

## **Applicability of Selectionism and Trial and Error in Large-Scale Development Projects**

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### **Abstract**

The aim of this paper is to discuss the applicability of selectionism and trial and error theories in the context of large-scale development projects in developing countries. These two theories are widely known as presenting the opposing intellectual discourse for risk management of projects with high level of complexity and unforeseeable uncertainty. The trial and error theory promotes continuous unplanned update of the project plan based on changes in the project environments. The selectionism theory promotes running parallel tracks to solve the same problem and pick-up the one that seems to be best upon completion of the study. These two theories have been widely discussed in the context of technological projects, which are highly complex and entail a lot of unforeseeable uncertainty. These two characteristics apply to large-scale development projects as these projects contain a large number of complex systems and are executed over an extended period of time, which cause a large number of changes in the assumptions and plans of these projects. Therefore, discussing these two theories in this context will help to better understand the nature of risk in these projects and the approach to be followed in order to manage its risks. The context of developing countries was selected as investments in these countries are generally risky due to the high level of instability.

Key words: large-scale projects, selectionism, trial and error, developing countries.

### **Introduction**

During the last two decades, the development sector was booming worldwide, especially within developing countries that are rich in natural resources. This boom increased pressure on governments to develop large-scale urban projects that can contain the newly emerging developments (Sagalyn 2007). The purpose of these projects is to divide large land areas into smaller parcels that meet demand requirements while providing necessary infrastructure for these parcels. In order to secure success of urban development projects, it is essential to mitigate or reduce the impact of its risks, especially that its processes usually entail a large number of unforeseen risks (Kyvelou and Karaïskou 2006).

The definition of a "large-scale project" differs from one reference to another. Some references consider the cost to be the indicator of the project's scale (Verveniotis 2008).

Other references define large-scale projects as the projects that have a social, economic and ecological impact on its context (Alastair et al. 2005). For the purpose of this paper, the later definition will be adopted as the relevance of the development cost varies upon the economic status of the country and the time, during which the project was executed as time is related to inflation.

Despite the fact that the development process extends till the end of construction, the main work is conducted prior to construction. This is the period, during which the investment framework is defined and the most critical decisions are taken. In addition, it holds the highest level of unforeseeable risk as the project is still at the beginning and the number of unforeseen risks at this stage is high (Figure 1). Partnership is established, consultants are appointed, funds are raised and approvals on studies are obtained prior to beginning of construction. Any wrong decision at this phase will have a ripple effect that might endanger the whole project. In addition, this is the period, during which the project manager have the highest level of control over the project as margin of change during later periods will be very limited. Furthermore, during the construction phase, trial and error is not an option due to its high implication on cost. Therefore, this period is the main focus of this paper.

