undiscovered rework that tends to rise in the same period.

CONCLUSION

The main contribution of this research is the development of a system dynamics model that will be useful for the management of electricity power projects in Sub Saharan Africa by enabling stakeholders understand the dynamics at play during the implementation of the projects, and how the risks involved may interact to generate undesirable trends leading to project delays and quality challenges. The results presented here are preliminary and exploratory in nature, as future research will seek to test variability on the exogenous and endogenous variables to come up with high impact levers.

The behaviour of the model provided some insights into the structure and behaviour of the factors

that contributes to the dynamics that lead to project delays in projects in the energy sector in Africa. Future and further research will seek to carry out sensitivity analysis and to validate the model.

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