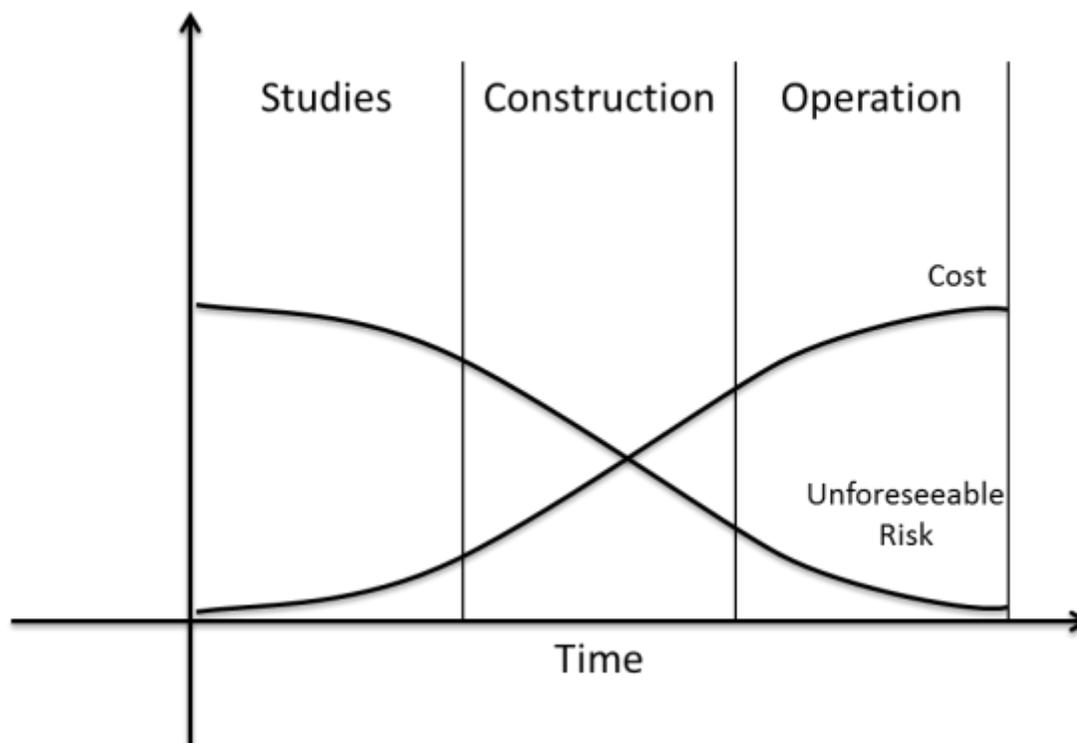


Figure 1: Cost as opposed to unforeseeable risk in the context of large-scale development projects.

The intellectual discourse between selectionism and trial and error theory has been widely discussed in the context of technological project that are complex and entail a lot

of unforeseeable uncertainty (Sommer S. and Loch C. 2004; Sommer S. and Dong J. 2009). In the first theory, it is assumed that the ultimate way to manage risk of complex projects is to run parallel tracks, by the end of which you could select the most convenient solution. A prerequisite for this theory is not having a budget constraint because this method increases the cost of the study. In case this requirement is not satisfied, this theory is not an option. In the latter theory, a single option is pursued with the possibility of revisiting this solution as soon as any change in one of the projects environments takes place. In this paper, we shall bring this discourse to the context of large-scale development project that are known to be highly complex and risky in order to understand how these theories could inform the risk management approach to be followed for these projects. The Shamiyah project was selected in order to analyze the nature of risk and the applicability of both selectionism and trial and error theories within this context.

## **1. Research methodology**

This research is a qualitative case study research as it does not require control over behavioral events (Royce and Bruce 1999; Yin 2009). The selected case study was used in order to investigate the practiced approach for risk management of this particular project and to illustrate the developed theory using examples from this case (Yin 2009).

Literature was reviewed in order to map comparative analysis between selectionism and trial and error and identify risks of large-scale projects. The list of these risks was used as a framework to develop a guide for interviews with managers and assistant managers that worked on the project and allowed for a consistent research methodology that enforced the research reliability (Yin 2009). The purpose of interviews was to identify the followed risk management approach and stages of the studies period along with risks that were faced. Collected information were analyzed to identify patterns, based on which recommendations for the approach to be followed for risk management of large-scale projects in light of the selectionism and trial and error theories, were formulated. Data were analyzed till saturation of different investigation issues. This technique is called theoretical saturation and is convenient for research of complex business environments. Results of interviews were complemented by personal observations and progress reports of selected projects.

The case study, which is the Shamiyah project, was selected based on its largeness of scale, international recognition and coverage of a wide spectrum of development phases. In addition, in this project both trial and error and parallel tracks were used. The Shamiyah project aims at the redevelopment of a 1.38 square kilometers hilly site - the Shamiyah District – facing the northern edge of the Haram Al-Shareef (the great mosque) in Makkah. The project is composed of three zones. A southern zone of 35,000 square meters is dedicated to the expansion of the northern piazza of the Haram; a middle zone of 980,000 square meters geared towards total redevelopment;

the eastern and western zones of 464,000 square meters assigned to rehabilitation. The final master plan is a result of an evolutionary design process in coordination with the Higher Commission for the Development of Makkah that started with six different master plan alternatives. Collaborators on the master plan study included: Architecture Studio, Dar al Omran, Gensler, Hamzah & Yeang in partnership with Saud-Consutl, HOK, & Al-Wakeel in partnership with M. Hamouie. Millennium Development International acted as the lead strategist, prepared necessary design briefs, and managed the full planning process and public negotiations process, and prepared the preliminary financial strategy and feasibility study for the project. The concept of the master plan is characterized by the following principles:

- Segregation of the pedestrian flow from the traffic to ensure public safety.
- Unlocking the value of land around the Haram and providing a more balanced value across the territory.
- Creating a multifaceted uses for the public spaces depending on the (peak) season and times of prayer.
- Preserving the mountainous characteristics of the site.
- Managing massive pedestrian flow from the Haram to the site with proper negotiation of the change in topography.
- Ensuring an effective public transportation and proper vehicular and parking service to the area.
- Creating the proper medium to ensure consensus among stakeholders.

## **2. Literature review**

In this section we will first illustrate literature on selectionism and trial and error, current risk management approaches of large-scale projects and risks of these projects.

### **2.1. Selectionism and trial and error**

Tushman and O'Reilly 1997 and McGrath 2001 claim that considering different variations is the ultimate way for achieving novelty. Selectionism may include multiple deviations for the same solution that are gradually narrowed down to the most convenient solution (Ward et al. 1995; Sobek et al. 1999), or multiple solutions that are tested before selecting the ultimate one (Stalk and Webber 1993).

Flipping to trial and error learning, Chew et al. 1991 and Lynn et al. 1996 promotes trial and error as a mean for continuous learning and highlight the importance of flexibility in

responding to unprecedented situations through knowledge making. In addition, project risk management promotes continuous learning and adaptation (Chapman and Ward 1997; Miller and Lessard 2000). The essential issue for the success of this approach is to adjust the project plan based on new data received during the course of project, whether this data is actively gathered or passively received.

## **2.2. Current risk management approaches for large-scale projects**

Two main strategic approaches for risk management of large-scale projects were identified. The first approach promotes subdividing large-scale projects into smaller work packages (Verveniotis 2008). This approach assumes that the smaller scale packages will become 'regular scale projects', and hence traditional project management techniques can be used to accomplish these smaller projects. The realisation of these smaller entities will lead to the accomplishment of the initial large-scale project. Despite the fact that this approach seems logical, it misses very important characteristics of large-scale projects; in most cases they represent a single entity, most of which needs to be executed at one, due to market openings being time related, economies of scale and technical requirements.

Sometimes large-scale projects are related to a big gap in supply within a specific sector; and hence, the timely completion of project execution will help in maximising capitalisation on market gap and closing the door for competition. Economies of scale are also important as the logic of developing a large project might create a certain magnitude that can create its own presence. This is usually applicable when developing new cities or city centres where the project itself becomes a destination. As far as the technical requirements, some projects can be executed only at once like the upgrade of infrastructure networks. Such projects can only be managed as one project as its elements are interrelated and minor changes within one element will have an impact on remaining elements.

The second approach focuses on reacting to risks as soon as they emerge and on finding innovative solutions for continuously evolving risks that face large-scale projects (Bryde & Brown, 2004; Charette, 1996; Pavlak, 2005; Pitsis, Clegg, Marosszeky, & Rura-polley, 2007; Ranasinghe, Ruwanpura & Liu, 2012). As per this approach, due to the high level of uniqueness associated with large-scale projects, risks cannot be predicted early on based on databases generated out of previous projects. Furthermore, if a contingency budget is allocated for potential risks in this type of projects, the project will be rendered unfeasible before its starts due to the complexity and diversity of associated risks. As a conclusion, it was not a coincidence that most of literature focused on this approach, which is found to be more convenient for large-scale development projects as compared to the other approach. This particular approach is similar to the trial and error approach that promotes reactive changes in the project based on emerging risks.

### **2.3. Risks of large-scale projects**

Literature was investigated in order to have a better understanding for the types of risk that are faced by large-scale development projects. As no references were found on risks related to the whole process of development management, literature focusing on the construction part of development was mainly investigated. Other complementary aspects of the relevant literature, namely, sustainability and private–public partnership, were investigated in order to prepare a comprehensive list of risks that are related to the type of projects under discussion. Sustainability was investigated since it is the most comprehensive theme of urban planning nowadays. It discusses mainly the impact of urban projects on their social, economic and ecological environments. Furthermore, as most of large-scale development projects usually take place in some kind of partnership between the private and the public sectors, the literature relating to this type of partnership was also investigated.

The identified list was organized along the three identified risk levels that were found to be applicable to the context of large-scale development projects, namely, project environment, external environment and institutional arrangement. However, little was found on how to mitigate these risks.

Risks at the project environment level include market, financial, technological, management, technical and operational risks (Datta and Mukherjee 2001; Dey 2009; Gil 2009; Perera, Dhanasinghe and Rameezdeen 2009; Siebert 1987). Market risks basically relay to large margin of error associated with projecting cost and revenue over long periods, which is usually the case in large-scale, long term projects (Dey 2009). Financial risks essentially relate to high level of capital loss or gain due to high level of uncertainty associated with the type of projects under discussion. The size of loss or gain will be proportionate to the size of invested capital (Dey 2009; Gil 2009; Perera, Dhanasinghe and Rameezdeen 2009). Technological risks principally convey to use of new technologies that might be neither fully tested nor available, like using new construction materials or techniques or using a new transportation system (Datta and Mukherjee 2001; Dey 2009; Siebert 1987). Management risks are related to managing the large number of parties involved (public agencies, consultants, contractors, operators, local communities and end-users) and their interdependence for the success of the project (Datta and Mukherjee 2001; Perera, Dhanasinghe and Rameezdeen 2009). Technical risks mainly relay to level of information provided in the preliminaries bill, tentative drawings and scope change (Dey 2009; Perera, Dhanasinghe and Rameezdeen 2009; Siebert 1987). Finally, operational risks are related to functionality of the project, like satisfaction of end-users, proper accessibility and durability of finishing (Dey 2009).

At the level of the external environment, the risks are political, social, environmental and economic risks (Datta and Mukherjee 2001; Dey 2009; Gil 2009; Lehtonen 2004; Perera, Dhanasinghe and Rameezdeen 2009; Siebert 1987; Lehtonen 2004; Senge et al. 2007). Political risks are primarily related to political stability that might affect the

development right over the project. Social risks basically convey to acceptance of local communities of the project, which might heavily impact the project especially if local communities have tendency towards violent reactions against projects that do not meet their expectations (Siebert 1987; Lehtonen 2004; Senge et al. 2007; Senge and Carstedt 2001). Environmental risks primarily relay to the level of environmental regulations that might lead to substantial increase or decrease in project cost (Dey 2009; Siebert 1987; Lehtonen 2004; Senge et al. 2007; Senge and Carstedt 2001). Economic risks are related to unexpected changes in economic indicators and assumptions that might affect the project cost like changes in wages, taxes or inflation (Datta and Mukherjee 2001; Dey 2009; Perera, Dhanasinghe and Rameezdeen 2009; Lehtonen 2004; Senge et al. 2007; Senge and Carstedt 2001).

Risks at the institutional arrangement level include opposition of interest, multidisciplinary nature of projects under discussion, political conflicts, lack of approvals facilitation and over optimism. Opposition of interest between the private sector and the public sector is caused by the fact that private sector is always looking for short term benefits to maximize return on investment, while the public sector looks for long term benefits like achieving sustainability (Koppenjan and Enserink 2009). Large-scale projects are multidisciplinary and require diversified expertise to cover its aspects, which might not be available in the public sector. Despite such expertise being usually provided by the private sector, the public sector still needs to have a fair understanding of these disciplines to structure the deal properly (Sagalyn 2007). Political conflicts are present in contexts where conflicting political parties have decision making power. Such conflicts can lead to either project delay or suspension (Sagalyn 2007). Lack of approvals is mainly found where bureaucracy has a long history: Public authorities who do not benefit directly from the project do not facilitate approvals (Vanmarrewijk et al. 2008). Over optimism is caused by over sighted announcements of the public parties that are involved in the project, in terms of time and budget. This might endanger the project, especially in terms of public acceptance in case of delays.

### **3. Findings**

The studies of the Shamiyah project were found to be arranged along two major tracks: technical and financial. The technical work stream included architectural design, urban design, engineering studies, infrastructure studies, value engineering, technical validation, hydro-geological studies, traffic impact assessment, pedestrian modeling, environmental studies, costing studies and way finding studies. The aim of this track was to come up with a project that is valid from different technical angles. For this purpose, these studies were managed simultaneously to make sure that each study meets the highest professional standards, and that all these studies are synchronized and folds within a single entity defining the technical dimension of the project. Hence, simultaneous management of all these studies that varies in required expertise was highly challenging and involved a high level of risk. In addition, a balance needs to be achieved between requirements of different parties. The requirements of this balance

are not a 'blue print' solution that can be adopted in different projects. Hence, solutions are to be proposed on case by case basis.

The technical track extended over four stages (Figure 1). The first stage entailed preparing six master plan options for the sake of exploring different options that could provide the ultimate development strategy for the project. These schemes were developed based on the challenges and risks that were known in that moment of time and included in the design brief shared with the consultants. After assessing the six schemes, it was found that three options hold value and it was decided to further develop these three options before deciding on the ultimate solution. Based on the assessment of the six schemes and on data received during the course of development of the six schemes, the project's challenges and risks were revised as new information on the project was available. The revision of the challenges and risks were the basis for development and revision of the three schemes. After conclusion and assessment of the outcome of the second stage, it was decided that two competitors shall join forces to develop a single master plan as each of the schemes prepared by those two consultants held its own merit. In the stage to follow, one consultant was selected to develop the scheme. In the latter two stages, the scheme was continuously revisited based on information and feedback received from different stakeholders. The followed approach was perceived to be allowing for identification of the ultimate solution for this highly complex project that holds a large number of uncertainties. Due to its large-scale and number of involved disciplines and systems, the project was highly complex. In addition, as the project was unprecedented in its context in terms of scale, a high number of unforeseeable risks were found.

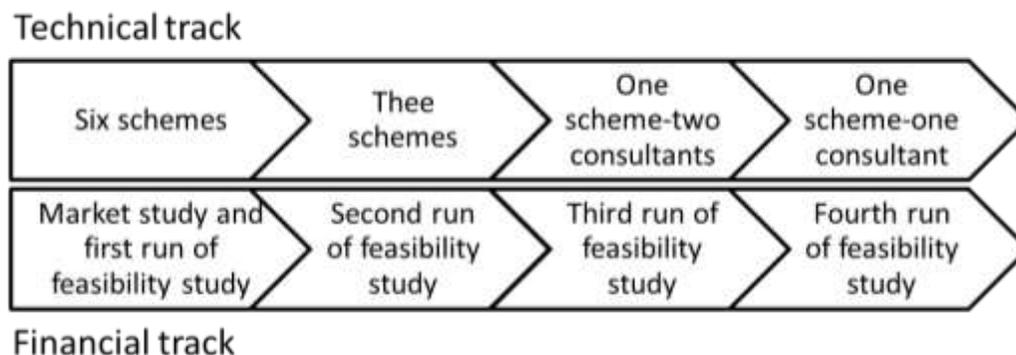


Figure 1: Process followed for studies of the Shamiyah project.

Examples of risks for the technical track along with the role of the adopted process in overcoming these risks were as follows:

- As the project was unprecedented in its context in terms of size and complexity, and therefore, new regulations that were not tested in previous projects were crafted for this project. As an example on these requirements, it was required to include in the project a number of public amenities like schools, hospitals and fire and police

stations. Such risk could not be foreseen as the convenience of such regulations could not be tested prior to initiating the design studies as the only mean to test such regulations is through design. In the course of the first stage, it was discovered that the public authorities exaggerated in requirements related to these amenities as its percentage of total built-up area was high, especially when compared to international benchmarks. In order to overcome this risk, the developed schemes along with international standards were used to demonstrate to the public authorities the convenience of the proposed mixture and size of public amenities, which were less than the requirements. In addition, the multiple options that were provided allowed for smoother negotiations and easier selection of the solution that is convenient to different parties as the authority was able to see directly the physical impact of each of the options.

- Designs of some infrastructure components that are essential to the project were not available during the course of the project, and therefore, the design of these components was added to the scope of the design consultants. This risk was not foreseen, as early in the process, it was confirmed by the public authorities that these designs will be ready during the course of the second design stage; nevertheless, the required designs got significantly delayed, which could substantially impact the project. Similarly to the previous point, provided alternatives were presented to the public authorities for them to select the most convenient solution. Despite the fact that this solution cost some additional money, it allowed avoiding receiving a design that might not be convenient to the project design, post completion of studies.

- Another risk is the presence of qualitative regulations with direct impact on the master. As per the regulations, it is not allowed to have 'major' cut in the terrain in order to conserve the natural characteristics of the area. The impact of this statement was not realized till later in the process as the quantification of the convenient volumes of cut shuffled drastically from one meeting to another, which had a major impact on the master plan. Again, using the different alternatives as a mean of negotiation to better illustrate the physical manifestation of different cut options, an agreement on this front was reached.

The financial track was mainly related to conducting a market study to validate the project program and identify different cost and revenue assumptions to be used in the financial model. This track was run in parallel with the technical one. The formulation process of the project program focused on maximizing capitalization on allowable built-up area while running in parallel the market study that was used to test the business logic of the project. This is due to the fact that demand in Makkah on accommodations in general and hotels is particular is extremely high because of the increase in number of visitors each year and the obvious lack of competition as Makkah is the only pilgrimage destination for the Muslims. This high demand encouraged the developer to initiate design studies to investigate possible options without waiting for results of the market study. The scope of the market study was basically to identify high level economic indicators and cost and revenue assumptions. The high level economic

indicators helped in analyzing profile of users in order to accommodate for their needs in the master plan. Despite the fact that the uses were set based on regulations, the typologies of units for each use were defined based on the outcome of the market study. In addition, the cost and revenue assumptions were investigated to provide necessary assumptions for the feasibility study that helped in optimizing the return rates of the project and assessing the feasibility of the developed design schemes. Furthermore, the feasibility study helped in confirming that the formulated project program based on the maximum allowable built-up area was financially feasible. Based on the outcome of the technical assessment for design solutions and the preliminary feasibility study, three alternatives were developed in the second stage, during which a second run for the feasibility study took place. During the final two stages, during which the final design solution was formulated, two additional runs for the feasibility were conducted in order to continuously monitor the financial performance of the scheme and to identify the expected return on investment for the final design. This track also entailed a number of unforeseeable risks. The following are examples of these risks:

- As Makkah is a prime location, value of real estate properties continuously increases, which increases the capital required for land acquisition. Hence, the acquisitions budget could not be fixed early on, especially that the inflation of real estate prices in Makkah cannot be projected due to irregular increase of prices in previous years. Furthermore, public authorities enforced compensation to local residents on the basis of discounted income stream of the property and not on asset value basis, in order to ensure a fair compensation. As many parameters are involved in this methodology, early identification of such budget was not possible. When the government finished evaluation of properties, the compensation budget was found to be very high; this could endanger the financial feasibility of the project. As an example, the price per meter square of land directly located on the Haram boundaries was one hundred fifty thousand dollars in 2003. By mid of 2006, it reached two hundred fifty thousand dollars. In order to overcome this risk, the investor and the project manager decided to invite the major land owners in the project area to enter the project as contributors in kind with their land value. Despite the fact that such measure increased the number of shareholders and reduced the percentage of ownership of initial developers, it helped in keeping the project feasible. Such measure has its own risk as the number of stakeholders increased, which could complicate the decision making process later on. In order to avoid such risk, the group decided to include the development strategy within the partnership agreement in order to preserve the decision making ability for the investor.

- Prior to 2008, the construction cost in Saudi Arabia substantially increased due to the real-estate boom that was taking place. When the project started in 2003, such extravagant increase was not foreseen as such increase in construction cost was not noticed in the recent years. Due to its large size, this could have a major impact on the financial feasibility of the project. In order to overcome this risk, cost estimators were continuously revisiting the project budget as the increase in cost did not follow recent trends.

- From a market perspective, the size of the project was a risk by itself as the developer was not sure if the market can absorb such project as the project was unprecedented in its context. In order to overcome this risk, different phasing scenarios were developed in order to accommodate with any unforeseen market changes. Phase one of the project was substantial enough in size in order to achieve the statement that the developer is looking for.

#### **4. Applicability of selectionism and trial and error theories in large-scale projects**

Risks that were faced in the case study are mostly unforeseeable due to its complexity and uniqueness, which renders databases generated out of previous projects obsolete. This was found to be similar to the context of identified literature, in which selectionism and trial and error theories were discussed. Nevertheless; the analysis of the nature of the identified risks lead to the conclusion that unpredictability in the context of the case study is twofold: unforeseeable in kind and unforeseeable in impact ( Figure 2).

The first category is related to risks that were not predicted from the beginning of the project as there were no early indications for the presence of these risks. Risks like unreasonable regulations and unprecedented increase in construction cost that were explained in the earlier section could not be predicted. The first risk could not be identified till the design is already underway and the second was an unusual event that could not be traced based on recent trends.

The latter category is related to risks that could be foreseen in terms of likelihood of occurrence while the impact of the risk when realized could not be identified. Risks like lack of design for crucial infrastructure components, qualitative regulations and large-scale of the project were considered as potential risks without identifying the impact of these risks. As an example, the presence of qualitative regulations was considered as alarming from the early beginning; nevertheless, the impact of this risk could not be predicted early on as the project manager cannot know how the public authorities will use such regulations. In addition, the risk of land prices was known from the beginning; yet, the impact of such risk on the project could not be known prior to completion of properties evaluation as Makkah is a unique place and the adopted method of evaluation was also unique.

These two different categories of unpredictability combined with the complexity component of large-scale development projects have implications on the approach to be selected for risk management. In first category, the full blindness of the risk implies adopting the trial and error approach as in case of adopting parallel tracks, the number of such tracks will be infinite as parameters are not available to define the most likely scenarios in such a case. For the latter category, selectionism would make more sense provided that no budget constrain is present as this will allow the managers of these

projects to test different possible solution based on predefined scenarios in order to select the most convenient solution. As both risk types were found within the same project, the structure within which these two approaches could be applied was formulated based on analysis of findings.

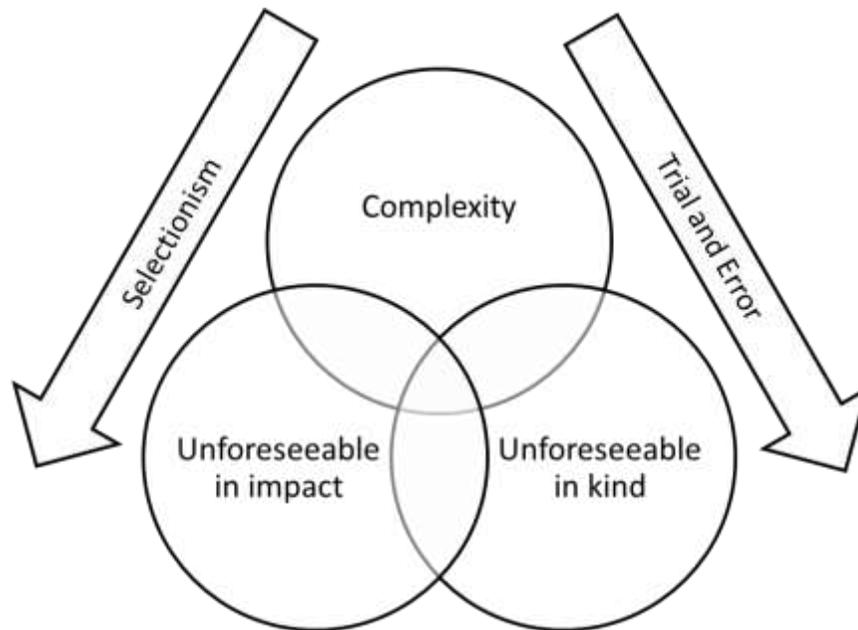


Figure 2: Conceptual applicability of the selectionism and trial and error in the context of large-scale development projects

As per the findings, the studies went through multiple stages that could be conceptualized as follows: multiple options, narrowed options and single option stages. The scenarios of the first stage were formulated based on risks and challenges defined at this stage. Identified risk were known to be a possibility without identifying the impact of these risks as large-scale projects hold a high level of uniqueness that renders databases generated out of previous of projects obsolete. In addition, the selected scenarios were revised before launching the narrowed options stage as more data became available, which allowed for enhancing the scenarios and even drastically changing some of them. Accordingly, despite the obvious application of selectionism during the first two stages, the definition of the scenarios involved the trial and error approach as the scenarios were revised based on newly available information by the end of early stages. During the last stage, a single scenario is adopted; yet, this scenario was continuously revised based on received information from different stakeholders and changes in the project context whether political or economic. Therefore, the adopted practices for this stage fall under the trial and error approach.

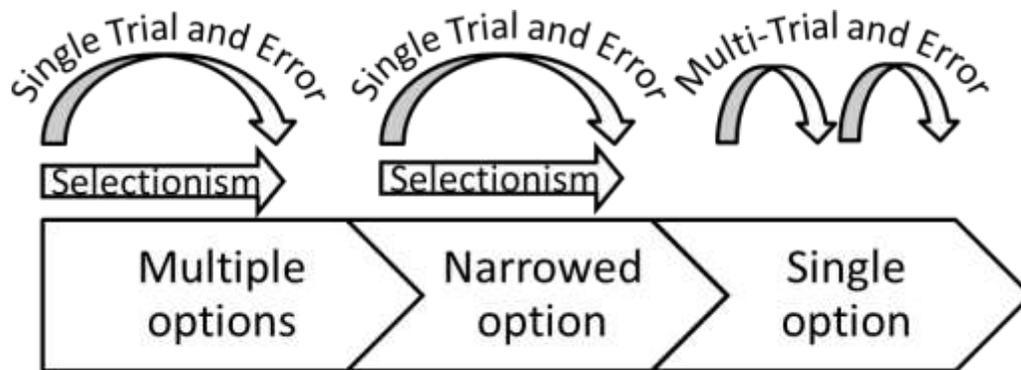


Figure 3: Structure of application for selectionism and trial and error in the context of large-scale development projects.

In brief, both approaches that are discussed in literature for risk management of complex projects with high level of uncertainty are applicable to the context of large-scale development projects. The applicability is dependent on the nature of the risk whether it is unforeseeable in kind or in impact while satisfying the complexity requirement in both cases. In addition, even in the multiple-option stages, in which the selectionism approach is adopted, the definition of the scenarios involves the trial and error approach. The trial and error approach is also adopted in the final stage of the design involving the development of a single solution derived out of lessons learned in the previous stages.

## Conclusion

This paper contributed to the body of literature related risk management of large-scale development projects. It brought the intellectual discourse related to selectionism and trial and error theories to the context of large-scale development projects and added a differentiation aspect on this front by distinguishing between risks that are unforeseeable in kind as opposed to those unforeseeable in impact. This paper shall be considered as a trigger for further development of risk management theories within the context of large-scale development projects, more so since literature still contain a number of gaps on this particular topic, especially in terms of models that could make current practices related to selectionism and trial and error more efficient.

Like any research work, this paper has limitations. As this is a case study research, its results are based on analyses of a single case study; hence, when analyzing dissimilar cases, results may vary. Though observations and progress reports were used, interviews were the main source of data. In addition, interviewed managers had to rely on their memory to answer questions. Therefore, they may have forgotten some events; hence, these were not included in collected data.

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